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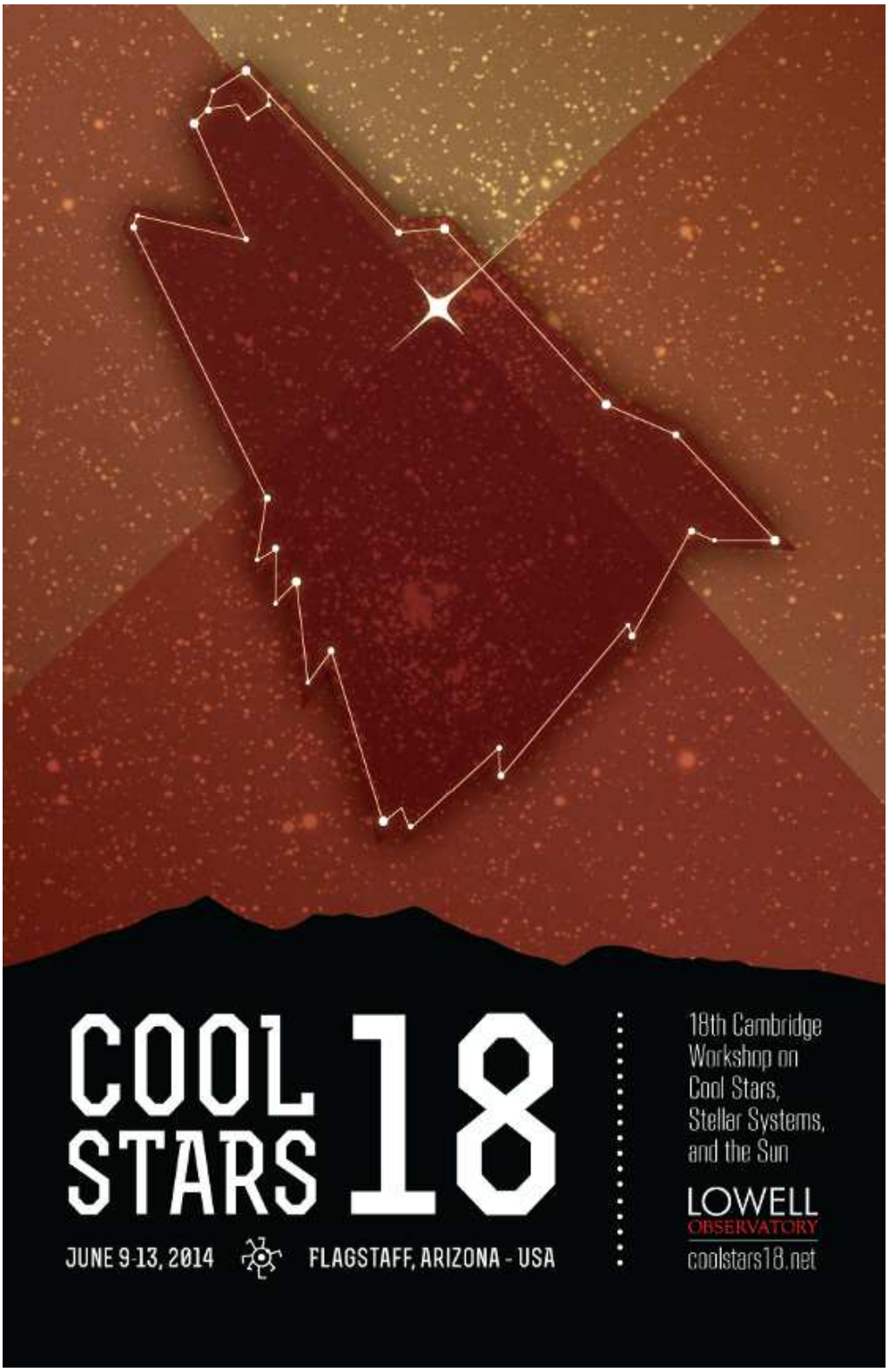
COOL STARS 18
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CS18 bags full of goodies awaiting the conference.

18th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun
Proceedings of Lowell Observatory (9-13 June 2014)
Edited by G. van Belle & H. Harris

Foreward

Gerard van Belle[1]

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A piece of advice: delete the fake Latin before inserting your own text and then compiling the LaTeX/PDFLaTeX.

Gerard van Belle opens up the Cool Stars 18 meeting.

18th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun
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The transition between X-ray emission regimes in the M34 open cluster

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Abstract. I report on a correlation between the saturated and non-saturated regimes of X-ray emission and the rotation sequences that have been observed in the M34 open cluster from extensive rotation periods surveys. An interpretation of this correlation in term of a transition between different dynamo regimes in the early stage of evolution on the main sequence is proposed.

1. Introduction

The present paper summarises the results of a study of the X-ray coronal emission in the M34 open cluster. M34 (NGC 1039) is located at a distance of about 470 pc (Jones et al., 1996). Its metallicity is close to solar (Schuler et al., 2003). Its age between 177 Myr (Meynet et al., 1993) and 251 Myr (Ianna & Schlemmer, 1993) is intermediate between that of the Pleiades ($\sim$ 125 Myrs) and that of the Hyades ($\sim$ 625 Myrs).

While stars in the Pleiades rotate at rates between 0.2 and 10 days (Hartman et al., 2010), stars in the Hyades are in general much slower rotators (Delorme et al., 2011). During the $\sim$ 500 Myrs time interval that separates these two clusters, late-type stars such as those present in M34 thus undergo significant changes in their surface rotation rate. These changes are the visible signature of modifications of their internal rotation profiles. These, in turn, could affect the dynamo processes that operate in their interiors, possibly altering the level of magnetic activity in their outer atmospheres. The purpose of the study was to look for the X-ray signatures of such possible modifications.

2. Observations

M34 was observed with the EPIC pn and the two EPIC MOS cameras on board the *XMM − Newton* space observatory (Jansen et al., 2001) The EPIC pn and MOS exposure times were 42 ksec and 39 ksec, respectively (see Fig. 1). A "thick" aluminum filter was used in front of the cameras to reject visible light from the stars. Detection was made of 189 X-ray sources that are listed in the *XMM − Newton* Serendipitous Source Catalog (Watson et al., 2009).

The X-ray data were complemented with recent measurement results of stellar rotation periods. The *XMM − Newton* X-ray source list was first correlated

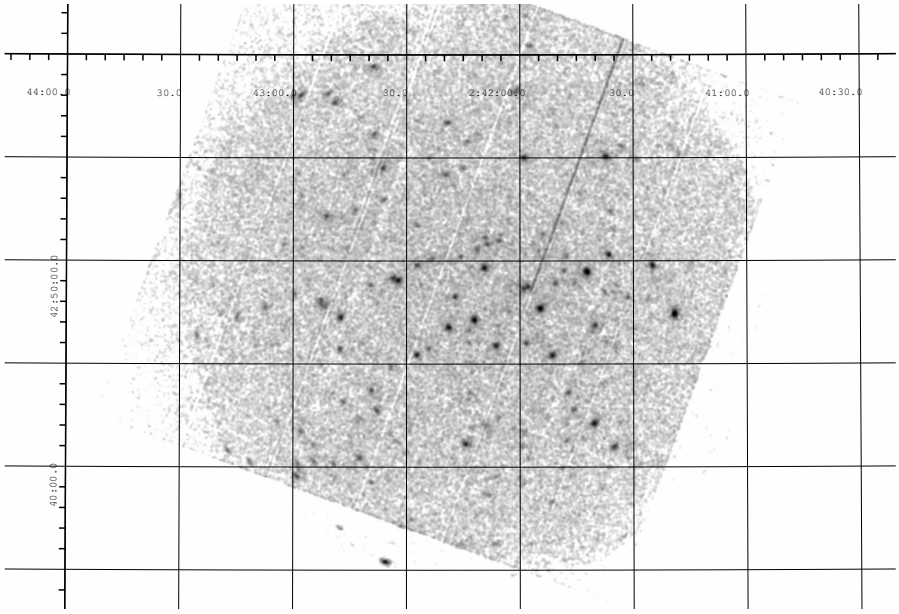

Figure 1.: Combined MOS1, MOS2, and PN image of NGC 1039 in the 0.5 to 4.5 keV band.

with the list of 83 kinematic and photometric late-type M34 cluster members with known rotation periods established by Meibom et al. (2011). It was then correlated with the results of a time series photometric survey of M34 in the V- and i- bands reported by Irwin et al. (2006). Finally, the list was correlated with the list of 55 solar-type stars in M34, whose rotation periods were derived from differential photometry by James et al. (2010). In total, 41 stellar members of the M34 open cluster have been found that have known rotational periods and for which X-ray emission has been detected.

X-ray fluxes were derived from the source count rates using energy conversion factors (ECF). These ECFs were calculated using the Portable, Interactive, Multi-Mission Simulator (Mukai, 1993) in the 0.5-4.5 keV range for optically thin plasmas with temperatures comparable to those found in the spectral fitting of active stellar coronae (Gondoin, 2006). The absorbing hydrogen column density towards M34 was estimated from the reddening correction $E_{B-V} = 0.07$ (Canterna et al., 1979) to about 3.4×10^{20} cm^{-2}. For absorbing hydrogen column densities lower than 10^{21} cm^{-2}, the energy conversion factor of the EPIC pn camera equipped with a thick filter in the 0.5-4.5 keV band is flat and well approximated by ECF $= 3.7 \times 10^{11}$ counts erg^{-1} cm^2 for plasma temperatures in the range (4-25) $\times 10^6$ K (Gondoin, 2006). The X-ray fluxes were then converted into stellar X-ray luminosities assuming a distance of 470 pc (Jones et al., 1996).

3. Analysis

The X-ray luminosities of F5 through M5 main-sequence stars relative to their bolometric luminosities have been found to depend on their Rossby numbers (Patten & Simon, 1996); (Randich, 2000). This number ($Ro = P_{\rm rot}/\ \tau_{\rm c}$) is an

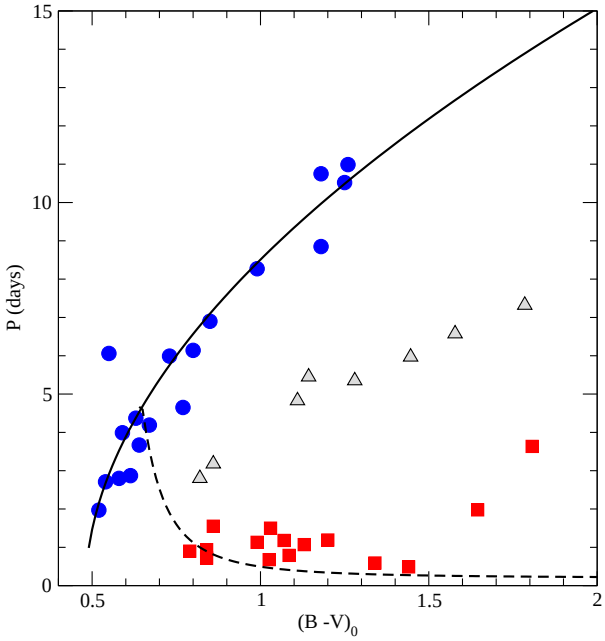

Figure 2.: Rotation periods vs. (B−V) indices of the M34 sample stars. The solid line represents the I sequence defined by Barnes (2007). The dashed line represents the C sequence determined by Meibom et al.(2011). M34 stars represented as blue circles and red squares were classified as I and C sequence stars, respectively. Grey triangles represent gap stars assumed to be evolving from the C to the I sequence.

important indicator in hydromagnetic dynamo theory that measures the extent to which rotation can induce both helicity and differential rotation, which are considered essential for a solar-type dynamo. While the stellar rotation period $P_{\rm rot}$ can be directly measured, $\tau_{\rm c}$ is sometimes derived from the mixing-length theory (Kim & Demarque, 1996) and usually empirically determined. A relationship between stellar mass and convective turnover time was recently derived by Wright et al. (2011) that is valid over the range 0.09 $M_{\odot} < M <$ 1.36 $M_{\odot}$. It is scaled such that values of $\tau_{\rm c}$ for solar-mass stars match those of Noyes et al. (1984) for the Sun. This relationship was used to estimate the Rossby numbers of the sample stars.

Young stars tend to group into two main sub-populations that lie on narrow sequences in diagrams where the measured rotation periods of the members of a stellar cluster are plotted against their B − V colors (Barnes, 2003); (Meibom et al., 2009). One sequence, called the I sequence, consists of stars that form a diagonal band of increasing period with increasing B − V color. In young clusters, another sequence of ultra-fast rotators called the C sequence, is also

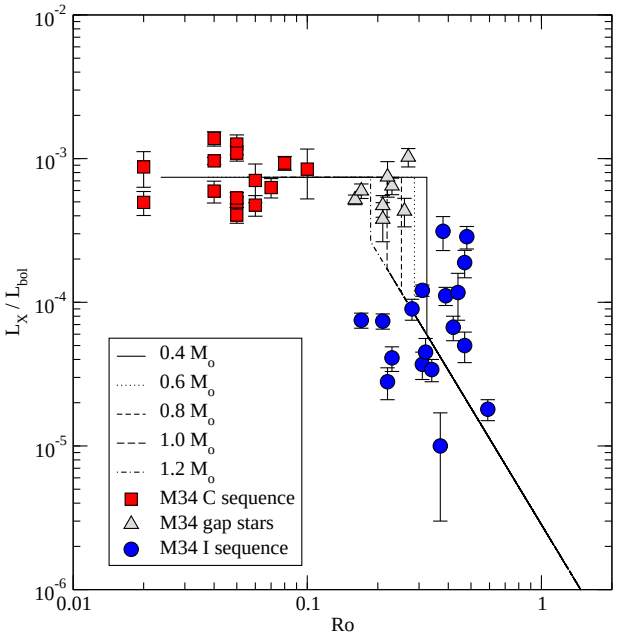

Figure 3.: X-ray to bolometric luminosity ratio vs Rossby number of the sample stars compared with a model of X-ray activity evolution (Gondoin 2013) for stars with masses between 0.4 and 1.2 $M_\odot$ having an initial period of rotation of 1.1 days on the ZAMS.

observed, bifurcating away from the I sequence towards shorter rotation periods. Some stars lie in the intervening gap between the I and C sequences.

Figure 2 shows the rotational periods $P_{\rm rot}$ of the sample stars as a function of their reddening corrected $(B - V)_0$ indices. It also displays the rotational isochrones of the I and C sequences. Their functional forms were first introduced by Barnes (2003a). For the I sequence, I used the form subsequently modified by Barnes (2007) in line with the gyrochronology analysis of M34 performed by (Meibom et al., 2011). The proximity of the M34 data points to these curves was used to determine their membership to the C and I sequences or the gap between them.

Figure 3 displays the X-ray to bolometric luminosity ratio vs Rossby number diagram of the M34 sample stars, distinguishing members of the I sequence, of the C sequence and of the gap. It shows a correlation between the X-ray emission regimes and rotation sequence classification. Indeed, members of the C sequence have small Rossby numbers ($Ro < 0.1$) and X-ray to bolometric luminosity ratios close to the 10^{-3} saturation level. Members of the I sequence, in contrast, have larger Rossby numbers ($Ro \geq 0.17$) and X-ray to bolometric luminosity ratios significantly smaller than the saturation limit.

Gap stars occupy an intermediary position in the L_X/L_{bol} vs. Ro diagrams. On the one hand, gap stars have Rossby number ($Ro \geq 0.17$) in the same range as those of some I sequence stars. They would therefore be expected to operate in a non-saturated regime of X-ray emission. On the other hand, their X-ray to bolometric luminosity ratio is similar to those of C sequence stars, i.e., close to the saturation level.

4. Discussion

A correlation between rotation sequences (see Fig. 2) and X-ray emission regimes (see Fig.3) is observed among main sequence stars in the M34 open cluster. A steep transition in the L_X/L_{bol} ratio is detected between the C sequence and gap stars that emit close to the 10^{-3} saturation level, and the I sequence stars, whose L_X/L_{bol} ratio is significantly lower. The L_X/L_{bol} ratio is a lower limit of the ratio between the surface magnetic flux and the outer convective flux (Gondoin, 2012). A decrease of this ratio around $Ro \approx 0.14$ - 0.4 is thus indicative of a drop in dynamo efficiency.

Independently from any specific model of stellar rotation evolution, the clustering of main-sequence stars in M34 into fast and slow rotation sequences in period vs colour index diagrams, and the low density of stars in the gap indicate that stars spend less time in this part of the diagram than on the C and I sequences. The transition from the C to the I sequence thus constitutes an evidence for a brief phase of strong surface rotation deceleration among some of the late-G and K type stars in M34. Such a decay is most likely due to rotational braking by stellar wind. If the magnetic field lines that sling charged particles from the wind into space are rooted in the photosphere, the convective envelope rotation should be decelerated by the wind torque more efficiently than the radiative core which is kept in rapid rotation by the conservation of angular momentum . Young stars shall thus develop a strong gradient in angular velocity at the base of the convection zone. Such a gradient is an essential ingredient for the generation of an interface dynamo at the base of the convection zone (Spruit, 2002).

According to a scenario described in Gondoin (2013), the correlation between rotation sequences and X-ray emission regimes would thus result from the co-existence of two dynamo processes among M34 stars, i.e. a boundary-layer interface dynamo and a convective envelope turbulent dynamo. This last process dominates in rapidly rotating C sequence stars. As the shear between the fast spinning radiative interior and the convective envelope increases during the transition of gap stars from the C to the I sequence, another process strengthens in which dynamo action occurs in the boundary region between the radiative core and the convective envelope. This dynamo process relies on differential rotation, but also induces important redistributions of angular momentum. As the stars reach the I sequence and the rotation of their convective envelope decays, the turbulent dynamo is quenched and the interface dynamo becomes dominant, decreasing progressively at later stages of evolution when rotation dies away.

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Our Cool Stars 18 'Great Debaters', Martin Asplund and Marc Pinsonneault.

Natalie Hinkel covered the details of her Hypatia database.

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Lithium abundance and rotation in the Pleiades and M34 open clusters

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Abstract. K-type stars of similar effective temperatures in clusters younger than about 250 Myrs are characterised by a wide dispersion in lithium abundance whose origin is not understood.

Photometric monitoring programs indicate that young stars tend to group into two main populations that lie on narrow sequences in diagrams where the measured rotation periods of the members of a stellar cluster are plotted against their (B - V) colours.

I report on the results of a study that investigated the dependence of lithium abundance with effective temperature distinguishing stars that belong to different rotation sequences in the Pleiades and M34 open clusters.

1. Introduction

Photometric monitoring programs have produced a large number of rotation period measurements in open clusters, including the Pleiades (Hartman et al., 2010) and M34 (Meibom et al., 2011). These measurements have shown (Barnes, 2003) that members of young stellar clusters tend to group on narrow sequences in diagrams where the measured rotation periods are plotted against masses or $B-V$ colour indices. I revisited the connection between Li abundance and rotation in the Pleiades and M34 open clusters in light of these new rotation rate measurements (Gondoin 2014).

2. Li abundances and stellar rotation periods measurements

2.1 The Pleiades

Recently, Hartman et al. (2010) conducted an extensive photometric time-series survey of the Pleiades based on the membership list of Stauffer et al. (2007). Rotation periods were measured on 368 stars with $0.4 \leq M/\mathrm{M}_{\odot} \leq 1.3$. I cross-matched these data with lithium abundance measurements in the Pleiades retrieved by King et al. (2000). The colour indices of the resulting 64 sample stars are in the range $0.5 < (\mathrm{B}-\mathrm{V})_0 < 1.33$ which corresponds to late-F, G, and early-K spectral types and to masses between 0.7 and 1.3 $\mathrm{M}_{\odot}$. All these stars have reached the main sequence since their Kelvin-Helmholtz contraction timescales is shorter than their age of about 100−150 Myrs (Stauffer, 2010).

2.2 The M34 open cluster

Lithium abundances in M34 were derived by Jones et al. (1997) from a high resolution spectroscopy study of stars with high membership probabilities. I correlated these data with the list of 83 kinematic and photometric late-type M34 cluster members with known rotation periods established by Meibom et al. (2011), with the results of a time series photometric survey of M34 reported by Irwin et al. (2006), and with the list of 55 solar-type stars in M34, whose rotation periods were derived from differential photometry by James et al. (2010). In total, 23 stellar members of the M34 open cluster have been found that have known rotational periods and Li abundances. Their colour indices in the range $0.55 < (B-V)_0 < 1.23$ and age estimate between 177 Myrs (Meynet et al., 1993) and 251 Myrs (Ianna & Schlemmer, 1993) indicate that these stars have reached the main sequence.

3. Analysis

3.1 Classification into rotation sequences

Observations of main sequence stars with G and K spectral types in young open clusters ($\sim$ 100-200 Myrs) show clear evidence for two distinct sequences of fast and slow rotators in period vs mass or $(B-V)$ colour index diagrams (Hartman et al., 2010). These rotation sequences are called hereafter the C and the I sequence along the paradigm advanced by Barnes (2003).

Figure 1 (bottom) plots the rotational periods P of the M34 sample stars as a function of their reddening corrected $(B-V)_0$ indices. It also displays functional forms of the I and C sequences that were first introduced by Barnes (2003). For the I sequence, I used the form subsequently modified by Barnes (2007) in line with the gyrochronology analysis of M34 performed by Meibom et al. (2011). From the data point positions relative to these curves, the M34 sample stars were classified as lying on the C sequence, on the I sequence, or in the gap between these two sequences.

Hartman et al. (2010) compared the mass-period diagrams, which are equivalent to colour-period diagrams, of the Pleiades and four other open clusters with similar ages. They noted that the mass-period diagram of the Pleiades is remarkably similar to that seen by Meibom et al. (2009) for the M35 open cluster which gyro-age ranges from 134 Myrs to 161 Myrs. Figure 1 (top) shows the colour-period diagram of the Pleiades sample stars with known Li abundances. It also displays functional forms of the I and C rotation isochrones derived from the gyrochronology analysis of M35 performed by Meibom et al. (2009). I classified the Pleiades sample stars as members of the C sequence, of the I sequence or of the gap based on their proximity to the 125 Myrs C and I isochrones.

Four stars in the Pleiades and one star in M34 with $(B-V)_0 < 0.7$ could not be classified and are marked by crosses in Fig. 1. These blue and bright objects are most likely close binaries in which the active component is locked into high rotation by synchronisation with the orbital period due to tidal effects.

3.2 Lithium abundance and rotation

The lithium abundances of the Pleiades and M34 sample stars are plotted as a function of their effective temperatures in Fig. 2. The lithium abundance

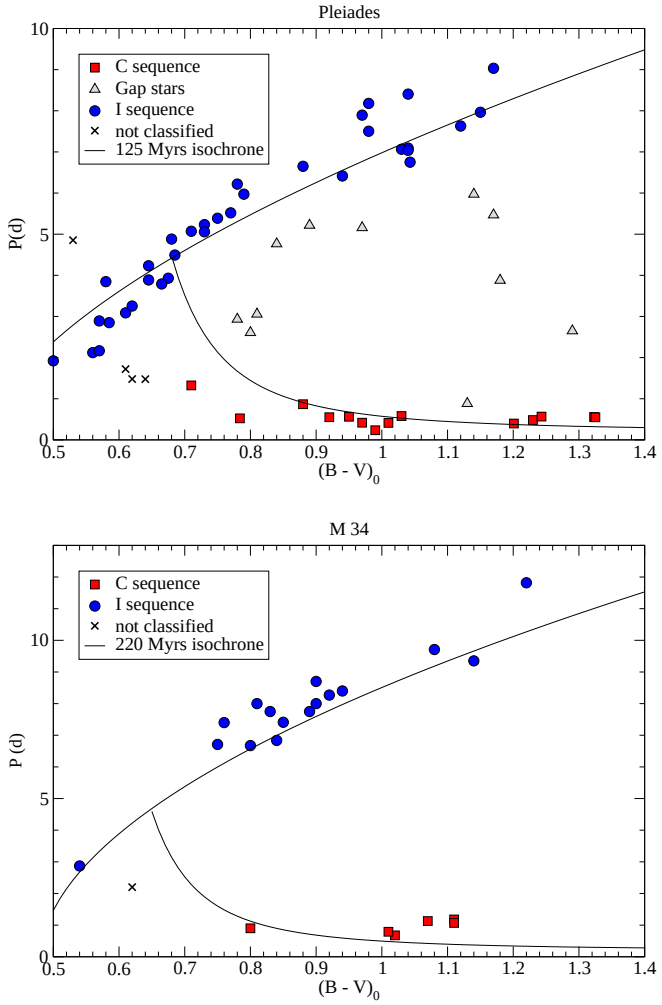

Figure 1.: Rotation periods of the Pleiades (top) and M34 (bottom) sample stars as a function of their $(B-V)_0$ colour indices compared with C and I isochrones.

decreases with effective temperature by nearly three orders of magnitude between 6000 K and 4000 K. This well-known decay is expected from standard models of stellar evolution that predict the attrition of Li as a function of stellar mass, and age. According to these models, pre-main sequence stars with low masses evolving down the Hayashi track develop high enough temperatures at the base of their convection zone for energetic protons to destroy Li there, thereby depleting their surface Li abundance. Reversely, little Li depletion is expected for stars reaching the zero-age main sequence (ZAMS) as A, F, or G dwarfs (Pinsonneault, 1997). Since Li depletion ceases as the surface convection zone recedes toward the surface and its base cools, standard models of stellar evolution also predicts that no further Li depletion occurs on the main-sequence for A, F, and G dwarfs

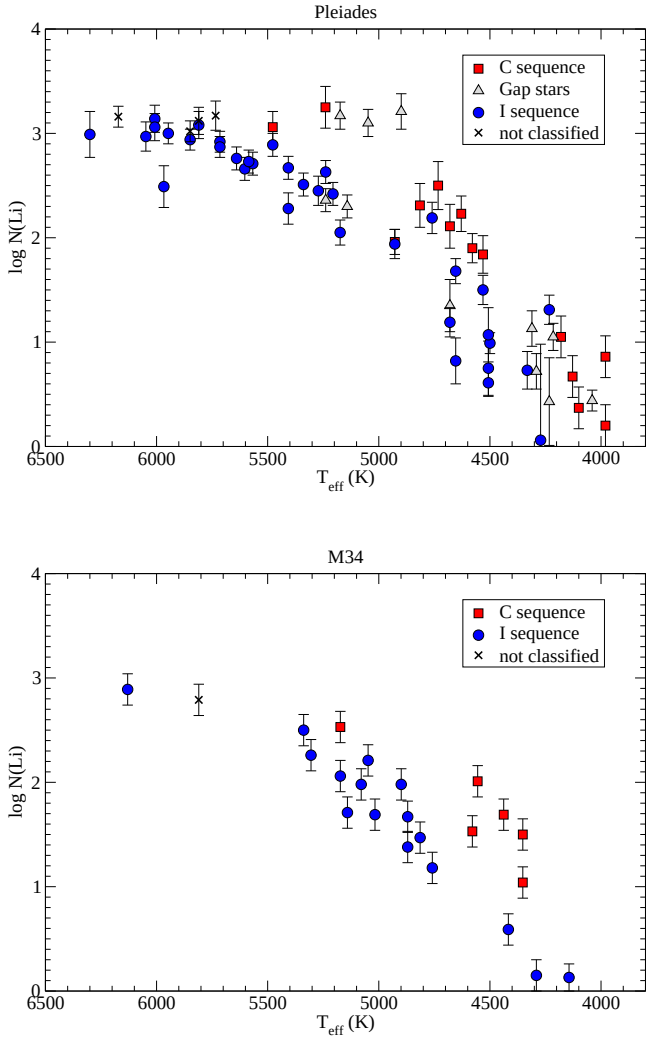

Figure 2.: Lithium abundance vs effective temperature for the Pleiades (top) and M34 (bottom) sample stars.

(Proffitt et al., 1989); (Deliyannis et al., 1990); (Swenson, 1990), whereas K and M dwarfs should continue to deplete Li as they evolve beyond the ZAMS. This prediction is consistent with Fig. 2. Indeed, G-type stars have similar Li abundance in the Pleiades and M34 while K-type stars have in average lower Li abundance in the older M34 cluster. This comparison is justified since the two clusters have similar metallicities (Schuler et al., 2003); (Taylor, 2008).

However, standard models also predict that ^{7}Li depletion in a star is a unique function of age, mass, and metallicity. Figure 2, in contrast, shows that stars with the same T_{eff} in the Pleiades or in M34 have significantly different Li abundances. The scatter in the star-to-star Li abundance is particularly large in the 5500−4000

K temperature range as noted by Jones et al. (1997) in M34 and by Soderblom et al. (1993a), Jones et al. (1996), and King et al. (2000) in the Pleiades. A comparison of the observed scatter in Li abundances with the estimated uncertainties indicates that this spread is statistically significant. Furthermore, Fig. 2 shows that, at any given temperature below 5500 K, C sequence and gap stars in the Pleiades have significantly higher lithium abundances than I sequence stars with the same effective temperature.

4. Discussion

Independently from any specific model of stellar rotation evolution, the clustering of young main-sequence stars into fast and slow rotation sequences in period vs colour index diagrams, their later evolution through the gap towards a single sequence, and the low density of stars in the gap indicate that stars spend less time in this part of the diagram than on the C and I sequences. The transition from the C to the I sequence thus constitutes an evidence for a brief phase of strong surface rotation deceleration among rapidly rotating late-G and K type stars in their early phase of evolution on the main sequence.

The fact that the transition from the C to the I rotation sequence in the Pleiades and M34 is correlated with a drop in Li abundance suggests that the associated decay of the rotation rate is accelerating the depletion of lithium in young late-G and K-type stars. Rotational braking by stellar winds is the commonly accepted explanation for the decay of stellar rotation on the main sequence. Since the magnetic field lines that sling charged particles from the wind into space are rooted in the photosphere, the wind torque is expected to decelerate the envelope rotation while the conservation of angular momentum should keep the radiative core in rapid rotation. Gap stars in young open clusters should thus develop a large shear at the base of their convection zone that triggers various instabilities. Studies indicate that these instabilities drive mass motions or gravity waves that redistribute angular momentum and mix the stellar material enhancing light-element depletion (Chaboyer et al., 1995); (Charbonnel & Talon, 2005); (Talon, 2008).

The dispersion in surface Li abundance observed among K stars in young open clusters could thus result from an acceleration of the Li depletion in rapidly rotating K stars due to shear instabilities at the bottom of the convection zone during a brief episode of strong rotational braking by stellar wind in their early evolution on the main sequence. This scenario explains that no lithium dispersion is observed in the Hyades and Praesaepe star clusters (Soderblom et al., 1993b) since, by the age of these clusters ($\sim$ 700 Myrs), observations show a clear convergence in the angular momentum evolution of all F, G, and K dwarfs towards a single sequence of slow rotators. All the stars have by then experienced a strong rotational braking that accelerated Li depletion and the coolest stars ($T_{eff} < 5000$ K) have fully depleted their lithium.

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Moira Jardine shows the way with stellar activity timescales.

Emily Rice and Lil' Brown Dwarf taking a break.

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High-resolution spectroscopy of Herbig Ae/Be Stars

Alicia Aarnio[1]

[1] *University of Michigan*

Abstract. In a multi-year, high-resolution optical spectroscopic survey, we have observed 60 Herbig Ae/Be stars, the higher mass counterparts of T Tauri Stars (TTS). We present here portions of our spectral atlas, as well as a detailed look at the 30 multi-epoch observations obtained during this program. We discuss our sample in the context of pre-main sequence evolution as a function of stellar mass; specifically, how our present picture of magnetospheric accretion for Herbig Ae/Be stars is diverging from the paradigm envisaged for TTS.

On the origin of stars with and without planets. Tc trends and clues to Galactic evolution

Vardan Adibekyan[1]

[1] *Centro de Astrofsica, Universidade do Porto (CAUP)*

Abstract. We explore a sample of 148 solar-like stars to search for a possible correlation between the slopes of the abundance trends versus condensation temperature, Tc slope, with stellar parameters and Galactic orbital parameters in order to understand the nature of the peculiar chemical signatures of these stars and the possible connection with planet formation. We find that the Tc slope significantly correlates with the stellar age and the stellar surface gravity. We also find some evidence that the Tc slope correlates with the mean galactocentric distance of the stars, indicating that stars originated in the inner Galaxy have less refractory elements relative to the volatiles. While the average Tc slope for planet-hosting solar analogs is larger than that of their counterparts without planets, this difference probably reflects the difference in their age and Rmean. We conclude that the

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age and probably the Galactic birth place are determinant for their chemical structure.

Toward Self Consistent MHD Model of Chromospheres of Late Type Evolved Stars

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[1]*NASA*

Abstract. The chromospheres of cool, evolved stars represent the interface layers between the photospheres and their outer atmospheres, in which the stellar wind forms, and, therefore, should play a critical role in specifying the amount of mechanical energy dissipating into atmospheric heating and in depositing the momentum needed to drive stellar winds. We present a self consistent magnetohydrodynamic (MHD) model of the chromospheric heating and acceleration of the outer atmospheres of cool evolved stars, using alpha Tau as a case study. We use a 1D MHD code with a generalized Ohms law that accounts for the effects of partial ionization in the stellar atmosphere to study Alfven wave dissipation and wave reflection as well as mode conversion effects. In addition, we apply a high resolution grid to fully resolve resistive heating in our model. We conclude that resistive (Joule) dissipation of electric currents, induced by upward propagating non-linear Alfven waves, is the major factor contributing to the heating throughout the stellar chromosphere. We also find that as Alfven waves reach the low chromosphere at 0.05Rstar with plasma beta close to unity, they are efficiently coupled to longitudinal modes, transferring about 1/3 of their energy flux into non-linear slow magnetosonic waves. At the top of the chromosphere, Alfven waves experience significant reflection, producing downward propagating transverse waves that interact with upward propagating waves and produce velocity shear in the chromosphere. The heating rates due to resistive heating and momentum deposition due to non-linear Alfven waves reflected from the top of the chromosphere are consistent with observational

constraints on the net radiative losses and mass loss rates from the wind from cool evolved stars.

Magnetic Interaction of a Super-CME with the Earth's Magnetosphere: Implications for the 770 AD Solar Energetic Particle Event

Vladimir Airapetian[1]

[1] *NASA/GSFC*

Abstract. Usoskin et al. (2013) have recently analyzed AD775 event to demonstrate that it can likely be attributed to a strong solar SEP event. Such an event can be initiated by a solar coronal mass ejection event with kinetic energies 100 times of the most powerful CME event ever observed on the Sun, the super-CME. Recent observations of superflares on solar-like slowly rotating stars suggest that such events may occur with the frequency of 1 event per 800-2000 yr. We have performed a 3D time-dependent global magnetohydrodynamic simulation of the magnetic interaction of such a CME cloud with the Earth's magnetosphere. We calculate the global structure of the perturbed magnetosphere and derive the latitude of the open-closed magnetic field boundary. We also estimate energy fluxes penetrating the Earth's ionosphere and discuss implications for the formation of auroral events and the consequences of energetic particle fluxes on biological systems.

The low mass population of the nearby, large young cluster Cep OB3b

Thomas Allen[1]

[1] *University of Toledo*

Abstract. We present results from an extensive multi-wavelength survey of Cep OB3b, one of the largest young clusters within 1 kpc of the Sun. We estimate that Cep OB3b has a membership of approximately 3000 young stars in a region of 10 x 7 pc (Allen et al. 2012). Similar in membership and overall size to the ONC, Cep OB3b is older and more evolved, with most of the young stars located in a cavity with a V-band extinction of less than 2.5 magnitudes. Star formation is still occurring in the molecular clouds that border the cavity. Literature age estimates for this region give a range between 3 Myr and 6 Myr (Mayne et al. 2007, Littlefair et al. 2010, Bell

et al. 2013). We have compiled an extensive multi-wavelength database of candidate member young stars that are well characterized with spectral types, bolometric luminosities, masses, isochronal ages, X-ray properties and the presence (or lack) of a disk. To construct a precise HR diagram for 700 cluster members, we derive an extinction law for this region between 500 nm and 2.2 um and find it intermediate between that of dense clouds (R 5) and that of the diffuse ISM (R 3). Using the Baraffe (1998) models and assuming a distance of 700 pc give an isochronal age of 3 Myr. We find that certain cluster properties, such as the disk fraction and rotation period distribution, vary spatially across the cluster. We analyze whether these variations are due to environmental differences (such as nearby massive O stars) or a mixture of ages in the cluster. In the case of the disks, we conclude that the variations are due to a mixture of ages.

Searching for the Elusive Substellar Members of Young Moving Groups with Pan-STARRS

Kimberly M. Aller[1]

[1] *IfA/Hawaii*

Abstract. Young moving groups (YMGs) are coeval, comoving groups of young (10100 Myrs) stars that have migrated from their birthsites after formation. They provide a fundamental evolutionary link between ongoing star formation in molecular clouds (1 Myr) and old field stars (¿1 Gyr). While surveys such as Hipparcos, the Digitized Sky Survey, have been used to make significant progress in the past 15 years in identifying the stellar members of YMGs, these surveys were insensitive to the lowest mass, optically faint, members. We have combined Pan-STARRS-1 (PS1) proper motions with opticalNIR photometry from PS1 and 2MASS for the first dedicated, homogeneous search for these elusive substellar YMG members (0.010.08 Msun). PS1 is uniquely suited for such a systematic search because of its large-area sky coverage (30,000 sq degs), precise astrometry, and far-red sensitivity. We have identified candidate young brown dwarf members using a combination of color selection, spectral energy distribution fitting and proper motion analysis. Near-IR spectroscopic followup shows that our combined photometric+astrometric methods are 510x more efficient than past efforts to identify young ultracool dwarfs in the solar neighborhood. Such substellar members of YMGs are valuable benchmarks to empirically define brown dwarf evolution with age and to study the lowest mass end of the initial mass function.

Our new, young brown dwarfs will also be valuable targets for future surveys of brown dwarf binarity and young exoplanet characterization.

Confirming the Age of a Free-Floating Exoplanet Analog

Katelyn Allers[1]

[1] *Bucknell University*

Abstract. We have discovered a nearby (24.6 pc) extremely red (J-K=2.84) late-L dwarf. PSO J318.5-22 is the first free-floating object that is truly an exoplanet analog, as it has colors, spectra and luminosity that are remarkably similar to the directly imaged exoplanets around HR 8799 and 2MASS J1207. Its position and tangential velocity point to possible membership in the 12 Myr old beta Pictoris moving group, which would imply a very low mass (6.5 $M_{\rm Jupiter}$). Here, we present high resolution K-band spectroscopy of PSO J318.5-22. Our analysis includes determination of vsin(i) and radial velocity. With this new data in hand, we reassess the probability that PSO J318.5-22 is a member of the beta Pictoris moving group.

Preparation of the CARMENES input catalogue. Low-resolution spectroscopy of M dwarfs

F. J. Alonso-Floriano[1]

[1] *UCM, Madrid*

Abstract. During the last three years, we have obtained low-resolution (R 1500) spectra of 754 M dwarfs and candidates with CAFOS at the 2.2 m Calar Alto telescope. They come from a number of sources (e.g., Lpine & Gaidos 2011 stars fainter than J = 9 mag, new virtual observatory searches, stars with doubtful spectral typing, etc.). For all of them, we have derived spectral classes and types from comparison with standard stars and from all spectral indices defined in the literature and usable in our wide wavelength coverage from 430 to 830 nm. We have studied how our 31 measured indices vary with gravity, metallicity and activity. We have also measured pseudo-equivalent widths of the Halpha, Hbeta and Hgamma lines in emission, and related them to youth, multiplicity and other chromospheric activity indicators. The least active, brightest, latest M dwarfs are potential targets of

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CARMENES, the radial-velocity exoplanet hunter being built for the 3.5 m Calar Alto telescope.

Herschel survey of brown dwarf disks in rho Ophiuchi

Catarina Alves de Oliveira[1]

[1]*European Space Agency*

Abstract. Recent observations of the rho Ophiuchi cluster (1 Myr) with the Herschel Space Observatory allow us to probe the spectral energy distribution (SED) of the brown dwarf population in the far-IR, where the disk emission peaks. We detected 12 Class II brown dwarfs with Herschel, which corresponds to one-third of all currently known brown dwarf members. We performed aperture photometry at 70, 100, and 160 micron, and constructed their SEDs,complemented with ancillary photometry at shorter wavelengths. We compared the observed SEDs to a grid of synthetic disks produced with the radiative transfer code MCFOST, and used the relative figure of merit estimated from the Bayesian inference of each disk parameter to analyse the structural properties. Comparison to models reveals that the disks are best described by an inner radius between 0.01 and 0.07AU, and a flared disk geometry with a flaring index between 1.05 and 1.2. Furthermore, we can exclude values of the disk scale-height lower than 10 AU (measured at a fiducial radius of 100 AU). We combined the Herschel data with recent ALMA observations of the brown dwarf GY92-204 (ISO-Oph-102), and by comparing its SED to the same grid of disk models, we derived an inner disk radius of 0.035AU, a scale height of 15AU with a flaring index of 1.15, an exponent for dust settling of -1.5, and a disk mass of 0.001Msun. This corresponds to a disk-to-central object mass ratio of 1%. We conclude that the structural parameters constrained by the extended SED coverage (inner radius and flaring index) show a narrow distribution for the young brown dwarfs

detected in rho Ophiuchi, suggesting that these objects share the same disk evolution and, perhaps, formation. [2013A&A...559A.126A]

Searching for Extrasolar Planets with the Owens Valley LWA

Marin M. Anderson[1]

[1] *California Institute of Technology*

Abstract. We present initial results of a high-cadence full sky radio imaging survey of exoplanet transients using the Owens Valley Long Wavelength Array (LWA), a low frequency (20-80 MHz) 256-element dipole array. The LWA's full cross-correlation and all-sky field-of-view provides the sensitivity needed to detect extrasolar planets through their coherent radio emission. Magnetized planets in our solar system produce extremely bright, highly polarized, coherent radio emission at low frequencies attributed to electron cyclotron maser emission. The detection of similar emission from an extrasolar planet represents the most promising method for directly measuring their magnetic fields and true rotation rate.

HI lines in Young Stellar Objects: a probe of accretion and circumstellar properties

Simone Antoniucci[1]

[1] *INAF - Osservatorio Astronomico di Roma (Italy)*

Abstract. HI recombination lines at optical/near-IR wavelengths are a powerful diagnostic tool for the study of accreting Young Stellar Objects (YSOs). On the one hand these lines are commonly used as a tracer of the mass accretion process, on the other hand they can also be employed to probe the physical properties of the gas in the circumstellar structures. A first example of the possible use of HI lines is given by the POISSON project (Protostellar Optical-Infrared Spectral Survey On NTT), a large low-resolution spectral survey of 150 YSOs from five different star-forming regions. In this work we used the near-IR HI lines as a proxy for the mass accretion rate (using empirical relationships connecting line flux to the accretion luminosity), thus obtaining a large database of values, which allowed us to study the temporal evolution of the accretion rate. A different application of results from HI lines involves the analysis HI decrements (i.e. the flux ratio of the

lines of a series relative to one used as reference). VLT/X-Shooter with its broad wavelength coverage and moderate spectral resolution is the perfect instrument to study the HI decrements of the Balmer, Paschen, and Brackett series. Based on X-Shooter spectra of a sample of YSOs in Lupus, I will discuss the potential and limitations of the decrement analysis. In particular, I will focus on the correlations between the decrement shape, the observed line profiles, and the (stellar and accretion) properties of the objects.

Low-resolution optical spectra of ultracool dwarfs with OSIRIS/GTC

Antoaneta Antonova[1]

[1]*Dept. of Astronomy, St. Kl. Ohridski University of Sofia*

Abstract. In a pilot project including ultracool dwarfs and late-M candidates from the 2MASS database, we have obtained low-resolution spectra with the OSIRIS instrument at the Gran Telescopio Canarias (GTC), La Palma. As a result, the 7 late-M dwarf candidates were spectrally classified and H alpha equivalent widths were measured. The ratio of H alpha to bolometric luminosity was calculated. The latter is the most common characteristic of magnetic activity in cool stars. The M8.5 dwarf LP 326-21 showed consistent levels of emission, as compared to those in the literature, while 2MASS 1707+64, also M 8.5, showed variable levels of H alpha emission as found in previous studies.

Activity-Rotation relation in the young cluster h Per

Costanza Argiroffi[1]

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Abstract. The activity-rotation relation in PMS stars is still an open issue. To bridge the gap between the well constrained case of MS stars and the puzzling case of very young PMS stars, we studied the activity-rotation relation in the young cluster h Persei. Because of its age (13 Myr) h Per contains both fast and slow rotators, allowing us therefore to test the different regimes of stellar dynamo. We analyzed a deep Chandra/ACIS-I observation to constrain the activity level of h Per members. Rotational periods were derived by Moraux et al. (2013) in the framework of the MONITOR

project (Aigrain et al. 2007; Irwin et al. 2007). From the comparison of the 1002 detected X-ray sources, and the 586 h Per members with measured rotational period, we obtained a final catalog of 201 h Per members with measured X-ray luminosity (ranging between 3.5x10^{2}9 and 1.1x10^{3}1 erg/s) and rotational period (ranging between 0.13 and 15.9 d). We find clear evidence for supersaturation in stars with mass between 1.0 and 1.4 $M_{\rm sun}$. This phenomenon is unobserved for lower mass stars.

Exploring deconvolution techniques of M-dwarf spectra

Pamela Arriagada[1]

[1] *DTM, Carnegie Institution of Washington*

Abstract. Doppler spectroscopy is uniquely able to find terrestrial mass planets and Solar System analogs around the nearest 2,000 stars within 50 pc. Only Doppler programs that can achieve 1 m/s precision will continue to find terrestrial mass planets in this decade. This work aims to improve the Doppler precision currently obtained with high resolution systems (Keck/HIRES and Magellan/PFS) on nearby late K and early M dwarfs, where one of the main weak spots of the velocity extraction code (Butler et al. 1996) lies in the deconvolution of the template spectra used in the modeling process, due to the lack of continuum these spectra present. A number of different deconvolution techniques that are found in the literature are explored, and their resulting precision are compared against each other.

Multiplicity of Planets Among the Kepler M Dwarfs

Sarah Ballard[1]

[1] *University of Washington*

Abstract. The Kepler data set has furnished more than 130 exoplanetary candidates orbiting M dwarf hosts, nearly half of which reside in multiply transiting systems. I investigate the proposition of self-similarity in this sample, first posited by Swift et al. (2013) for the analysis of the 5-planet system Kepler-32. If we compare the predictions of a single mode of planet multiplicity and coplanarity to the Kepler sample, we find that the population of systems with two planets or more is well-replicated. However, the num-

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ber of singly-transiting systems remains too high to be consistent with this proposition, even accounting for a higher false positive rate among systems exhibiting only one periodic transit. I investigate astrophysical explanations for this feature of Kepler's multiple planet population orbiting small stars, and explore whether the data set supports two distinct modes of planet formation around M dwarfs. I discuss the relative unlikelihood of select bias or unusually high false positive rates as an explanation, in contrast.

Bridging the gap on tight separation brown dwarf binaries

Daniella C. Bardalez Gagliuffi[1]

[1] *UCSD*

Abstract. Multiplicity is a key statistic for understanding the formation of very low mass (VLM) stars and brown dwarfs. Currently, the separation distribution of VLM binaries remains poorly constrained at small separations (¡ 1 AU), leading to uncertainty in the overall binary fraction. We approach this problem by searching for late M/early L plus T dwarf spectral binaries whose combined light spectra exhibit distinct peculiarities, making their identification independent of separation. We define a set of spectral indices designed to identify these systems, and use a spectral template fitting method to confirm and characterize spectral binary (SB) candidates from a library of 738 spectra from the SpeX Prism Spectral Libraries. We present ten new binary candidates, confirm two previously reported candidate and rule out two previously identified candidates, all with primary and secondary spectral types between M7-L7 and L8-T8 respectively. We find that blue L dwarfs are the primary contaminants in our sample and propose a method for segregating these sources. If confirmed by follow-up observations, these

systems may potentially add to the growing list of tight separation binaries, giving further insight into brown dwarf formation scenarios.

A unified model for rotation, coupling, desaturation, and angular momentum loss from cool stars

Sydney A. Barnes[1]

[1] *Leibniz Institute for Astrophysics*

Abstract. A model is presented for internal coupling in cool stars that also describes the rotational aspects of magnetic saturation, implying that the two phenomena (coupling and de-saturation) are equivalent. Correspondingly, rotational stellar models should not explicitly include both. The key transition in the model is also coincident with the transition in X-Ray flux from saturated to unsaturated regimes. The model provides a new formulation of the rate of loss of angular momentum from cool stars, significantly different from the Kawaler (1988) formulation and subsequent ones. The loss rate is maximal during the rotational transition in cool stars, and declines towards zero at the highest rotation rates. Correspondingly, the mass loss rates from cool stars are predicted to decline precipitously during their phase of fast rotation. The integrated mass loss is small enough that the masses of cool stars can be considered essentially constant on the main sequence. This further implies that the Faint Sun (or Warm Earth) Paradox cannot be resolved by postulating a more massive young Sun.

Nearby low mass stars and brown dwarfs with the VVV survey.

Juan Carlos Beamin[1]

[1] *P. Universidad Catolica de Chile - European Southern Observatory*

Abstract. The VVV survey is an ESO VISTA Public survey, observing over 500 sq. degrees towards the Galactic bulge and southern disk in the near infrared, imaging around 100 times each pointing in the Ks band, over a period of 5-7 years. A search for high proper motions has successfully found dozens of new nearby low mass stars (VLMS) and brown dwarf candidates. The VVV data allow us to calculate proper motion and parallaxes, and also study the long-term variability of VLMS with a precision of 0.05 magnitudes.

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Spectroscopic follow up is being obtained to confirm the spectral types and obtain full kinematic information. Here we show the main results on nearby companions to known high proper stars, the first brown dwarf discovered by the VVV survey, and isolated low mass stars and binaries. A detailed list of fully characterized objects as well as refined catalogs of high proper motion objects will become available as the VVV survey progresses.

MHD simulations of near-surface convection in cool main-sequence stars

Benjamin Beeck[1]

[1] *Max Planck Institute for Solar System Research*

Abstract. The solar photospheric magnetic field is highly structured owing to its interaction with the convective flows. Its local structure has a strong influence on the profiles of spectral lines not only by virtue of the Zeeman effect, but also through the modification of the thermodynamical structure (e.g. line weakening in hot small-scale magnetic structures). Many stars harbour surface magnetic fields comparable to or larger than the Sun at solar maximum. Therefore, a strong influence of the field on the surface convection and on spectral line profiles can be expected. We carried out 3D local-box MHD simulations of unipolar magnetized regions (average fields of 20, 100, and 500G) with parameters corresponding to six main-sequence stars (spectral types F3V to M2V). The influence of the magnetic field on the convection and the local thermodynamical structure were analyzed in detail. For three spectral lines, we determined the impact of the magnetic field on the disc-integrated Stokes-I profiles. Line weakening has in many cases a stronger impact on the spectral line profiles than the Zeeman effect. Moreover, for some stars, the correlation between the magnetic field and the vertical velocity strongly influences the line shapes. These effects can impair determinations of stellar magnetic fields since these measurements neglect the local structure of the magnetic field and its interaction with the convective flows. The MHD simulations presented can be used to quantify

these effects and thus help to improve magnetic field measurements of cool main-sequence stars.

Ultra-Cool dwarfs in the VISTA Hemisphere Survey

V.J.S. Bejar[1]

[1] *Instituto de Astrofsica de Canarias*

Abstract. The VISTA Hemisphere Survey (VHS) is a near-IR public survey that will cover the entire Southern sky in the JKs filters over the next years, to a depth 3-4 mag fainter than 2MASS/DENIS. To date, VHS collected data of about 8000 deg^2, and this area will increase in the following years, providing large enough area to study a large variety of scientific goals. The VHS Ultra-Cool Dwarf group aims at completing the census of the coolest members of the solar vicinity, elaborating a new catalog of high proper motion stars, identifying benchmark companions of nearby stars, extremely wide low-mass binaries (physical separations of tens of thousands of AU), and companions of metal poor stars. In this talk, we present recent results of our searches including the identification of a new L dwarf member of the moderately metal poor triple system HD 221356, several wide M, L and T companions of nearby field dwarfs, and a new T companion to a planet host star.

The AstraLux M dwarf survey part 2: The multiplicity of mid- to late-type M dwarfs

Carolina Bergfors[1]

[1] *University College London*

Abstract. The multiplicity properties of M dwarfs provide key constraints on the formation of very low mass stars and brown dwarfs. Identification and orbital monitoring of individual close and nearby young low mass binaries can in addition provide fundamental physical parameters, such as dynamical mass, that are crucial for constraining the mass-luminosity relation and evolutionary models. Multiplicity surveys also provide essential information for target selection in exoplanet surveys. In the AstraLux M dwarf multiplicity survey, we used high resolution Lucky Imaging to statistically investigate the multiplicity of a large sample (700) early- to mid-type M dwarfs. Here we

extend the survey to include 286 M5-M8 dwarfs in the solar neighbourhood to further explore the multiplicity properties in the mass range between solar type stars and brown dwarfs. Among these mid- to late-M dwarfs, we confirm 68 common proper motion binaries/multiples, using astrometric measurements in several epochs and colour criteria. 43 of these are new discoveries. The multiplicity fraction in this mass range is found to be 26-31% and the results are consistent with a continuous trend in multiplicity fraction and semi-major axis distribution from more massive stars to very low mass stars and brown dwarfs, supporting a common formation scenario for stars and brown dwarfs.

Treatment of Molecules in 3D NLTE Radiative Transfer

Alexander Berkner[1]

[1] *University of Hamburg*

Abstract. The photosphere of cool stars is both rich in molecules and an environment where the assumption of LTE can not be upheld. Unfortunately, detailed 3D non-LTE calculations involving molecules are hardly feasible with current computers. For this reason, we present our implementation of the superlevel technique, in which molecular levels are sorted into superlevels, to reduce the number of unknowns in the rate equations and, thus, the computational effort and memory requirements involved, and show the results of our first tests against the 1D implementation of the same method.

Solar cycle Dependency of Sun-as-a-Star Photospheric Spectral Line Profiles

Luca Bertello, Alexei A. Pevtsov, Mark S. Giampapa, Andrew R. Marble[1]

[1] *National Solar Observatory*

Abstract. We investigate solar-cycle related changes in the profile of several photospheric spectral lines taken with the Integrated Sunlight Spectrometer (ISS) operating at the National Solar Observatory at Kitt Peak (Arizona). Daily high spectral resolution (R = 300,000) measurements of the Sun-as-a-star were obtained since December 2006, covering the decline

of solar cycle 23 and the rising phase of cycle 24. We present time series of line parameters (including core intensity, full width at half maximum, and equivalent width) and discuss their correlation to indices of solar magnetic activity. Because of their different response to variations in the thermodynamic and magnetic structures of the solar atmosphere, the measured line shape parameters provide an excellent tool for disentangling thermal and magnetic effects occurring during different phases of the solar cycle. The results of this analysis may also help with developing a better understanding of magnetic cycle of activity in other solar-like stars.

Building a Volume-Limited sample of L/T Transition Dwarfs with Pan-STARRS and WISE

William Best[1]

[1]*Institute for Astronomy, University of Hawaii*

Abstract. The current census of L/T transition brown dwarfs (spectral types L6-T5) is a compilation of magnitude-limited surveys with varying sensitivity, spatial coverage, and spectral completeness. While 90 L/T dwarfs within 25 pc have been found, and several individual objects have been studied in detail, many fundamental properties of the L/T transition remain poorly understood. We are building a complete, volume-limited sample of L/T transition dwarfs within 25 pc. We have searched 30,000 deg^2 in the the Pan-STARRS1 3pi and WISE all-sky surveys for brown dwarfs spanning the L/T transition. We have spectroscopically confirmed a total of 117 new L and T dwarfs (an 82% success rate); 80 of these are L/T transition dwarfs, 30 of which have photometric distances within 25 pc. Our discoveries help to form a well-defined, robust sample of L/T dwarfs that can constrain atmospheric models and improve our understanding of the progression from dusty and cloudy L dwarfs to clear T dwarf photospheres, and better characterize the handful of extremely red late-L dwarfs that have been discovered. Our sample also provides more targets for variability searches,

and for high-resolution imaging and spectral decomposition to identify L+T binaries whose colors mimic those of single L/T transition objects.

The binary fraction of the very coolest brown dwarfs

Beth Biller[1]

[1] *University of Edinburgh*

Abstract. In the last few years, discoveries of the very coolest brown dwarfs T¡800 K have accelerated, due to results from WISE, UKIDSS, and other IR surveys. These objects close the gap in mass between brown dwarfs and planets – indeed many of them have planetary masses. Companions around such objects are among the lowest mass imaged to date. Here we present results from a HST WFC3 SNAP programme to obtain IR imaging of newly discovered ¿T8 dwarfs in order to search for planetary mass companions to these objects. For our sample with typical estimated distances of 10-15 pc, WFC3's 0.13" IR platescale allow us to probe equal magnitude binaries down to separations of 0.2", corresponding to physical separations of 2-3 AU. In order to clearly distinguish cool substellar/planetary mass companions from background stars, we observed in the F127M and the F138M filters, since true cool companions should show deep water absorption features at 1.4 um. Combining our results with other published samples, we present the strongest constraints to date on the binary fraction for ¿T8 cool brown dwarfs.

The Most Distant Stars in the Milky Way: Confirmation of an M giant near the Galaxy's Virial Radius

John Bochanski[1]

[1] *Haverford College/Rider University*

Abstract. We have assembled a sample of over 400 M giant candidates from UKIDSS and SDSS, spread over 2,400 sq. deg. Our spectroscopic follow-up campaign has identified nine M giants to date. Here, we report on the spectroscopic confirmation of an M giant in the outer halo of the Galaxy, at a distance of ¿ 180 kpc. The star was previously identified as an M giant candidate based its near-infrared and optical colors, and its lack of any measurable proper motion. The M giant was confirmed using optical

spectroscopic features, and has a heliocentric radial velocity of -60 km/s. It is the most distant Milky Way star found to date, and is likely the result of accretion in the outer halo. We discuss the likely scenarios for its formation, and the implications of distant halo giants on the evolution of the Milky Way's halo.

Modeling the accretion shocks in classical T Tauri stars: the role of local absorption on the X-ray emission

Rosaria Bonito[1]

[1] *UNIPA-INAF-OAPA*

Abstract. We investigate the X-ray emission from accretion shocks in classical T Tauri stars, due to the infalling material impacting the stellar surface. Several aspects in both observations and models of the accretion process are still unclear: the observed X-ray luminosity of the post-shock plasma is below the predicted value, the density vs temperature structure of the shocked plasma, with increasing densities at higher temperature, is opposite of what expected from simple accretion shock models. To address these issues we performed numerical magnetohydrodynamic simulations describing the impact of an accretion stream onto the stellar surface (exploring different configurations and strengths of the magnetic field) and considered the local absorption due to the surrounding medium. We explored the effects of absorption for different viewing angles and for the He-like line triplets commonly used for density diagnostic. From the model results we synthesize the X-ray emission from the accretion shock, producing maps and spectra. We perform density and temperature diagnostics on the synthetic spectra, and we directly compare our results with the observations. Our model shows that the X-ray fluxes detected are lower than expected because of the local absorption. The emerging spectra suggest higher density for higher temperature, proving that

a detailed model accounting for a realistic treatment of the local absorption is needed to interpret the observations of X-ray emitting accretion shocks.

The Outer Architecture of M Dwarf Planetary Systems

Brendan Bowler[1]

[1] *Caltech*

Abstract. High-contrast imaging is a powerful tool to probe the outer architecture of planetary systems and directly study the atmospheres of extrasolar giant planets. Previous imaging surveys have primarily focused on intermediate- and high-mass stars, revealing a handful of self-luminous planets. Yet M dwarfs have largely been neglected despite having more favorable planet-star contrasts and representing about 75% of all stars. As a result, little is known about the population of gas-giants at moderate separations (10-100 AU) in this stellar mass regime. In this talk I will describe the results of the Planets Around Low-Mass Stars (PALMS) high-contrast adaptive optics imaging survey targeting newly identified nearby (¡35 pc) young (¡300 Myr) M dwarfs with Keck II/NIRC2 and Subaru/HiCIAO. With a sample size of over 120 young M dwarfs, PALMS is the largest direct imaging planet search in this stellar mass regime. I will present the discoveries and statistical results and discuss their implications for the formation of gas-giant planets around the most common stars in our galaxy.

The low-mass pre-main sequence population of the Orion OB1 Association

Cesar Briceno[1]

[1] *Cerro Tololo Interamerican Observatory*

Abstract. I will present the results of our large scale photometric and spectroscopic census of the Orion OB1 association, spanning 180 sq.deg. with emphasis on the wide off-cloud regions that contain somewhat older populations of stars in the age range 4-10 Myr. With 2000 confirmed T Tauri stars, this is the largest and most complete sample to date of low-mass young stars in this important evolutionary stage. We show that the off-cloud stellar population consists of various newly recognized clusters amidst

a general low-density background, and that the ONC is surrounded by a few sq.deg. halo of young stars.

X-ray Emission from Young Stars in the TW Hya Association

Alexander Brown[1]

[1] *CASA, University of Colorado*

Abstract. The 9 Myr old TW Hya Association (TWA) is the nearest group (typical distances of 50 pc) of pre-main-sequence (PMS) stars with ages less than 10 Myr and contains stars with both actively accreting disks and debris disks. We have studied the coronal X-ray emission from a group of low mass TWA common-proper-motion binaries using the Chandra and Swift satellites. Our aim is to understand better how high energy photons affect the conditions around young stars and their role at early stages in photo-exciting atoms, molecules and dust grains in both the circumstellar disk and lower density circumstellar gas, and later, once planet formation is underway, by influencing protoplanetary evolution and the atmospheric conditions of the newly formed planets. The X-ray properties for 7 individual stars (TWA 13A, TWA 13B, TWA 9A, TWA 9B, TWA 8A, TWA 8B, and TWA 7) and 2 combined binary systems (TWA 3AB and TWA 2AB) have been measured. All the stars with sufficient signal require two-component fits to their CCD-resolution X-ray spectra, typically with a dominant hot (2 kev (25 MK)) component and a cooler component at 0.4 keV (4 MK). The brighter sources all show significant X-ray variability (at a level of 50-100% of quiescence) over the course of 5-15 kilosecond observations. We present the detailed X-ray properties for each of the stars and examine how the coronal emission correlates with stellar rotational properties and how it is affecting their circumstellar environment. This work was supported by Chandra grant

GO1-12031X and NASA Swift grants NNX09AL59G and NNX10AK88G to the University of Colorado.

Spectral variability observations of the very nearby brown dwarf binary Luhman 16AB with HST

Esther Buenzli[1]

[1] *Max-Planck Institute for Astronomy, Heidelberg*

Abstract. The recently discovered very nearby (2 pc) brown dwarf binary Luhman 16AB provides an extraordinary opportunity for detailed study of atmospheric conditions at the L/T transition. There, cloud evolution dramatically alters the observed spectra. The B component, an early T dwarf, was found to be highly variable on time scales of about 5 hours, but with rapidly evolving light curves, indicating evolving patchy cloud cover. For the A component, a late L dwarf, tentative variability was found at wavelengths ¡ 1 micron. We have obtained resolved spectral variability observations at sub-percent precision of both components with HST from 1.1 to 1.66 microns, covering 6.5 hours. We find strong variability of the B component at all wavelengths with significant changes after only one rotation period, while we put firm limits on the variability of the A component. We discuss patchy cloud models and compare the characteristics of the spectral variability to that of other variable brown dwarfs.

The SpeX Prism Library 2.0: Science, Education and Art from 1000 M, L and T Dwarf Spectra

Adam Burgasser[1]

[1] *UC San Diego*

Abstract. Over the past decade, thousands of low-resolution (R 100), near-infrared (0.8-2.4 micron) spectra of the coolest stars and brown dwarfs M, L, T and Y dwarfs have been obtained with the SpeX spectrograph on the 3m NASA Infrared Telescope Facility. Since 2009, I have curated of a subset of these data in the SpeX Prism Library (SPL), a resource that has been utilized in over 100 studies of cool stars, brown dwarfs, exoplanets and even high redshift galaxies. Yet the SPL has largely served as a repository. In this poster I present the design and early work from SPL 2.0, which

will include updated and uniformly calibrated data extractions, standardized (Virtual Observatory) data formats, integration of ancillary photometric and astrometric data, and a Python-based toolkit called SPLAT that will facilitate rapid science and student research projects. I will also demonstrate examples of how SPL data can be used for data-driven artwork/performance and public outreach/education.

Prominence activity, flare and post-flare loops on the RS CVn-type binary SZ Psc

Dongtao Cao and Shenghong Gu[1]

[1] *Yunnan Observatories, Chinese Academy of Sciences*

Abstract. We present the results of time-resolved high-resolution spectroscopic observations of the very active RS CVn-type star SZ Psc, obtained during two observing nights in 2011 October 24 and 25. Several optical chromospheric activity indicators formed at different atmospheric heights were analyzed using the spectral subtraction technique, which show the remarkably different behavior and reveal a series of interesting magnetic activity phenomena in short period of time. Blue-shifted absorption feature presented in the subtracted spectra, as a result of cool prominence motion while seen in projection against the stellar disk, was found in the first observing night. This event was associated with the subsequently strong optical flare observed in our second observing night. The flare was characterized by the prominent He i D3 line emission, together with stronger chromospheric emission in several other active lines. An obviously developmental absorption feature was occurred on the blue wing of the Balmer line profiles accompanied by the gradual decay of flare, which can be explained as cool post-flare loops. Interestingly, a X-ray flare took place at the similar orbital phase was detected by using the Gas Slit Camera (GSC) of the Monitor of All-sky X-ray Im-

age (MAXI) after a few days of our observations, suggesting that there is a long-lived active region over the surface of SZ Psc.

Lithium Inventory of 2 $M_{\rm sun}$ Red Clump Stars: Is Li created during the He Flash?

Joleen Carlberg[1]

[1] *Carnegie Institution of Washington*

Abstract. Recent studies of Li abundances in field red giant stars have suggested that the phenomenon of enriched surface Li may be a short-lived phase of red clump evolution for stars with masses near 2 $M_{\rm sun}$. Although the exact mechanism for generating this Li is not fully understood, it may be related to the He-core flash that immediately precedes the red clump stage. To test the incidence and timescale of this proposed process, we are targeting 25 red clump stars in four southern open clusters, using the cluster ages to ensure that the stellar masses are 2 $M_{\rm sun}$. Additionally, we observe at least one upper red giant branch star in each cluster to establish the baseline Li abundance prior to the He flash. Here, we present results for the three clusters observed to date. None of the stars are Li-rich according to the usual criterion (A(Li) ¿ 1.5 dex), but at least one red clump star shows moderate Li enrichment compared to the other stars in the cluster, suggesting that it may have passed through a more Li-rich stage.

The HST Treasury "Advanced Spectral Library (ASTRAL)" Programs

K.G. Carpenter and T.R. Ayres for the ASTRAL Science Team[1]

[1] *NASA's GSFC*

Abstract. Over the past three years, two of the largest-ever HST stellar spectroscopic Guest Observer programs have been undertaken. The "Advanced Spectral Library (ASTRAL)" Project (PI = T. Ayres) consists of two Treasury Programs, the first in Cycle 18 on "Cool Stars" (GO-12278) and the second in the current Cycle 21 on "Hot Stars" (GO-13346). These programs are designed to collect a definitive set of representative, high-resolution (R 30,000-100,000), high signal/noise (S/N¿100) spectra, with full UV coverage (1200 - 3000) of prototypical stars across the HR diagram, utilizing

the high-performance Space Telescope Imaging Spectrograph (STIS). ASTRAL/Cool Stars obtained spectra of 8 F-M evolved late-type stars, including iconic objects like Betelgeuse and Procyon. ASTRAL/Hot Stars is in the process of observing 21 early-type stars, which span a broad range of spectral types between early-O and early-A, both main sequence and evolved stars, fast and slow rotators, as well as chemically peculiar and magnetic objects. The targets include equally iconic Sirius, Vega, and the classical wind source Zeta Puppis. All of these extremely high-quality STIS UV echelle spectra will be available from the HST archive and, in post-processed and merged form, at http://casa.colorado.edu/ ayres/ASTRAL/. These data will enable investigations of a broad range of problems – stellar, interstellar, and beyond – for many years into the future. Here we describe the details of the observing programs and the spectra now available for community use; and then present some illustrative examples of the on-going scientific analyses, including a study of the outer atmospheres and winds of the two evolved M stars in the sample, the M3.4 giant Gamma Cru and the M2Iab supergiant Alpha Ori and a first look at a "high definition" UV spectrum of the magnetic chemically peculiar "Ap" star HR 465.

Zeeman Doppler Imaging of the surface activity and magnetic fields of young solar-type stars

Brad Carter, Stephen Marsden and Ian Waite[1]

[1] *University of Southern Queensland*

Abstract. The cyclic magnetic activity of the modern-day Sun is generally considered to be powered by a self-regenerating interface-layer dynamo. However, Zeeman Doppler Imaging of the spots and magnetic fields of active young solar-type stars suggests that a distributed rather than interface-layer dynamo is present. This poster outlines the techniques we have used to map and study the spots and surface magnetic fields of a small sample of

young active solar-type stars, the results obtained, and the implications for magnetic field generation in young cool stars.

Asteroseismology for Galactic Archaeology

Luca Casagrande[1]

[1] *The Australian National University*

Abstract. We present results from the ongoing SAGA survey (Stromgren for Asteroseismology and Galactic Archaeology), which currently includes photometry for over 20000 stars in the Kepler field, 1000 of which are red giants with seismic information. Coupling Stromgren metallicities with the Infrared Flux Method, and the unique asteroseismic determination of stellar masses and radii, powerful new diagnostics for Galactic studies are obtained. With our sample we detect clear mass and metallicity gradients in the Galactic disc and discuss the impact of our results for understanding some of the processes relevant in the formation of the Milky Way disc.

Herbig Ae/Be vs T Tauri Stars: Accretion and Outflows with 1-micron Spectroscopy

Paul Wilson Cauley[1]

[1] *Rice University*

Abstract. Herbig Ae/Be stars (HAEBES) are often described as the higher mass counterparts to T Tauri stars (TTSs). Although some HAEBES display similar accretion and outflow signatures as classical TTSs (CTTSs), the overall line profile statistics indicate significant differences in the mass flow frequencies for the two groups. In this talk we present the first high-resolution study of the He I 10830 line in a large sample of HAEBES. He I 10830 is an excellent tracer of outflows and accretion near the star-disk interaction region due to the meta-stability of the lower energy level and has been used extensively to investigate the mass flows around CTTSs. We interpret our line profiles within the context of wind and accretion models developed for CTTSs and show that the frequency of occurrence for each type of line profile differs significantly between HAEBES and CTTSs, indicating that, in general, different star-disk interactions are at play in each mass regime. Our results also add to the growing evidence that HBe stars interact with

their environments differently than HAe stars. We conclude that the accretion and outflow scenarios common to CTTSs cannot be applied blindly to HAEBES. In particular, the magnetospheric accretion, which can account for many of the observed properties of CTTSs, does not appear to be the dominant accretion mechanism in HAEBES.

Understanding Astrophysical Noise from Stellar Surface Magneto-Convection

Heather Cegla[1]

[1] *Queen's University Belfast*

Abstract. Cool, low mass stars with a convective envelope have bubbles of hot, bright plasma rising to the surface where they eventually cool, darken and sink. The motions of these plasma bubbles induce stellar line asymmetries since the radial velocity (RV) shift induced from the uprising granules does not completely cancel the shift from the sinking intergranular lanes. Furthermore, these line asymmetries are constantly changing as the ratio of granular to intergranular lane material continues to change due to magnetic field interplay. The net result for Sun-like stars is shifts in the line profiles on the order of several tens of cm/s. Hence an understanding of magneto-convection and its effects is paramount in any high precision RV study. One particular area impacted is the RV confirmation of Earth-analogs; the astrophysical noise from the host star stellar surface magneto-convection completely swamps the 10 cm/s signal induced from the planet. We aim to understand the physical processes involved here so that we may disentangle the effects of magneto-convection from observed stellar lines. To do so, we start with a state-of-the-art 3D magnetohydrodynamic simulation of the solar surface. Motivated by computational constraints and a desire to breakdown the physics, we parameterize the granulation signal from these simulations. This parameterization is then used to construct model Sun-as-a-star observations with a RV precision far beyond current instrumentation. This parameterization across the stellar disc, for a variety of magnetic field strengths, is presented here, alongside the current results from the model star observations. We find several line characteristics to be correlated with the induced RV shifts. Particularly high correlations were found for the velocity asymmetry (comparing the spectral information content of the blue wing to the red wing) and brightness measurements (approximated by integrating

under the model observation profiles), allowing significant granulation noise reduction.

New Age-Rotation Constraints at Old Ages from Wide Binaries

Julio Chaname[1]

[1] *Universidad Catolica de Chile*

Abstract. Independent age-rotation measurements for solar-type stars at old, several-Gyr ages are almost non-existent. They are however urgently needed to inform models of angular momentum evolution, as well as for the calibration of gyrochronology relations useful for a wide variety of topics, from the evolution of planetary systems to the genesis of the Milky Way itself. Here we present some of the first such constraints after the Sun, obtained by our program targeting wide binary systems hosting an evolved star plus a main sequence companion. The new constraints span ages from 2 to 7 Gyr, and have been obtained via standard photometric and spectroscopic techniques. We also present results of an asteroseismic pilot study that uses the MOST satellite for expanding on these goals.

The Coordinated Synoptic Investigation of NGC 2264

Ann Marie Cody[1]

[1] *IPAC*

Abstract. Young stellar objects (YSOs) are notorious for displaying brightness variations of ¡1-100% on a variety of timescales from hours to years. Understanding the origin of these variations can help illuminate the structure of their magnetospheres and inner circumstellar disks. The Coordinated Synoptic Investigation of NGC 2264 ("CSI 2264") has recently revolutionized our view of YSO variability by providing high-precision, ¿30-day optical and infrared light curves on thousands of T Tauri stars. With a sampling interval of one hour or less in our time series, we have resolved many previously unappreciated light curve features, including rapid fading events as well as brief flux bursts. We present new statistical metrics that can successfully distinguish eight different categories of light curve morphology. The physical origin of some of these categories is understood (e.g., starspots,

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eclipses), but the mechanisms behind other types of light curve behavior have yet to be fully elucidated. We will show how high-resolution spectroscopy can aid in understanding the physical conditions pertaining to YSOs.

A Grid of MHD Models for Stellar Mass Loss and Spin-down Rates of Solar Analogs

Ofer Cohen[1]

[1] *Harvard-Smithsonian CfA*

Abstract. Stellar winds are believed to be the dominant factor in the spin-down of stars over time. However, stellar winds of solar analogs are poorly constrained due to observational challenges. In this paper, we present a grid of magnetohydrodynamic models to study and quantify the values of stellar mass loss and angular momentum loss rates as a function of the stellar rotation period, magnetic dipole component, and coronal base density. We derive simple scaling laws for the loss rates as a function of these parameters, and constrain the possible mass loss rate of stars with thermally driven winds. Despite the success of our scaling law in matching the results of the model, we find a deviation between the "solar dipole" case and a real case based on solar observations that overestimates the actual solar mass loss rate by a factor of three. This implies that the model for stellar fields might require a further investigation with additional complexity. Mass loss rates in general are largely controlled by the magnetic field strength, with the wind density varying in proportion to the confining magnetic pressure B^2. We also find that the mass loss rates obtained using our grid models drop much faster with the increase in rotation period than scaling laws derived using observed stellar activity. For main-sequence solar-like stars, our scaling law for angular momentum loss versus poloidal magnetic field strength retrieves the well-

known Skumanich decline of angular velocity with time if the large-scale poloidal magnetic field scales with with the square of the rotation rate.

A Method for Identifying M dwarfs with Ultra Cool Companions in 2MASS and WISE

Neil Cook[1]

[1] *University of Hertfordshire*

Abstract. Locating unresolved ultra cool companions to M dwarfs is important to enable dynamical mass and transit radii tests of brown dwarf models, identifying warm exoplanets and, constraining planet formation models. The recent Wide-Field Infrared Survey Explorer all-sky/All-WISE data release combined with the Two Micron All Sky Survey (2MASS) provides unprecedented near-to-mid infrared multi-band coverage for all bright M dwarfs across the sky. We present an optimized method for identifying unresolved ultra cool companions to M dwarfs. We identify an all-sky sample of bright M dwarfs based on optical and near-infrared colors, reduced proper motion, with strict E(H-W2) constraints and near minus mid infrared photometric uncertainty less than 0.04. We hunt for evidence of mid infrared excess using comparison samples of M dwarfs selected from common near-infrared multi-color parameter-space. We also consider low resolution spectroscopic followup to further the selection process. The best candidates will be targeted with adaptive optics, radial velocities, and light curves (for transit) where appropriate. We present the method used and our preliminary candidates.

Short-term Activity in Young Solar Analogs

Christopher Corbally, Richard Gray, Jon Saken[1]

[1] *Vatican Obs., Appalachian State U., Marshall U.*

Abstract. Knowing the chromospheric activity in YSAs gives us an insight into the conditions in the early solar system when life was establishing a foothold on the earth. To complement a 7-year history of monitoring YSAs on long and medium timescales, a program of high-cadence, high signal-to-noise spectroscopy started in 2013 at VATT, a 1.8-m telescope situated on Mt. Graham, AZ, to detect activity behavior on timescales of minutes to

hours. This is addressing the question of the energy output and frequency of flares on a subset of our program stars. Initial, spectacular results will be presented.

Preparation of the CARMENES input catalogue. Multiplicity of M dwarfs from tenths of arcseconds to hundreds of arcminutes

Miriam Corts Contreras[1]

[1] *Universidad Complutense de Madrid*

Abstract. With the help of CARMENCITA, the CARMENES Cool dwarf Information and daTa Archive, we investigate the membership in double, triple or higher-order multiplicity systems of M dwarfs in the solar neighbourhood observable from Calar Alto in order to prepare and characterize the final sample of stars of CARMENES. Our multiplicity study covers a wide range in projected physical separations, from 0.5 to 55000 AU. The inner range is covered with a lucky-imaging survey of over 600 M dwarfs with FastCam at the 1.5 m Telescopio Carlos Snchez, complemented with a literature survey. Visual or physical companions within arcseconds to our targets may induce spurious variations in the radial velocity of the primary and mimic the presence of planets. The outer range is covered with a detailed analysis of Washington Double Stars catalogue data and optical images taken by us with TCP and CAMELOT at the 0.8 m IAC80 telescope, accompanied in doubtful cases with an astrometric study with public images and all-sky catalogues. The global picture of multiplicity of M dwarfs, at all physical separations and mass ratios, will appear in all its glory.

A Kinematic Survey of the Perseus Molecular Cloud: Results from the APOGEE Infrared Survey of Young Nebulous Clusters (IN-SYNC)

Kevin Covey[1]

[1] *Lowell Observatory*

Abstract. Demographic studies of stellar clusters indicate that relatively few persist as bound structures for 100 Myrs or longer. If cluster dispersal is a 'violent' process, it could strongly influence the formation and early evolution of stellar binaries and planetary systems. Unfortunately, measuring the

dynamical state of 'typical' (i.e., 300-1000 member) young star clusters has been difficult, particularly for clusters still embedded within their parental molecular cloud. The near infrared spectrograph for the Apache Point Observatory Galactic Evolution Experiment (APOGEE), which can measure precise radial velocities for 230 cluster stars simultaneously, is uniquely suited to diagnosing the dynamics of Galactic star formation regions. We give an overview of the INfrared Survey of Young Nebulous Clusters (IN-SYNC), an APOGEE ancillary science program studying the kinematics of young stars in the Perseus and Orion star forming regions. Some models predict a super-virial state for clusters that have just dispersed their molecular cloud; our observations, by contrast, rule out a significantly super-virial velocity dispersion in IC 348, a young cluster in Perseus that has recently expelled its primordial gas. We conclude with ongoing work to measure velocity dispersions and characterize stellar populations in NGC 1333, an embedded cluster in Perseus, and the ONC & L1641 molecular filament in Orion, and plans to survey additional young clusters as part of the APOGEE-2 survey.

TRENDS Discovery of a Benchmark T-dwarf Companion

Justin R. Crepp[1]

[1]*Notre Dame*

Abstract. The TRENDS high-contrast imaging program uses adaptive optics and coronagraphy to directly detect and characterize substellar companions that are responsible for accelerating their parent star, as manifest through subtle Doppler signals. In this talk, I will present the first directly imaged benchmark T-dwarf companion orbiting a solar-type star with a measured radial velocity acceleration. The object, HD 19467 B, has blue colors and is more than 100,000 times fainter than its primary star at near-infrared

wavelengths. We have calculated a firm lower limit to its mass using orbital dynamics.

Global, Spatially-resolved Meteorology of Cloudy Brown Dwarfs

Ian Crossfield[1]

[1] *MPIA*

Abstract. Models of brown dwarf atmospheres long predicted that clouds (formed of condensed mineral species) should sculpt the emission spectra of these cool substellar objects. Observations of brown dwarfs show ubiquitous variability on brown dwarfs with temperatures ranging from 2300 K to below 400 K. This variability is attributed to patchy regions of thin and thick clouds, but interpretation of these results is limited because they rely on disk-integrated measurements. Now, bright new brown dwarfs and improved observing facilities allow us to produce the first 2D global maps of these objects via Doppler Imaging techniques. I will review our team's work, which has resulted in the first global cloud map of any brown dwarf, and will discuss the exciting scientific prospects for mapping many more such objects across a wide range of temperatures in the years to come. Terrestrial weather permitting, I will also present the first 'weather movie' of the formation, evolution, and dissipation of global weather patterns on any body beyond the Solar system.

Reliability of Spectral Diagnostics of Temperature and Youth for 550 $M_{\rm Jupiter}$ Mass Objects

Kelle Cruz[1]

[1] *Hunter College, CUNY & AMNH*

Abstract. Advancements in the understanding of brown dwarf atmospheres and evolution directly impact exoplanet studies. Recent discoveries have made it now clear that brown dwarfs have clouds with a diversity of structures and compositions, similar to what is suspected for directly imaged exoplanets. Unlike for planets, detailed spectral studies are possible for brown dwarfs spanning a range of masses, temperatures, and ages due to their lack of a close, bright companion star. This talk will present the

results of a comprehensive analysis of the optical and NIR spectra of field (35 Gyr) and juvenile-age (10100 Myr) brown dwarfs, including low-gravity, low-mass (520 $M_{\rm Jupiter}$) objects. In particular, we will highlight the spectral diagnostics at moderate resolution in the NIR (R 200, 0.72.5 micron) which are qualitatively indicative of temperature, youth, low-gravity, and cloud properties for 5100 $M_{\rm Jupiter}$ mass objects. In addition, we will discuss the relative accuracies of the diagnostic spectral features and their reliability. The methods we will describe can be used to assess the youth of brown dwarfs and exoplanets without strong age constraints from moving group membership or the host star.

Dating middle-aged stars

Jason Curtis[1]

[1] *Penn State*

Abstract. Ruprecht 147 is the oldest nearby star cluster, with an age of 3 Gyr at 300 pc, which allows R147 to serve as a sorely needed intermediate-aged benchmark. Stellar ages are difficult to infer for main sequence stars, but age can reveal itself through the spin down of stars via magnetic braking, which also causes magnetic activity to wane with time. We will present results from our studies of the magnetic activity and rotation of FGK stars. We also hope to have newly identified M dwarf members by the time of this meeting, and will discuss their activity, manifested in chromospheric H-alpha emission.

Disk Evolution in T Tauri Binary Systems

Sebastian Daemgen[1]

[1] *University of Toronto*

Abstract. Binaries are the most common outcome of star formation. Accordingly, most protoplanetary disks are born and evolve under the influence of a nearby stellar companion. Among the expected consequences of the resulting disk truncation, stirring, and irradiation are a reduced disk lifetime in close binaries and a predominance of circumprimary over circumsecondary material with possible consequences for, e.g., planet formation around ei-

ther component. Observational constraints are currently sparse due to the high angular resolution required to determine the evolutionary states of individual binary components and their disks, in particular in the interesting separation range between 10 and 100AU where the expected effects are most pronounced. In the largest coherent study of its kind we use high-angular resolution near-infrared spectroscopy and photometry to measure the presence of accretion and hot circumstellar dust around the individual components of 52 multiple stars with separations between 20 and 800 AU in the Orion Nebula Cluster and Chamaeleon I star-forming regions. We confirm evidence from spatially unresolved studies that the overall disk frequency is lower in binaries with ¡100 AU separation. The inferred mass accretion rates, however, appear to be indistinguishable from those of single stars. In addition, we see evidence that circumsecondary disks live on average shorter than their circumprimary counterparts and find an unexpected deficit of wide binaries with two accreting components. Together with information about the presence of cold outer dust around binary components from recent sub-/mm studies, we attempt to draw a coherent picture of protoplanetary disk evolution in binaries that is consistent with the observed disk properties and planet frequencies.

Parallaxes for Cool Subdwarfs

Conard Dahn and Hugh Harris[1]

[1] *U. S. Naval Observatory*

Abstract. Parallaxes and absolute magnitudes are presented for about 18 cool, low-luminosity, metal-poor subdwarfs measured at the Naval Observatory, Flagstaff. With other subdwarfs from other sources, a census of cool subdwarfs is shown in several color-absolute-magnitude diagrams. For this paper, "cool subdwarfs" are defined as having $M_V > 14.0$ and evidence of a subdwarf nature (spectroscopic evidence or a tangential velocity > 150 km/s). The next step in the program will be to combine the data for these stars with data for warmer counterparts to create a complete proper mo-

tion limited sample and calculate an improved halo luminosity function to supersede the version presented earlier in Dahn et al. 1995.

Accretion discs as regulators of stellar angular momentum evolution in the ONC and Taurus

Claire Davies[1]

[1] *The University of St Andrews*

Abstract. Stars form from the collapse of dense molecular cloud cores. If angular momentum was conserved during their contraction, stars would reach rotational velocities in excess of those required to break them apart. However, stars with accretion discs are found to be rotating well below break-up speed, suggesting that an angular momentum removal mechanism must operate - likely some form of outflow. Previous observational studies of stellar angular momentum evolution have primarily focused on the apparent relationship between stellar rotation periods and indicators of disc presence or accretion. Here, we calculate the stellar angular momentum and compare its evolution in stars with and without accretion discs. Our study focusses on two of the youngest, nearby regions of star formation, namely the Orion Nebula Cluster and Taurus. The stellar masses, radii, and ages are recalculated in a consistent manner, using recently published intrinsic colours for pre-main sequence stars and their most up-to-date spectral types. We ensure the reliability of the stellar rotation periods by carefully removing all previously reported sources of bias. This results in a consistent sample of fully convective stars of spectral type K0 to M6.5 in these two regions. Our findings reinforce previous results suggesting the importance of accretion discs in regulating the early evolution of stellar angular momentum. Furthermore, we show that the efficiency of this process is related to the lifetime of the disc.

Rotational Velocities of Nearby Mid M-Dwarfs

Cassy Davison[1]

[1] *Georgia State University*

Abstract. We present rotational velocities for nearby mid M-dwarfs (M3.5V-M6.0V) obtained using CSHELL on NASA's Infrared Telescope Fa-

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cility. These results are important as new spectrographs are now being designed and built with sufficient precision (1-10 m/s) to find terrestrial planets in the habitable zone of slowly-rotating, inactive, single, nearby low mass stars (mid to late M-dwarfs). However, the multiplicity, activity and projected rotational velocities for the majority of these cool neighbors are not known, which severely limits the potential target list. This data set will provide a more complete assessment of the stellar properties of these stars within 25 pcs and establish a clean sample of slowly rotating, quiet single stars suitable for terrestrial planet searches.

Cool companions to nearby stars - detection and characterisation with adaptive optics observations

Robert De Rosa[1]

[1] *ASU, USA/University of Exeter, UK*

Abstract. With a combination of imaging and spectroscopy, we are pursuing a series of programs designed to detect and characterise new and previously identified substellar companions. We present the results of two large-scale adaptive optics imaging surveys for brown dwarf companions to nearby A and M-type stars. By combining dedicated observations with previously published high-contrast measurements, we measure the frequency of wide-orbit brown dwarf companions (M ¿ 20 Mjup) to these two samples of stars. These surveys provide benchmark results on the substellar population, quantifying the difference between the stellar, brown dwarf and exoplanet companion populations for a wide range of primary masses an important measurement that is needed to inform formation models. In addition to our companion search program, we have been characterising the atmospheric properties of a sample of young, low mass directly imaged substellar companions with multi-wavelength observations. For example, we have obtained the largest wavelength coverage (0.4m 5.0 m) of an exoplanet analogue atmosphere the planetary mass companion to AB Pic. The thermal-IR measurements are particularly sensitive to the effects of clouds, chemistry, and metallicity, and, when combined with near-IR spectroscopy and optical photometry, provide comprehensive wavelength coverage of the bulk of the emergent flux from these young substellar objects. The long-term goal of the study is to use the optical, near-IR, and thermal-IR spectra and photometry

of the targets to define an empirical sequence of young object atmospheres spanning the brown dwarf/planet mass transition.

Benchmark companions to nearby stars from Pan-STARRS 1

Niall Deacon[1]

[1] *MPIA*

Abstract. We present the largest sample of benchmark ultracool dwarf companions to stars to date. Pan-STARRS1 with its large sky coverage (30,000 sq.deg.), red-sensitive detectors and multiple epochs provides the ideal tool for discovering wide, common proper motion systems. We have used these data to identify 48 wide, ultracool (M7-T5) companions to nearby stars. This represents a doubling of the number of late M dwarf companions wider than 300 AU and an 80% increase in the number of L companions in the same separation range. We examine the population of ultracool companions as a whole and highlight interesting benchmark systems which can be used to constrain the properties of ultracool atmospheres.

Measuring magnetic fields in young stars

Casey Deen[1]

[1] *Max Planck Institut fr Astronomie*

Abstract. We present Theremin, a MCMC code which measures the fundamental parameters (Teff, log g, K-band veiling, and mean magnetic field strength) of young stellar objects. Theremin compares observed medium resolution (R 10,000) spectra against a grid of synthetic spectra (computed using MoogStokes) which spans a region of parameter space germane to YSOs (2500K ¡ Teff ¡ 6000K, 3.0 ¡ log g ¡ 5.0, 0.0kG ¡ B Field ¡ 4.0 kG). This method promises to be a powerful tool in the study of pre-main sequence

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stellar evolution. As an example, we show the results of Theremin when applied to the famous TW Hydra.

Li depletion in FG stars: planets and rotation

Elisa Delgado Mena[1]

[1] *CAUP*

Abstract. Light elements can give us important information about the mixing processes inside stellar interiors. However, their depletion mechanisms are not completely understood yet. A wide spread in Li and Be abundances has been observed in clusters like M67 or NGC3960 as well as in field solar type stars but it cannot be explained with standard models. In this work we present new determinations of lithium abundances for 678 main sequence stars with and without planets in the Teff range 5600-7200 K, observed inside HARPS-GTO samples or with other high-resolution spectrographs. We first study the relation of planets with Li abundances. We confirm significant differences in the Li distribution of solar twins (Teff = T? 80 K, log g = log g? 0.2 and [Fe/H] = [Fe/H]? 0.2): the full sample of planet host stars (22) shows Li average values lower than "single" stars with no detected planets (60). If we focus on subsamples with narrower ranges in metallicity and age, we observe indications of a similar result though it is not so clear for some of the subsamples. Moreover, we find indications that the amount of depletion of Li in planet-host solar-type stars is higher when the planets are more massive than Jupiter. We suggest that the presence of planets might cause additional rotationally induced mixing in the external layers of planet host stars and thus an extra Li depletion. When we move to hotter temperatures we find a group of stars that present strong depletion of Li as compared with similar stars and that are still far from the Li-dip produced near 6400K. We explore the possible cause of this effect by checking their ages and vsini values. These stars indicate that non-standard processes

like rotationally-induced mixing or episodic accretion may produce strong depletion of light elements.

Ground-based transmission spectrum of WASP-80 b, a gas giant transiting an M-dwarf

Laetitia Delrez[1]

[1] *University of Lige (Belgium)*

Abstract. At the current point in time, transiting exoplanets are the only extrasolar planets whose atmospheric properties can be studied in detail. During a transit, a small portion of the star light passes through the upper atmosphere of the planet, at the day-night terminator region. Some wavelengths are absorbed or scattered more effectively by the atmospheric constituents, causing wavelength-dependent transit depth variations. Via simultaneous multi-wavelength observations of transits, these variations can be measured and used to study the chemical composition, thermal structure and cloud coverage of the atmospheric limb. We will present here some results from our ground-based multi-object spectroscopy program aiming to measure the transmission spectrum of the hot Jupiter WASP-80 b using the VLT/FORS2 and Magellan/MMIRS instruments. WASP-80 b is a unique object as it is the only known specimen of gas giant orbiting an M-dwarf that is bright enough for high SNR follow-up measurements. Due to the nature of its host star, this hot Jupiter is actually more warm than hot, with an estimated equilibrium temperature of only 800K. It is thus a prime target to improve our understanding of giant exoplanet atmospheres in this temperature range.

How typical is the Sun's magnetic cycle lengths ?

Jos Dias do Nascimento Jr[1]

[1] *Harvard-Smithsonian Center for Astrophysics - CfA*

Abstract. Over the past three decades the question of how typical the Sun is within the class of solar-type stars has been the subject of active investigation. Previous studies has suggested that the Sun's magnetic cycle period Pcyc is unusual compared with similar stars, falling between sequences of active and inactive stars. The HARPS planet-search has been gathering

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high-precision Ca II H&K chromospheric activity measurements for about 7 years, and has measured a large number of new Pcyc. We collect the most robust cycles among these for stars which are solar analogs (main-sequence stars with 0.8 Msun ¡ mass ¡ 1.2 Msun) or solar twins twins (stars with Teff, [Fe/H] and mass indistinguishable from the Sun). Combining this new sample with older data, we revisit the relation between rotation periods Prot and Pcyc. Our preliminary analysis shows that the Sun does not has a special position between the active and inactive sequences, but instead follows a new solar-analog sequence proposed here.

ROTATION AND AGES OF SOLAR ANALOGS REVEALED BY THE KEPLER MISSION

Jos Dias do Nascimento Jr[1]

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Abstract. We present a new sample of 70 solar-type field stars that potentially contain solar analogs and possibly even twins. We present stellar rotation periods and ages for this sample. By taking into account a control sample we analyze properties of new solar twins by using long-cadence data (Q0-Q16) to study their rotation. These were measured by detecting periodic photometric modulation caused by star spots. We included in the sample the evolved solar-type stars 16 Cyg A & B that represents a proxy to the future of our own Sun. Our study is particularly interesting to test how stellar sismo- and gyro- ages can be reliable in an dataset of a controlled set of stellar parameters.

Monitoring the Variability of Newly-discovered Symbiotic Stars: A Progress Report

Caitlin Doughty[1]

[1] *University of Washington Astronomy Department*

Abstract. Seven new symbiotic stars (SS) identified from low-dispersion spectroscopic observations were monitored during the summer and fall of 2013 at the University of Washington's Manastash Ridge Observatory to determine whether or not they showed variability on timescales of days to months. These SS were identified initially on the basis of H-alpha emission

and red colors from the IPHAS survey, but nothing has been noted regarding their variability. Using photometric observations taken over the course of four months and sets of five to six comparison stars, we found that several of the target stars demonstrated variations of a few tenths of a magnitude in the H-alpha filter while others exhibited variations of up to one magnitude in both the R and I filters. Further observations of these stars are planned at MRO during 2014.

When good fits go wrong: determining realistic best fits and uncertainties on L dwarf physical parameters

Stephanie Douglas[1]

[1] *Columbia University/American Museum of Natural History*

Abstract. Understanding the true uncertainties on parameters derived from model fits to low- and medium-resolution data will be particularly important with the advent of JWST. We expect NIRSpec on JWST to provide moderate-resolution spectra of hot jupiters and greatly expand the spectroscopic sample of L dwarfs. A typical method for inferring physical parameters (effective temperature, surface gravity, and possibly dust or cloud properties) of brown dwarfs is to fit synthetic spectra to observed data. Synthetic spectra can be found that reproduce the observed data reasonably well, both qualitatively and statistically. However, the parameters implied by these best-fit spectra are often unphysical: the good fits have gone wrong. Furthermore, best-fit model parameters are frequently presented in the literature without associated uncertainties, despite knowledge that the models lack important opacity sources and cloud physics. Unlike at low-resolution, fitting synthetic spectra to high-resolution data of M and T dwarfs implies parameters that agree with the current understanding of brown dwarf evolution. Although we can derive more reliable parameters at high resolution, available data is scarce and observations require large telescopes (e.g. NIRSPEC on Keck). In contrast, low- and moderate-resolution data is widely available for L dwarfs (from SpeX, FIRE, Triplespec, etc). Using a sample of normal L dwarfs with low-resolution SpeX data, we are determining realistic uncertainties on model fits to low-resolution data. We are employing Markov chain Monte Carlo methods to robustly characterize degeneracies between model parameters and uncertainties on best-fit values. The overall goal of our project is to compare the parameters implied by fitting synthetic spectra from multiple atmospheric models to observed L dwarf data at multiple resolutions. We will present preliminary results showing how well (or poorly) model fits

to low-resolution spectra of L dwarfs can constrain effective temperature, surface gravity, and other physical parameters.

HCO+ in LkCa 15 transitional disk

Emily Drabek-Maunder[1]

[1]*Imperial College London*

Abstract. LkCa 15 is an extensively studied star in the Taurus molecular cloud known for its transitional disk. This disk is observed to have a large cavity in dust continuum emission with a normal gas accretion rate onto the central star. Gaps in transitional disks have been proposed to result from the interaction of multiple planets forming in the disk, but there are currently few observations available to support this claim. If multiple planets do create these observed cavities, it is possible the gas would flow across the gap to accrete onto the star with relatively little accretion onto the planets themselves. We present single-spectrum HCO+ J=4-3 observations of the LkCa 15 transitional disk from the JCMT. We will further investigate the process of accretion in the system by estimating the amount of gas that is present in the disk cavity. This allows us to distinguish between two possible driving scenarios for the stars high accretion rate, including high surface-density gas flowing at slower radial velocities or low surface-density gas moving at high velocities (potentially by means of streamers).

Stellar Spectroscopy during Exoplanet Transits: Dissecting fine structure across stellar surfaces

Dainis Dravins[1]

[1]*Lund Observatory, Sweden*

Abstract. Stellar Spectroscopy during Exoplanet Transits: Dissecting fine structure across stellar surfaces Dainis Dravins(1), Hans-Gnter Ludwig(2), Erik Dahln(1), Hiva Pazira(1,3) (1) Lund Observatory, Box 43, SE-22100 Lund, Sweden (2) Zentrum fr Astronomie der Universitt Heidelberg, Landessternwarte Knigstuhl, DE-69117 Heidelberg, Germany (3) Department of Astronomy, AlbaNova University Center, SE-10691 Stockholm, Sweden Differential spectroscopy during exoplanet transits permits to study small stellar surface portions that successively become hidden behind the planet. Deduced

center-to-limb behavior of stellar line shapes, asymmetries and wavelength shifts will enable detailed tests of 3-dimensional hydrodynamic models of stellar atmospheres, such that are required for any precise determination of abundances or seismic properties. Such models can now be computed for widely different classes of stars (including metal-poor ones and white dwarfs), but have been feasible to test in any detail only for the Sun with its resolved surface structure. Exoplanet transits may also occur across features such as starspots, whose magnetic signatures could be retrieved from spectra of sufficient fidelity. Knowing the precise background stellar spectra, also properties of exoplanet atmospheres are better constrained: e.g., the Rossiter-McLaughlin effect becomes resolved as not only a simple change of stellar wavelengths, but as a variation of the full line profiles and their asymmetries. These studies are observationally challenging since exoplanets cover only a tiny fraction of the stellar disk. Current work with lowest-noise ESO VLT/UVES spectra demonstrates that spatially resolved stellar spectra can be reconstructed for the brightest exoplanet host stars. Ongoing exoplanet surveys will likely find other bright hosts to be observed with existing spectrometers, but forthcoming high-fidelity instruments such as PEPSI on LBT or ESPRESSO on VLT will be required to extend such studies to also fainter and rarer stellar types.

Activity of quiet stars reveals their inclination

Xavier Dumusque[1]

[1] *Harvard Smithsonian Center for Astrophysics*

Abstract. Stellar activity, even in quiet stars, is an important limitation to very high precision radial velocity (RV) measurements, which complicates the detection of small mass planets. However activity gives us some important information on stars: activity level, rotational period, presence of differential rotation, presence of magnetic cycles, age with gyrochronology. I will show with this presentation that modeling activity can give us the inclination of the star relative to the line of sight. Several active region simulations have tried to reproduce the variation seen in RVs. These models, assuming dark spots, are successful to explain the RV variation seen on active stars, however cannot explain the modulation seen on quiet stars where plages are dominating. In addition, in these simulations, degeneracy exists between active region latitude and stellar inclination, making it impossible to access to one of these parameters independently. With a new model to simulate the RV effect of spot and plages, based on solar spectra, we manage to reproduce the variation that is observed on HD189733 (spot dominated) and Alpha Centauri B (plage dominated). A good match is observed for the RV variation, but also for others parameters of the cross correlation func-

tion such as the bisector span (BIS) and the FWHM. Modeling these three parameters at the same time and comparing with observations allows us to strongly reduce the degeneracy between latitude and inclination, and therefore to measure stellar inclination. Stellar inclination angle with a precision of 20 degrees can be measured and even better if simultaneous photometry exists. This will allow us, without any Rossiter McLauglhin measurement, to calculate the spin orbit angle of transiting planets, and also, assuming a spin orbiting alignment, the true mass of non-transiting planets only detected with RVs.

Airborne Transit Observations of Cool Stars

Edward Dunham[1]

[1]*Lowell Observatory*

Abstract. Multicolor data taken during an exoplanet transit locally probe starspots, limb darkening, and surface temperature variation of the host star as well as determining important planetary parameters. The High-speed Imaging Photometer for Occultations (HIPO) is a 2-channel CCD imager for SOFIA originally designed to observe stellar occultations but now also being applied to transit work. HIPO can be co-mounted with FLITECAM, a 1-5 micron imager and grism spectrometer, the combination being known as FLIPO. By adding images from SOFIA's science-grade guide camera to the FLIPO data we can obtain simultaneous data at four wavelengths, three optical and one IR. Bright stars with no nearby comparison star are often difficult to observe, but will be among the best targets for SOFIA. Cool IR-bright stars will be good FLITECAM targets for water-sensitive observations, and will be sufficiently faint optically that nearby comparison stars are likely to be available for differential correction. We look forward to the additional targets, bright, red, or both, that the K2 and TESS missions are likely to provide. We have been exploring the precise photometric performance of FLIPO with an eye toward exoplanet transit and host star characterization work through specific tests and a demonstration transit observation involving the cool, spotted star HD 189733. We describe here the progress made to date with the HIPO data. We have had some success with absolute HIPO photometry on isolated bright stars thanks to the low and stable extinction in the stratosphere. Important corrections include: Rayleigh scattering, ozone absorption in the Chappuis band, image position sensitivity, focus errors, and mean static air density. The density effect is related to PSF broadening

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by scattering in the turbulent shear layer over the telescope. An expected shear layer dependence on Mach number appears to be unimportant.

TW Hya: Insights from Time-Domain Multi-Wavelength Spectroscopy

Andrea Dupree, N. S. Brickhouse, S. R. Cranmer[1]

[1] *Harvard-Smithsonian CfA*

Abstract. High resolution ultraviolet, optical, and near-infrared spectra of TW Hya, the nearest accreting T Tauri star, cover a decade and reveal substantial changes in accretion and wind properties in one star. Stable absorption features in H-alpha, appear caused by an accreting column silhouetted in the stellar wind. Measurements of dynamics from the line profiles support a dipole accretion model: the free-fall velocity of material correlates inversely with the strength of the post-shock emission. Terminal outflow velocities appear to be directly related to the amount of post-shock emission, giving evidence for an accretion-driven stellar wind. Line-profiles when compared to existing models suggest that 3 elements are needed: (1) a turbulent post-shock region producing chromospheric emission; (2) an accretion-driven stellar wind; (3) infalling material.

Permitted Emission Line Profiles in T Tauri Stars

Suzan Edwards[1]

[1] *Smith College*

Abstract. Permitted Emission lines in Classical T Tauri stars often have complex kinematic features that suggest a composite origin. We have begun a line profile analysis for 18 classical T Tauri stars based on simultaneous HIRES and NIRSPEC spectra with the goal of identifying kinematic components in different lines and comparing their line ratios to the local line excitation models of Kwan and Fischer (2011). Decomposition of permitted lines in T Tauri stars into broad and narrow components has been a recognized approach since Hamann and Persson (1992). To date, we have decomposed lines of the Paschen series, Ca II infrared triplet, He I 5876 and OI 8446 into multiple Gaussian components. While some lines have simple Gaussian shapes, others require up to three components to describe the ob-

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served profiles. We identify commonalities among these three lines and use ratios of similar kinematic components to explore physical conditions in the line-forming region.

Current Results of the Living with a Red Dwarf Program: Activity-Rotation-Age Relationships for M-dwarfs

Scott G. Engle[1]

[1] *Villanova University*

Abstract. Red Dwarfs (dM-stars) make up over 75% of the local stellar population. This is among the reasons they are being targeted in more planet-hunting programs. As such, the ability to accurately estimate the age of a field dM star is of critical importance. However, due to their long lifetimes and very slow nuclear evolution, the best method for determining ages is likely through magnetic tracers such as X-UV activity levels and stellar rotation rates. The Living with a Red Dwarf programs database of dM-stars with photometrically determined rotation periods (via starspot modulations) is becoming substantial. It has recently been expanded to include dM stars with well-detached WD companions through which reliable ages can be determined. When combined with dM stars possessing cluster/population memberships, or specific kinematics, a full range of calibrators is being realized. We report on our continuing efforts to build reliable Activity-Rotation-Age relationships for dM-stars, utilizing X-UV measures obtained by us with HST and Chandra, as well as archival data. Such relationships permit the assessment of the habitability of planets hosted by red dwarfs, by delineating the X-UV radiation environments these planets are exposed to, and have been exposed to in the past. After proper calibration, the relationships can also permit the age of a field red dwarf (and their hosted planets) to be determined through measures of either its rotation period or X-UV activity level.

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Searching for brown dwarfs in Chamaeleon

Taran Esplin[1]

[1]*Penn State University*

Abstract. We present a survey for brown dwarfs in the Chamaeleon I star-forming region. Candidates were selected using proper motions and photometry obtained from a variety of telescopes and verified by limited spectroscopy. With our survey, we are able to measure the initial mass function of Chamaeleon down to 0.01 solar mass.

Little Imbalance in Gravitational Pressure of Sun Causing Deadly Climate Change on Earth.

Ahmad Reza Estakhr[1]

[1]*Researcher*

Abstract. It was believed that the sun-like Stars are quite stable for millions of years, results of my researh shows this belief may not be true. when the gravitational compression reduces the size of the core, increasing temperature of earth. and the outward thermal pressure (from fusion reactions)

increases the size of the core of sun, reducing temperature of earth, this was the reason of 2014 deadly cold wave.

The Influence of Magnetic Fields on the Structure of Low-Mass Stars

Gregory Feiden[1]

[1] *Uppsala University*

Abstract. Magnetic fields are increasingly being invoked to explain discrepancies between observations of the fundamental properties of low-mass stars and predictions from stellar evolution models. However, the efficacy of the magnetic field hypothesis remains unclear. Results from different stellar evolution codes that include effects of magnetic fields agree about the properties of magnetic fields required to relieve the observed discrepancies. But, there are differing interpretations about whether the required magnetic properties are physically plausible. Star spots have also been invoked to explain the same phenomena, but they, too, skirt the realm of what is thought to be physically realistic. In this talk, I will review the current evidence for and against the hypothesis that magnetic fields are strongly impacting the structure of low-mass stars. Emphasis will be placed on results obtained using so-called "magnetic" stellar evolution models that have been used to explain discrepancies in low-mass eclipsing binaries, young stellar associations, and relatively young open clusters. Along the way, I will attempt to take seemingly disparate and contradictory pieces of evidence and form them into a cohesive picture of how magnetic fields are influencing the structure of low-mass stars.

Updating the Dartmouth Stellar Evolution Model Grid: Pre-Main-Sequence Models & Magnetic Fields

Gregory Feiden[1]

[1] *Uppsala University*

Abstract. We present the current status of an effort to create an updated grid of low-mass stellar evolution mass tracks and isochrones computed using the Dartmouth stellar evolution code. Emphasis is placed on reliably extending the present grid to the pre-main-sequence, where modeling uncertainties

have the greatest impact. Revisions to the original code release include: updated surface boundary conditions, the introduction of deuterium burning, and magnetic fields. The mass track grid contains models with a mass above 0.1 solar masses and metallicities in the range of -0.5 dex to +0.5 dex. Magnetic mass tracks are calculated for surface magnetic field strengths between 0.1 kG and 6.0 kG using two different prescriptions for magneto-convection. Standard and magnetic model isochrones are available for ages older than 1 Myr. Tabulated quantities include the stellar fundamental properties, absolute photometric magnitudes, magnetic field properties, convective turnover times, apsidal motion constants, and lithium abundances. The complete grid of mass tracks and isochrones will be publicly available.

A Progress Report on New Spectroscopic Orbits of Potential Interferometric Binaries

Francis C. Fekel, Michael H. Williamson, Matthew W. Muterspaugh, Jocelyn Tomkin[1]

[1] *Tennessee State University*

Abstract. We discuss the status of a program to obtain radial velocities from high-resolution, red-wavelength spectra to improve the orbits of bright known spectroscopic binaries that are potential targets of ground-based interferometers. Most of the 30 orbits still to be published are solar-type stars or late-type giants. Of the 55 systems that have been extensively observed in this project, four or 7% have been found spectroscopically to have a long-period companion, making the systems at least triple. Of the remaining 30 systems, we have detected the secondary of a dozen former single-lined binaries. The combination of spectroscopy and astrometry from interferometric observations will result in three-dimensional orbits and so will produce many additional systems with masses to better than 1% and well determined dis-

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tances. Orbital inclinations for some of our stars can also be obtained with astrometry from the upcoming GAIA mission.

On the gas content of transitional disks: a VLT/X-Shooter study of accretion and winds

Carlo Felice Manara[1]

[1] *European Southern Observatory*

Abstract. Transitional disks are thought to be a late evolutionary stage of protoplanetary disks whose inner regions have been depleted of dust. The mechanism responsible for this depletion is still under debate. To constrain the various models proposed to explain this phase it is mandatory to have a good understanding of the properties of the gas content in the inner part of the disk. Using the VLT/X-Shooter spectrograph, which is a broad band - UV to NIR - medium resolution instrument, we derive the stellar, accretion, and wind properties of a sample of 22 transitional disks. The analysis of these properties allows us to put strong constraints on the gas content in a region very close to the star (¡ 0.2 AU) which is not accessible with any other observational technique. With a self-consistent technique we derive mass accretion rates and wind properties of all the targets. The accretion rates and wind properties of 80% of the transitional disks in our sample are comparable to those of classical TTauri stars. Even considering the incompleteness of our sample, this shows that there are (at least) some transitional disks with accretion properties compatible with those of classical TTauri stars. Only in 2 cases the mass accretion rates are much lower, while the wind properties remain similar. We do not see any strong trend of the mass accretion rates with the size of the dust depleted cavity, nor with the presence of a dusty optically thick disk very close to the star. These results suggest that the

inner disk of the strongly accreting transitional disks in our sample is still gas-rich. Here we present the results of this work.

Expanded SEDs and Bolometric Luminosities as Direct Measures of Brown Dwarf Physical Parameters

Joe Filippazzo[1]

[1] *City University of New York*

Abstract. Bolometric luminosities are one of the few direct measurements we can make to characterize low mass stars and brown dwarfs in the absence of observations such as asteroseismology, interferometry and eclipsing binaries. Combining optical and near-infrared spectra with optical, NIR and MIR photometry, we construct detailed spectral energy distributions for a sample of 135 brown dwarfs across effective temperatures of 700-2800K for both field age (3-5 Gyr) and young (10-150 Myr) objects. Model atmospheres are used to fill gaps in the spectra and parallaxes and kinematic distances provide precise measurement of bolometric luminosities while minimizing assumptions about the source. This technique will greatly expand the number of touchstones we have to characterize the atmospheres and evolution of substellar objects. And a sample of such breadth will improve our understanding of the effects of physical parameters such as effective temperature, surface gravity and clouds on brown dwarf spectra and allow us to find new young candidates.

X-ray activity and proto-planetary disks - new insights from the Coordinated Synoptic Investigation of NGC2264 (CSI NGC2264)

Ettore Flaccomio[1]

[1] *INAF - Osservatorio Astronomico di Palermo*

Abstract. The evolution of proto-planetary disks is affected by the central protostars through irradiation and magnetic interactions. X-ray/UV coronal and accretion-shock emission may drive gas ionization and heating and, consequently, photo-evaporation and disk dispersal. The magnetosphere connecting the star and inner disk mediates mass and angular momentum exchanges and modifies the disk structure. These processes are coupled since

the intensity of X-ray/UV irradiation depends the physical and geometrical characteristics of disks, as well as to those of stellar coronae and accretion shocks. Observational evidence of huge warps in the inner disks, due to the interaction of a tilted magnetosphere with the ionized disk gas, have recently been found. These still-unclear processes are highly dynamic and involve material emitting in different bands: the inner disk dust (mIR), the stellar photosphere (optical), accretion shocks (UV/X-rays), and coronae (X-rays). Observationally, multi-band, time-resolved studies are therefore needed. I will presents selected results form the Coordinated Synoptic Investigation of NGC2264 (CSI NGC2264), an unprecedented multi-wavelength month-long observing campaign of the NGC2264 star forming region. Three space telescopes (Spitzer, CoRoT and Chandra) were employed to simultaneously monitor a rich sample of 3Myr old stars in in the mid-IR, optical and X-ray bands. This data is allowing an unprecedented characterization of the dynamics of the respective emission regions as well as of their interactions. I will investigate the relations among X-ray (coronal) and optical (photospheric)/mid-IR(disk) emission, on timescale from hours to 1 month, with particular reference to the obscuration of coronal plasma by temporally varying disk structures.

Near-Infrared Radial Velocities of Hundreds of Kepler Eclipsing Binaries With APOGEE

Scott Fleming[1]

[1]*STScI*

Abstract. Combining precise photometric and spectroscopic data of detached eclipsing binaries (EBs) can be used to derive masses and radii of the stellar components to a few percent. At this level, the derived masses and radii can be used to constrain new models of stellar structure. One active area of research involves observed radii of stars that are larger than model predictions. This effect is largely seen for stars with masses $< 0.8\ M_{\rm solar}$. However, the sample of EBs with high-precision measurements is largely underpopulated at low masses and long periods. Here we present early results of our program to observe 100 Kepler EBs in two fields with APOGEE as part of SDSS-III. This high resolution (22500), near-infrared (H-band), multi-object (230 science targets), RV-stable (100-200 m/s) spectrograph is ideal for studying Kepler EBs, particularly those with low flux contrast. We derive masses and radii at the few percent level for F/G + K/M EBs that are part of our sample. Such systems are particularly well-suited for studying the mass-radius relationship. Our sample also includes pairs of stars with mass ratios close to unity (to within 1-2%). Such mass "twins" also provide a useful testbed for stellar internal structure, since any observed differences in radii or effective temperature in stars with essentially the same mass

attest to the component interactions that change stellar evolution mechanisms. Finally, we highlight plans to observe another several hundred EBs with APOGEE in SDSS-IV from both Kepler and the ground-based KELT transit survey.

The evolution of surface magnetic fields in young solar-type stars

Colin Folsom[1]

[1] *Institut de Recherche en Astrophysique et Plantologie*

Abstract. The surface rotation rates of young solar-type stars decrease rapidly with age from the end of the pre-main sequence though the early main sequence. This suggests that there is also an important change in the dynamos operating in these stars, which should be observable in their surface magnetic fields. Here we present early results in a study aimed at observing the evolution of these magnetic fields through this critical time period. We are observing stars in open clusters and stellar associations to provide precise ages, and using Zeeman Doppler Imaging to characterize their complex magnetic fields. Results for ten stars, in four associations between 21 Myr and 125 Myr old, are presented. We find a trend towards weaker less dipolar magnetic fields with age, but no clear trends with rotation period. Observations are in progress to extend the sample to a wider range of ages and rotation periods.

Brown Dwarfs in Young Moving Groups

Jonathan Gagn[1]

[1] *Universit de Montral*

Abstract. This poster presents the current status of the BANYAN All-Sky Search (BASS) for late-type (¿ M5) members to young moving groups. This includes candidate selection strategy as well as first results of a spectroscopic follow-up. The BASS survey already allowed us to uncover a few dozen

completely new young candidates in nearby moving groups, as well as a few planetary-mass companions.

Young Brown Dwarfs in Nearby Moving Groups

Jonathan Gagn[1]

[1] *Universit de Montral / Caltech*

Abstract. In this talk, I will first wrap up the principal characteristics and performance of your new BANYAN II Bayesian inference algorithm that estimates the membership probability of low-mass stars and brown dwarfs to nearby, young moving groups, without the need of having radial velocity or parallax measurements. Then, I will present how we used BANYAN II in a cross-correlation of the whole 2MASS and WISE catalogs to identify several hundreds of late-type candidates to moving groups in this way. This will be followed by the presentation of the current status of an extensive follow-up with optical and near-infrared spectroscopy (FIRE, SpeX, GMOS-S, GMOS-N, OSIRIS, MAGELLAN) to find signs of low-gravity (thus youth) in our target sample. These results include new, very compelling young mid-M to early-L brown dwarf candidates to TW Hydrae, Beta Pictoris, Tucana-Horologium, AB Doradus, Columba, Carina and Argus.

A Map for the World: An All-Sky Catalog of the Nearest, Brightest M Dwarf Stars

Eric Gaidos[1]

[1] *University of Hawaii at Manoa*

Abstract. The nearest, brightest M dwarf stars are considered the most propitious targets in the search for and study of Earth-size and habitable, Earth-like planets. We have constructed the largest all-sky catalog of nearby bright M dwarfs to date: 2600 stars with J¡9 selected by parallax or proper-motion and confirmed by spectroscopy and visible and infrared colors. Stars were selected from the Lepine SUPERBLINK proper motion catalog after cross-correlating with the 2-MASS, Hipparcos, Tycho-2 catalog and All-Sky Compiled Catalog v. 2.5. Visible-wavelength photometry was obtained by matching sources in the AAVSO Photometry All-Sky Survey (release 7). Moderate resolution spectra of more than 90% of the catalog were obtained at

four telescopes on three continents and Hawaii. Our magnitude-limited catalog is dominated by early-subtype (M0-M4) dwarfs. Calculation of gravity-sensitive indices from these spectra show the contamination rate by giant stars to be much less than 1%. We find the effective temperatures of the stars by fitting predictions of the BT-SETTL version of the PHOENIX stellar atmosphere model to our spectra and calibrating the best-fit temperature against observations of well-characterized Boyajian et al. interferometry targets. We use the empirical relations revised by Mann et al. to convert temperatures into stellar radii, luminosities and masses. These parameters can be used both to estimate the mass or radii of planets found by the Doppler or transit methods, respectively, and for accurately determining the occurrence of planets in the sample. For a subset of the catalog observed by an integral field spectrograph we estimate metallicities and screen for binaries. The distribution of [Fe/H] is Gaussian with a mean of -0.03 dex, consistent with previous studies. Finally, we estimate the number of planets that will be discovered in the habitable zones of these stars by future exoplanet surveys.

Chemical abundance analysis of the symbiotic red giants

Cezary Ga?an[1]

[1] *Nicolaus Copernicus Astronomical Center of the PAS, Warsaw, Poland*

Abstract. Symbiotic stars are the long period, interacting binary systems composed of red giant donors and white dwarf companion (occasionally replaced by a neutron star). Their study is therefore very important to understand interacting binary evolution involving RGB/AGB stars. Knowledge of the elemental abundances is of special significance since they can be used to track mass exchange history. However, the number of symbiotic giants with fairly well determined photospheric composition is insufficient for any statistical considerations, and most are G or K-type giants whereas vast majority of symbiotic stars contain M-type giants. Here we present the detailed chemical abundance analysis obtained for roughly a dozen of M-type symbiotic giants. The analysis is based on the high resolution (R 50000), high S/N 100, near-IR spectra (at H- and K-band regions) obtained with Phoenix/Gemini South spectrometer. Spectrum synthesis employing standard LTE analysis and atmosphere models was used to obtain photospheric abundances of CNO and elements around the iron peak (Sc, Ti, Fe, and Ni). Our analysis reveals a significantly sub-solar metallicity, [Fe/H] -0.75, for the RW Hya giant confirming its membership of the Galactic halo population. We obtained slightly sub-solar metallicities ([Fe/H] -0.2 - -0.45) in 60% objects and a near-solar metallicities were found in the rest cases of our sample. The very

low 12C/13C isotopic ratios, 6-11, in almost all these giants indicate that they have experienced the first dredge-up.

Extreme High-Spatial Resolution Imaging of the Lowest Mass Pleiades

Eugenio Victor Garcia[1]

[1]*Lowell Observatory*

Abstract. The Pleiades is an ideal venue for studying observed discrepancy in brown dwarf binary frequency between field (few Gyr) and young star-forming region (few Myr) populations given its intermediate age (120+/-20 Myr). We have obtained Hubble Space Telescope Wide Field Camera 3 UVIS observations of a sample of the most recently discovered ¡ 40 Mjup brown dwarfs in the Pleiades. Given the excellent stability of the WFC3 point-spread function, we have developed a binary fitting technique which allows us to search for the existence of companions at tight separations of lambda/2D (30 mas, 4 AU). Such angular resolution is only matched by aperture masking techniques on 10-m class telescopes and visible light AO at Magellan. These constraints allow us to test if our sample is consistent with the binary frequency of field brown dwarfs at separations of 5 AU, where most companions are known to exist. This high angular resolution binary fitting technique can be extended to WFPC2, NICMOS and ACS observations of Pleiades and field brown dwarfs, allowing for a search of companions at tight separations.

The Gran Telescopio CANARIAS Variable Star One?Shot Project

David Garcia-Alvarez[1]

[1]*IAC, La Laguna, Tenerife, Spain*

Abstract. Stellar variability types are assigned on the basis of lightcurve appearance, which often remains unchallenged without further observational evidence. The VSOP (Variable Star One-shot Project) is a large international collaboration, which has so far obtained spectra of more than 1200 stars during the past few years using ESO facilities. Operationally this program is perfectly suited for a modern, efficient observatory, providing the

10,4m Gran Telescopio CANARIAS (GTC) with a large pool of filler observations. Scientifically, our aims are: (1) obtain first spectroscopy of all unstudied variable stars suitable for GTC, (2) generate an influx of serendipitous discoveries across all fields of astrophysics, (3) provide data products to the public in a fast and automatic way.

Magnetic Modulation of Stellar Angular Momentum Loss

Cecilia Garraffo[1]

[1]*Harvard-Smithsonian Center for Astrophysics*

Abstract. Angular Momentum Loss (AML) is important for understanding astrophysical phenomena such as stellar rotation and magnetic activity, close binaries, and cataclysmic variables. Magnetic breaking is the dominant mechanism in the spin down of young late-type stars. We study AML as a function of stellar magnetic activity. We argue that the complexity of the field and its latitudinal distribution are crucial for the AML rates. AML is modulated by magnetic cycles and stellar spin down is not just a simple function of large scale magnetic field strength.

A mid-IR imaging search for substellar companions of the nearest stars

Bartosz Gauza[1]

[1]*Instituto de Astrofisica de Canarias*

Abstract. At the relatively old ages of the solar vicinity, very low-mass brown dwarfs and massive planetary companions have cooled down to temperatures below 500-600 K and emit most of their flux in the mid-IR. In this talk we outline the first results of our program aiming at detection of substellar companions of the nearest stars of the Northern Hemisphere. We use the mid-infrared instrument CanariCam operating at the 10.4 m GTC telescope, to perform a deep, direct imaging search in the N-band (Si-2 filter, 8.7 ?m), reaching the diffraction limit of the telescope. We are sensitive to objects with fluxes above 0.5 mJy at 8.7 microns and at separations in the range from 1 to 10 arcsec, which translates into planet masses down to 10 MJup and physical separations of 5-45 AU for our sample stars. These separations imply relatively long orbital periods (P¿12 yrs), which are yet

unexplored with astrometry or radial velocity programs, and offers a unique opportunity to explore the separations where giant planets are expected to form.

Characterization of WD 0806-661B Using Spitzer and Hubble Space Telescope Photometry

Christopher R Gelino[1]

[1] *NASA Exoplanet and Science Institute*

Abstract. WD 0806-661B, a common proper motion companion to a white dwarf, was discovered by multi-epoch Spitzer observations. The IRAC colors and absolute magnitudes indicate that it is a brown dwarf approximately as cold as the ¿=Y2 dwarf WISE 1828+2650, the coldest spectroscopically confirmed brown dwarf (Teff 300K). We have obtained multi-wavelength HST WFC3/IR observations to characterize this object over a broad spectral regime. In this poster we present these data and, in conjunction with the Spitzer data, compare WD 0806-661B with late-type T dwarfs and Y dwarfs.

On the Spectroscopic Properties of the Retired A Star HD 185351

Luan Ghezzi[1]

[1] *Harvard-Smithsonian CfA*

Abstract. Doppler-based planet surveys have shown that, besides metallicity, the planet occurrence is also correlated with stellar mass, increasing from M to F-A spectral types. However, it has recently been argued that the subgiants (which represent A stars after they evolve off the main sequence) may not be as massive as suggested initially, which would significantly change the correlation found. To start investigating this claim, we have studied the subgiant star HD 185351, which has precisely measured physical properties based on asteroseismology and interferometry. An independent spectroscopic differential analysis based on excitation and ionization balance of iron lines yielded the atmospheric parameters Teff = 5035 +- 29 K, log g = 3.30 +- 0.08 and [Fe/H] = 0.10 +- 0.04. These were used in conjunction with the PARSEC stellar evolutionary tracks to infer a mass M = 1.77 +- 0.04 Msun, which agrees well with the previous estimates. Lithium abundance was also

estimated from spectral synthesis (A(Li) = 0.93 +- 0.30) and, together with Teff and [Fe/H], allowed to determine a mass M = 2.0 [+0.1 -0.3] Msun, which is independent of the star's parallax and surface gravity. Although a variation of up to 0.4 Msun can be observed between the different measurements, all values are higher than 1.6 Msun, which supports the correlation between planet occurrence and stellar masses.

The Variability of Photospheric Line Bisectors in the Sun-as-a-Star

Mark Giampapa[1]

[1] *National Solar Observatory*

Abstract. We utilize spectra obtained with the SOLIS Integrated Sunlight Spectrometer (ISS) to examine the variability of line asymmetries in selected solar photospheric lines since 2007. The intrinsic asymmetry that characterizes the photospheric lines in the Sun and late-type stars arises from the velocity-brightness correlation between hotter and brighter upward (blue shifted) moving granules and downward (redshifted) flowing plasma in the intergranular lanes. Thus, the intrinsic line asymmetries present in the ISS spectra are a diagnostic of the nature of global velocity fields in the solar or stellar atmosphere. We adopt the line bisector as a measure of the intrinsic asymmetry and calculate various measures of the velocity span, or amplitude, in the Mn I line at 539.5 nm and the nearby Fe I feature at 539.3 nm, respectively. We examine the correlation of the time series of velocity spans in these features with the solar cycle as manifested in the Ca II K line. The National Solar Observatory is operated by the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation.

Investigating the Coronal Dynamics of High Differential Rotation Stars

Gordon Gibb[1]

[1] *University of St Andrews*

Abstract. We investigate the effects of various differential rotation rates and photospheric surface diffusion constants on the formation time and lifetime of a flux rope formed along the polarity inversion line of a decaying

bipolar active region. In order to do this we apply a magnetic flux transport model to determine the evolution of the stellar photospheric field. This evolving photospheric field is used to drive the evolution of the coronal magnetic via a magnetofrictional technique. We find that increasing the differential rotation rates (decreasing equator-pole lap times) decreases the flux rope formation times. Increasing the photospheric surface diffusion decreases the formation times. We find that the formation time is approximately proportional to the square root of the lap time. The lifetimes of flux ropes are found to be proportional to the lap times, with stars with differential rotation rates of eight days having lifetimes of only two days. We conclude that such high differential rotation stars may have very dynamical coronae. Additionally, we propose that features such as the prominences observed on the Sun may not be able to form on very high differential rotation stars, as the lifetimes of the flux ropes in which the cool plasma condenses may be shorter than the radiative collapse timescale for the plasma.

The first low-mass, pre-main sequence eclipsing binary with evidence of a circumbinary disk

Ed Gillen[1]

[1] *University of Oxford*

Abstract. We present a new double-lined, detached eclipsing binary, which comprises two pre-main sequence M dwarfs and shows evidence of circumbinary material. This unique system, which could be a precursor of the circumbinary planetary systems discovered by Kepler, enables us to test evolutionary models of low mass stars, and the interaction between a close binary and a circumbinary disk. It was discovered by the CoRoT space mission during a continuous, 23-day observation of the NGC2264 star-forming region. We used the CoRoT photometry together with WHT/ISIS and VLT/FLAMES spectra to solve the orbit and derive the fundamental parameters of both stars, obtaining: Porb=3.874575 0.000001 days, M1=0.67 0.01 M?, M2=0.495 0.007 M?, R1=1.30 0.04 M? and R2=1.11 0.05 R?. This system lies in a region of parameter space where observational constraints of stellar evolution models are scarce; comparison with several families of these models indicates an apparent age of ?3.56 Myr, consistent with the age of NGC2264. The systems spectral energy distribution shows a mid-infrared excess that can be modelled as thermal emission from dust in the inner cavity of a circumbinary disk. Additionally, the CoRoT light curve contains large-amplitude, rapidly evolving out-of-eclipse variations, which might be due in part to occultations of the central stars by the dust or the inner edge of the disk. We are now analysing the out-of-eclipse variability using a second season of coordinated CoRoT, Spitzer and CFHT/MegaCam observations. We will also discuss variations in the systems multi-component

H? line profile. This is one of a dozen eclipsing binary systems discovered during CoRoT observations of NGC2264, spanning a wide range of primary masses, mass ratios and orbital periods. We are in the process of obtaining orbital solutions for all of these, and I will also present a brief update on this work.

The nature of variability in early L dwarfs

John Gizis[1]

[1] *University of Delaware*

Abstract. The M/L transition features the onset of dust formation, a change on character in magnetic activity, and the hydrogen-burning limit. I report on Kepler and Spitzer observations of a nearby L1 dwarf. Starspots, clouds, and aurorae have all been proposed as causes of variability in early L dwarfs; I show how the space and ground-based observations constrain and rule out many scenarios. Besides the periodic variations, white light flares are detected, and I discuss the importance of flares in the magnetic energy budget.

Observational constraints to the magnetospheric structure of T Tauri stars

Ana Ins Gmez de Castro[1]

[1] *AEGORA Research Team, Universidad Complutense de Madrid*

Abstract. UV observations of the TTSs have provided a coherent view of the magnetospheric structure of the TTSs suitable to be compared with the predictions of theoretical models on the atmospheric physics, the interaction between the magnetosphere and the Keplerian disk and the source of the

jets and outflows. In this poster we will present the summary results for the overall magnetospheric structure.

Observational constraints to the physics of the jets of TTSs from UV observations

Ana Ins Gmez de Castro[1]

[1]*AEGORA Research Team, Universidad Complutense de Madrid*

Abstract. UV observations of the TTSs have provided a coherent view of the magnetospheric structure of the TTSs suitable to be compared with the predictions of theoretical models on the atmospheric physics, the interaction between the magnetosphere and the Keplerian disk and the source of the jets and outflows. In this poster we will present the summary results for the jet formation region and launching mechanisms.

Observational constraints to the atmospheric structure and the accretion shocks

Ana Ins Gmez de Castro[1]

[1]*AEGORA Research Team, Universidad Complutense de Madrid*

Abstract. UV observations of the TTSs have provided a coherent view of the magnetospheric structure of the TTSs suitable to be compared with the predictions of theoretical models on the atmospheric physics, the interaction between the magnetosphere and the Keplerian disk and the source of the

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jets and outflows. In this poster we will present the summary results for the stellar atmosphere and the accretion shocks.

The Young Solar Analogs Project

Richard Gray, Christopher Corbally, Jon Saken[1]

[1]*Appalachian State University*

Abstract. The Young Solar Analogs project (Appalachian State University, Vatican Observatory) has monitored 31 solar-type stars with ages between 300 Myr and 1.5 Gyr since 2007. The ultimate goal of the project is to give insight into the conditions in the early solar system when life was establishing a foothold on the earth. That early life had to contend with a hostile space environment: strong X-ray and UV fluxes, irradiance variations one to two orders of magnitude greater than seen today, and strong flares and coronal mass ejections. From the beginning we have been monitoring our set of young late F- to early K-dwarfs spectroscopically at Ca II H & K and in the G-band. We began monitoring these stars photometrically in a 5-band system (Stromgren-v, Johnson-Cousins B, V, and R, and narrow-band H-alpha) in 2011. Recently, we started high-cadence, high-S/N spectroscopy of our program stars with the Vatican Advanced Technology Telescope, and are experimenting with high-cadence photometry in order to detect and characterize flares. After nearly 7 years of monitoring we see a variety of stellar cycling behavior in both Ca H & K and in the G-band. We have also determined rotational periods, detected differential rotation, and have evidence for active longitudes in a number of our program stars. Many of our stars also show periods between 30 and 60 days that may be related to the convective overturn timescale. We have confirmed for many of our stars the results of the Lowell SSS project that found that young solar-type stars are fainter at activity maximum, opposite to the behavior of the sun. We have found that this inverse behavior extends to rotational modulation – these young stars brighten when a large spot passes across the

visible hemisphere. We will also review early results from our high cadence program.

HST FUV monitoring of TW Hya

Hans Moritz Guenther[1]

[1] *CfA*

Abstract. Classical T Tauri stars (CTTS) show strong, broad and asymmetric FUV emission lines. Neither the width, nor the line profile is understood. Likely, different mechanisms influence the line profile; the best candidates are accretion, winds and stellar activity. We monitored the C IV 1548/1550 doublet in the nearby, bright CTTS TW Hya to correlate it with i) the cool wind, as seen in COS NUV Mg II line profiles, ii) the photometric period from joint ground-based monitoring, iii) the accretion rate as determined from the UV continuum and iv) the Ha line profile from independent ground-based observations. The observations span 10 orbits distributed over a few weeks to cover the typical time scales of stellar rotation, accretion and winds. On short time scales (seconds) the variability in the data is compatible with counting statistics when we take certain instrumental effects (the detector dead-time fraction increases when the wavelength calibration lamps are switched on). This rules out any type of coherent accretion shock fluctuation as predicted in some simulations. On longer time scales (days) variability of a factor of 3 in the continuum and similarly massive changes in the line shape are seen. The ratio of the two lines of the doublet indicates that the lines are optically thick, calling into question the idea that the blue-shifted components of the C IV lines are formed in the pre-shock region.

Revising the Wilson-Bappu effect

Cecilia Mara Guerra Olvera[1]

[1] *Universidad de Guanajuato*

Abstract. We use the versatile PHOENIX model atmosphere code, which includes a gravity-scaled chromosphere mode above the temperature minimum to model the Ca II K emission line profile for solar-type stars with

different gravity. With models matching the line profile and chromospheric emission fluxes of relatively inactive stars, we are able to reproduce the Wilson-Bappu effect. We also quantify the apparent mean temperature minimum for an entirely inactive Sun by a model matching the basal Ca II flux, which was observed on several occasions in the extraordinay 2008/9 minimum.

A Search for Disk-Born Stellar Companions

Kevin Gullikson[1]

[1] *University of Texas*

Abstract. Most stars form in binary or multiple systems through either the core fragmentation or circumstellar disk fragmentation mechanisms. While simulations of these processes can not yet follow the systems to a steady state, disk fragmentation tends to generate companions with a lower mass than core fragmentation. Disks around young intermediate-mass stars are massive enough to create low-mass stellar companions, like a scaled-up version of disk-instability planet formation. We will describe a survey of nearby main sequence A and B-type stars in which we specifically look for K/M companions within $\sim$ 100 AU. We use high signal-to-noise ratio, high resolution echelle spectra to search directly for the spectral lines of the secondary. This method can detect lower-mass companions than current adaptive optics imaging or radial velocity monitoring for companions from 20-50 AU for most stars in our sample, where we expect a population of disk-born companions may reside. In addition, the high signal-to-noise ratio measurements allow us to constrain the temperature of known single-lined spectroscopic binary companions. We will discuss early results of our survey, which is nearly complete for B stars.

The Radio and Optical Aurorae of Brown Dwarfs

Gregg Hallinan[1]

[1] *Caltech*

Abstract. Aurorae are detected from all the magnetized planets in our Solar System, including Earth. They are generated by powerful, magne-

tospheric current systems that lead to downward precipitation of energetic particles into the high-latitude regions of the upper atmosphere. In the case of the gas giant planets, these aurorae include intense radio emission at kHz and MHz frequencies produced by the downward precipitating electrons, and a myriad of continuum and line emission in the infrared, optical and ultraviolet associated with the collisional excitation and ionization of the hydrogen-dominated atmosphere. I will present radio and optical data of a low-mass dwarf of spectral type M8.5, located right at the boundary between stars and brown dwarfs, from which we have detected both radio and optical auroral signatures that bear striking resemblance to those detected from gas giant planets. The dissipated power associated with these aurorae is 10^6 times larger than those produced in the Jovian magnetosphere, revealing such emissions to be a scale-independent and potentially ubiquitous signature of magnetospheric current systems. As well as signalling a transition in magnetic activity at the end of the main sequence, auroral currents may play a causal role in modifying atmospheric opacity in near infrared bands, relating to recent reports of weather phenomena on cool brown dwarfs. In addition, I will present results from recent radio (VLA) and optical surveys (Keck) that extend studies of the auroral phenomenon into the L and T dwarf regime. In particular, the detection of radio emission from multiple candidates requires the presence of magnetic field strengths that are challenging for current dynamo theories.

Photometric Variability of Y Dwarfs

Kevin Hardegree-Ullman[1]

[1] *University of Toledo*

Abstract. Condensate clouds are present in brown dwarf atmospheres due to their low surface temperatures. Y dwarfs are the coolest (Teff ¡ 600 K) class of brown dwarfs currently known and thus allow us to study the unique atmospheric physics that occur at these temperatures including the formation of sulfide, chloride, and water clouds. Dynamic inhomogeneities in cloud cover should manifest as photometric variabilities in the observed light curves of brown dwarfs, as shown by Morales-Caldern et al. (2006) in two brown dwarfs at 4.5 microns, and Heinze et al. (2013) in one brown dwarf at 3.6 microns. We will describe our ongoing program to monitor fourteen Y dwarfs for photometric variability at 3.6 and 4.5 microns with the Spitzer Space

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Telescope and present initial results including the first detection of Y dwarf variability.

Astrometric Orbits and Masses for Three Low-mass Binaries

Hugh Harris, Conard Dahn, Trent Dupuy[1]

[1] *U.S. Naval Observatory, Flagstaff*

Abstract. Masses for low-mass stars and brown dwarfs are best determined dynamically using binary systems. Accurate astrometry of the photocenter of the unresolved binary, combined with one observation resolving the binary, can be used to determine the orbital elements. We present data for three systems, two heretofore unknown binaries and one previously studied. The orbital periods range from 7 to 13 years, a range where astrometric orbits can be well determined. Gaia data can help with these ground-based solutions, even with its partial orbital coverage, by providing accurate astrometric data for reference stars as well as the binaries.

The Kepler View of Flares on Low Mass Stars

Suzanne Hawley[1]

[1] *University of Washington*

Abstract. We report on our short cadence Kepler programs to monitor M dwarfs for flares. New flare frequency distributions are presented and the flare rates between active and inactive stars are compared. The timing distirbution of flares, and correlation with starspot phase, is also examined. The morphology of a typical flare light curve is analyzed in detail, and the various features are connected to physical properties of flare emission that have been inferred from previous ground-based spectroscopic and photometric data. One of our targets is a binary M dwarf and we use a novel technique

to separate the two light curves and determine the flare frequency distribution on each star.

Understanding the Suns activity to improve exoplanet radial-velocity detections

Raphaelle D. Haywood[1]

[1] *University of St Andrews*

Abstract. The detection and characterisation of low-mass exoplanets through radial-velocity (RV) surveys is predominantly limited by the intrinsic variability of the stars themselves. In order to understand and model the effects of stellar activity on RV observations, we use the Sun as a test case for study. Using HARPS spectra of sunlight reflected off the bright asteroid Vesta, we have obtained the Suns activity-driven RV variations over two solar rotations. Combining these results with high spatial resolution images from SDO/HMI allows us to deduce the RV signature of individual photospheric structures such as spots, faculae/plage, and surface granulation. We model the activity-induced RV variations of the Sun in terms of the continuum lightcurve, the chromospheric Ca II H&K emission and the line-profile distortions produced by spots drifting across the solar disk. The aim of this work is to identify photometric and spectroscopic proxies that will be key to disentangling planetary orbits from stellar activity.

Precise fundamental properties of a surprisingly hot, low metallicity, 0.2 Msun M dwarf

Leslie Hebb[1]

[1] *Hobart and William Smith Colleges*

Abstract. We present the analysis of a newly discovered late M dwarf (0.2 Msun) in a 14-day eclipsing binary with a higher mass G-dwarf primary star. By performing stellar characterization on the primary star spectra and a detailed eclipsing binary analysis using the radial velocity curve combined with the optical and infrared light curves, we derive an accurate mass, radius, temperature and metallicity for both the primary and secondary components. The result of our analysis shows the primary star to be a 10 Gyr old, -0.4 metallicity, 0.925 Msun star evolving off the zero age main sequence.

The mass and radius of the M dwarf secondary are consistent with stellar evolution models of the same age and metallicity for a 0.2 Msun star, but the temperature is significantly hotter than expected. We find a surprisingly hot temperature of 3800 K for this very low mass star.

Brown Dwarfs with Dynamic, Rapidly Changing Clouds

Aren Heinze[1]

[1] *Stony Brook University*

Abstract. As recently as two years ago, the existence of substantial aperiodic photometric variations in brown dwarfs was regarded with skepticism. This was warranted: difficult-to-quantify photometric systematics can easily mimic non-periodic variations, and theory did not necessarily predict the swift, global changes in brown dwarf cloud distributions that aperiodic data appeared to imply. However, new evidence shows that the photometric amplitude and phase of certain brown dwarfs (in particular Luhman 16B) can indeed change significantly on a rotational timescale. We present several new examples of brown dwarfs with confirmed aperiodic behavior, and we show that there is a wide range in the extent of aperiodicity among variable brown dwarfs. Some objects show perfectly periodic variations that remain coherent over many rotations, while for others the amplitude and phase change so rapidly that the true rotation period may be difficult to discern. The extent of a given brown dwarf's photometric aperiodicity should be determined mostly by the rapidity of its cloud evolution, and therefore aperiodicity constitutes a direct probe of the dynamics of brown dwarf atmospheres and an important new parameter in the analysis of brown dwarfs.

M dwarf Metallicity Distribution and Galactic Chemical Evolution

Neda Hejazi[1]

[1] *York University*

Abstract. Neda Hejazi (York University) Michael. M. De Robertis (York University) Peter.C. Dawson (Trent University) Based on 24 carefully selected M dwarfs and the most recent BT-Settl model atmospheres, we present new photometric calibrations to estimate metallicity and effective temper-

ature of dwarf stars with spectral types ranging from K7 to M3. Using these calibrations, the metallicity and temperature distributions of a volume-limited sample, including over 450,000 late-type K and early-type M dwarfs from the Sloan Digital Sky Survey (SDSS) and the Two-Micron All Sky Survey (2MASS), are studied. The results show a decrease in temperature with increasing metallicity, which is consistent with theoretical models. The recently measured FGK dwarf metallicity distributions are in better agreement with our M dwarf distribution than that from the previous study. There is a scarcity of metal-poor stars in the M dwarf metallicity distribution as compared to the distribution predicted by the Simple Closed Box Model, implying the existence of the M dwarf Problem", similar to the previously known G and K dwarf problems.

SEEDS - direct imaging survey for exoplanets

Krzysztof Helminiak[1]

[1]*Subaru Telescope; NCAC Torun*

Abstract. High-contrast direct imaging observations enable the discovery and characterization of exoplanets on wide orbits from their host stars, whose detections are impractical with indirect methods. The SEEDS campaign, which is currently in its fourth year, aims at directly imaging and characterizing giant exoplanets with the Subaru 8-m telescope. The total SEEDS sample will reach 500 targets selected from the solar neighborhood, moving groups, open clusters and star-forming regions. SEEDS also surveys exoplanets in planetary systems with debris discs. The sample adequately covers stellar ages ranging from 1 Myr to a few Gyr. SEEDS has detected new sub-stellar companions, including planets with properties that have not been known, unique compared with the previously directly imaged planets. These include a several-Jupiter-mass planet orbiting a nearby Sun-like star

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GJ504. High-contrast imaging by SEEDS has also provided better characterizations if the exoplanet systems detected by indirect techniques.

Optical Photospheric and Accretion Properties of Nearby T Tauri Stars

Gregory Herczeg[1]

[1] *KIAA/Peking University*

Abstract. Measurements of the mass and age of young stars from their location in the HR diagram are limited by not only the typical observational uncertainties that apply to field stars, but also by large systematic uncertainties related to circumstellar phenomena. I will present results from a large spectroscopic survey of 280 nearby T Tauri stars, in which we simultaneously measure accretion, extinction, and spectral type from the full optical spectrum. The primary advances in this project are (1) the systematic incorporation of a simplistic accretion continuum in optical spectral type and extinction measurements calculated over the full optical wavelength range, (2) systematic and direct measurements of accretion rates from the Balmer continuum for a large sample, and (3) the uniform analysis of a large sample of stars, many of which are well known and can serve as benchmarks. Differences between spectral types can be subtle and difficult to discern, especially when accounting for accretion and extinction. Large discrepancies in extinction between optical and near-IR extinction measurements likely result from methodological differences. We discuss how the uncertainties in spectral type and extinction affect luminosity measurements and contribute to luminosity spreads seen in HR diagrams of young clusters.

EMPIRICAL LIMITS ON RADIAL VELOCITY PLANET DETECTION FOR STARS YOUNGER THAN THE SUN

Lynne Hillenbrand[1]

[1] *caltech*

Abstract. We report initial results from our long term program measuring precision radial velocities and chromospheric activity levels for stars younger than the Sun. Using a sample of roughly 170 stars, we establish an empirical relationship between chromospheric activity, parameterized by R'HK, and radial velocity "jitter", or rms in the observed radial velocities. The

jitter floor, which increases with increasing stellar activity, limits the minimum mass companion that is detectable around young stars using the radial velocity technique to values significantly higher than those corresponding to the instrumental limit. Adopting a median activity-age relationship and assuming a solar-mass primary, we can derive the astrophysical limits to planet detection as a function of stellar age in a typical monitoring program thathas several tens of observations. For stars younger than 100 / 300 / 1000 Myr, the stochastic jitter component restricts detectable companion masses to greater than 0.3 / 0.2 / 0.1 $M_{\rm Jupiter}$ at the mean jitter-activity levels.

Magnetic field extrapolation in binary and star-planet systems

Volkmar Holzwarth, Scott Gregory, and the BinaMIcS collaboration[1]

[1] *Kiepenheuer-Institute for Solar Physics, Freiburg i.Br., Germany*

Abstract. Magnetic fields have a decisive influence on the structural, dynamical and thermal properties of the coronae of cool stars. Since even in the case of the Sun direct observations of coronal magnetic fields are difficult to accomplish, extrapolation methods are frequently used to infer them from observed magnetic field distributions in the photosphere. The potential field source surface (PFSS) approximation has proven helpful in the description of large-scale solar and stellar (as well as planetary) magnetospheres, because it accounts for the existence of stellar winds through the assumption of magnetic fields becoming purely radial at a certain distance above the photosphere. Albeit more sophisticated extrapolation methods have been developed since, the PFSS approach remains significant, since the resulting magnetic field represents the stable, lowest-energy state consistent with given boundary conditions. Here, we extend the PFSS technique to the case of a system with two close objects, such as binary star systems or exoplanet systems. We describe the theory and numerics of the two-centre extrapolation technique and demonstrate its applicability in the case of the close pre-main sequence binary V4046 Sgr, for which magnetic surface maps for both stellar components have been reconstructed based on Zeeman-Doppler imaging observations. Our results reveal a joint magnetosphere with complex magnetic field structures connecting the two components. Further observable diagnostic signatures of the coronae are discussed as well as the applicability of

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the method to the case of magnetic interaction between a host star and a close-in hot Jupiter.

The Lyon-Exeter grid of (sub)stellar evolution models

Derek Homeier[1]

[1] *CRAL/ENS-Lyon*

Abstract. We present a new grid of evolutionary calculations for low-mass stars and brown dwarfs coupled to the latest PHOENIX atmosphere models and their synthetic spectra and colours. This represents the first full update of the Lyon evolution tracks and isochrones since the work of Baraffe et al. (1998) and its extensions (2003). The interior models are using updated 1D atmospheric structures as an outer boundary condition, which have been calibrated with an improved mixing length theory treatment of the convection in optically thin layers. The outer photosphere and deep adiabat thus succeed in matching thermal profiles extracted from 2D and 3D radiative hydrodynamic models to an unprecedented level of accuracy. This coupling between evolution and atmosphere models provides a consistent treatment of the fully convective envelopes of late-M stars and substellar objects, e.g. with matching choices for the mixing length, and compositions updated to the solar abundances of Asplund et al. (2009) and Caffau et al. (2011). Our new model grid shows notably different results both compared to the models of Baraffe et al. (1998) and calculations combining updated atmosphere models with the older evolution tracks. We find marked improvement on comparing the resulting isochrones to colour-magnitude diagrams of disk stars as well as young clusters, although some residual discrepancies remain due to incompletely known opacities in the optical and near the onset of dust formation. But the PHOENIX Settl atmosphere models paving the way for the extension of these calculations to the lowest mass brown dwarfs already uniquely reproduce the L/T transition. The colours of cooler T and Y dwarfs are also matched with improved accuracy thanks to the inclusion of low-temperature grains as additional opacity sources. All of these

condensates, down to planetary cloud species like water ice and ammonium hydrosulphide, are treated in a single modelling framework.

Probing rotational dynamo extremes: X-ray and optical spectroscopy of the 0.5 day period eclipsing binary, HD 79826.

David Huenemoerder[1]

[1] *MIT Kavli Institute*

Abstract. The highly modulated optical light curve of HD 79826 (spectral type G5) was discovered in the Chandra guide-star light curves, indicating a period of about 0.5 days, a strong and migrating distortion wave, and a shallow eclipse. We subsequently obtained simultaneous Chandra high resolution X-ray spectra and optical photometry, along with contemporaneous ground-based photometry and spectra. X-ray rotational or eclipse modulation was totally obscured by X-ray variability and flares. X-ray spectra are characterized by coronal emission near the saturation limit of Lx/Lbol = 0.001. Optical spectra show extremely rotationally broadened features, variable with orbital phase. Optical light curves show the modulation to be not only rapidly migrating in phase, but also of variable amplitude. We will further characterize the X-ray emission through measurements of line widths, velocities, and fluxes, and provide coronal plasma models. This star is near or at the limits of dynamo saturation, and since it is partially eclipsing, has potential to be well characterized in terms of fundamental stellar parameters. Acknowledgments: This work was supported by NASA through the Smithsonian Astrophysical Observatory (SAO) contract SV3-73016 for the Chandra X-Ray Center and Science Instruments.

NGC 3201: Population Studies from Photometric Metallicities

Joanne Hughes[1]

[1] *Seattle University*

Abstract. NGC 3201 is in a rare, retrograde orbit around the Milky Way. This could be interpreted as evidence that it is a captured globular cluster, the remnant of a larger, disrupted system. Since 1998, some spectral samples infer a spread in [Fe/H] of up to 0.4 dex (around an average of

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[Fe/H]=-1.5 dex), and others found the spread less than 0.12 dex. However, even the studies which do not find a distinguishable spread in [Fe/H] show other chemical signatures of multiple episodes of star formation. High-resolution spectral analysis has been limited to upper-RGB stars because of the S/N required. To explore the chemical composition of unmixed stars, we must observe fainter, less evolved objects, which can only be reached with low-resolution spectra and imaging (as yet). Photometric studies are complicated by a steep extinction gradient towards the cluster, so we both minimized the extinction gradients and used the reddening-free Stromgren index, [m]. We found a method to determine the position-dependent E(B-V)=0.22-0.29 values; this uncertainty level alone would introduce a spread in photometrically estimated [Fe/H]-values of +0.1 dex and -0.3 dex independent of any other factors intrinsic to a star. We reduced the systematic effects to +0.05 and -0.15 dex, which enabled us to show that the spread in [Fe/H] is real but dependent on which RGB stars were sampled. We investigate the relationship of [m] to [Fe/H] and other elements within 1st and 2nd generation stars.

Monitoring the behaviour of spots using photometric data

Panos Ioannidis[1]

[1] *Hamburger Sternwarte*

Abstract. We use high accuracy photometric data to monitor the behaviour of spots. We develop an algorithm which can calculate the size, longitude and latitude of spots or spot groups, using high accuracy photometric light curves, in short computational time. To do so, it separates the light curve in rotational-period sized intervals and then it calculates those parameters, by using limb darkened spot crossing models. The results can

then be then used to identify population of spots, active regions on the stellar surface, mean spot lifetime or even activity cycle evidences.

The MEarth-North and MEarth-South transit surveys: searching for habitable super-Earth exoplanets around nearby M-dwarfs

Jonathan Irwin[1]

[1]*Smithsonian Astrophysical Observatory*

Abstract. Detection and characterization of potentially habitable Earth-size extrasolar planets is one of the major goals of contemporary astronomy. By applying the transit method to very low-mass M-dwarfs, it is possible to find these planets from the ground with present-day instrumentation and observational techniques. The MEarth project is one such survey with stations in both hemispheres: MEarth-North at Mount Hopkins, Arizona, and MEarth-South at CTIO, Chile. We present an update on recent results of this survey, for planet occurrence rates, and interesting stellar astrophysics, for which our sample of 3000 nearby mid-to-late M-dwarfs has been very fruitful. All light curves gathered during the survey are made publicly available after one year, and we describe how to access and use these data.

Anchoring the age-rotation relation with the ZAMS cluster Alpha Per

David Jaimes[1]

[1]*Department of Astronomy, Columbia University*

Abstract. Calibrating the age-rotation-activity relation (ARAR) in low-mass stars requires systematically mapping out the properties of stars in coeval populations. The Palomar Transient Factory (PTF) Open Cluster Survey (POCS) is an effort to measure rotation periods and coronal or chromospheric tracers of magnetic activity for stars in clusters ranging from 80 Myr and 2.5 Gyr. We present preliminary POCS results for Alpha Per (Mel 20), the youngest survey target. Late-type stars in this cluster are arriving on the zero-age main sequence (ZAMS), and provide an essential anchor point for modeling the ARAR. We revisit the clusters membership, and construct a revised catalog that considers a stars distance from the cluster center in addition to photometric and proper-motion data from a number of surveys.

In addition, we present on-going efforts to use our PTF data from roughly eight months of optical monitoring to expand the sample of measured rotation periods for Alpha Per members. Only 40 rotation periods have been measured in Alpha Per to date, limiting the clusters utility as a benchmark for the early stage ARAR. With an updated membership catalog and new rotation periods measured with PTF, Alpha Per will provide critical data for defining the ZAMS-era ARAR.

The Bcool magnetic snapshot survey of solar-type stars

Sandra Jeffers[1]

[1] *Goettingen University*

Abstract. Stellar magnetic field measurements obtained from spectropolarimetry offer key data for activity and dynamo studies, and we present the results of a major high-resolution spectropolarimetric Bcool project magnetic snapshot survey of nearly 200 solar-type stars from observations with the Telescope Bernard Lyot and the Canada-France-Hawaii Telescope. Surface magnetic fields were detected for one third of our sample, including surprising detections on a few subgiant stars. In this talk we will show how the magnetic field strength (longitudinal field) is correlated with basic stellar parameters such as rotation rate, age, chromospheric activity indicators as well as with spectral type. This survey constitutes the most extensive spectropolarimetric survey of cool stars undertaken to date, and suggests that it is feasible to pursue magnetic mapping of a wide range of moderately active solar-type stars to improve understanding of their surface fields and dynamos.

Detecting planets around enigmatic stars

Sandra Jeffers[1]

[1] *Goettingen University*

Abstract. Astrophysical noise in late-type stars can be either predictable or stochastic and covers several orders of magnitude. It can be viewed as either a facet of the intricate nature of stars, or a nuisance parameter that precludes the study of weak planetary signals. In this talk I will present

our latest results in understanding how such stellar variability can impact the detection of planets around young active stars by simulating planetary systems and using common planet hunting algorithims to realistically asscess the detection limits. We find that Jupiter-mass planets can be detected close-in around fast-rotating young active stars, Neptune-mass planets around moderate rotators and that Super-Earths are only detectable around very slowly rotating stars. I will also present our latest results in removing this stellar activity directly from the radial velocity profiles using a modified version of Doppler Imaging.

Preparation of the CARMENES input catalogue. High-resolution spectroscopy of M dwarfs

Sandra Jeffers[1]

[1]*IAG, Goettingen*

Abstract. CARMENES is the next generation of planet hunting instruments that will focus on detecting planets around M dwarfs. In preparation for this survey we will obtain high-resolution (R = 30,000-48,000) observations of 500 M dwarfs to carefully select the most promising targets to ensure the highest chance of success. Our aim is to remove single- and double-line spectroscopic binaries and, especially, fast rotators from the sample. Here we present the preliminary results of our observations which comprise data from FEROS at ESO/MPG 2.2m La Silla, CAFE at 2.2m Calar Alto and HRS at Hobby Eberly Telescope.

Are planetary orbits aligned with binary orbits?

Eric Jensen[1]

[1]*Swarthmore College*

Abstract. Many extrasolar planets follow orbits that differ markedly from the nearly circular and coplanar orbits found in our solar system. These orbits, along with the population of hot Jupiters orbiting close to their host stars, suggest substantial orbital evolution after planet formation. A possible driver of this evolution is the influence of a stellar or substellar binary companion on an orbit that is inclined relative to the planetary orbital plane. It is currently unknown how common it is for planetary and binary orbits

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to be misaligned, though a handful of young binary systems are known to host misaligned disks. Here we report the first results of a campaign to map the misalignment of planet-forming disks in binaries using ALMA. We detect the Keplerian rotation of both two disks in the young binary HK Tau, measuring their full three-dimensional angular momentum orientation and showing that they are misaligned by 60-70. Thus, at least one disk is substantially misaligned with the binary orbit. This misalignment is present at the time of planet formation and presumably is an outcome of the binary formation process. If confirmed in a larger sample of systems, this indicates that misalignment-driven mechanisms may be an important driver of the diversity of planetary orbits.

The HST-FGS parallax of XO-3 and Implications for its Hot Jupiter

Christopher M. Johns-Krull[1]

[1]*Rice University*

Abstract. We use HST+FGS to measure the parallax of the transiting planet host star XO-3. Our parallax measurement, 5.674 +/- 0.139 mas, gives a distance to this planet hosting star of 176.2 +/- 4.3 pc. This distance implies a radius for the star XO-3 of 1.40 +/- 0.04 Rsun and a radius for its planet XO-3b of 1.26 +/- 0.04 Rjup. The predicted radius for XO-3b is 1.15 Rjup taking into account insolation from the central star. The measured radius is then marginally larger than model predictions, but at less than the 3 sigma level. XO-3b is somewhat unique among hot Jupiters in that it has a substantial eccentricity (e 0.22) at a short orbital period (p = 3.2 d) and thus may be subject to tidal heating, a proposed mechanism for explaining the inflated radii of some giant exoplanets. However, the agreement of the

measured and predicted radius does not suggest a major role for tidal heating, at least in the case of this exoplanet.

Update on the Stellar Surface Imaging Project at NPOI

Anders M. Jorgensen[1]

[1] *New Mexico Tech*

Abstract. A. M. Jorgensen, H. R. Schmitt, M. Landavazo, B. Sun, D. Mozurkewich, G. T. van Belle, D. J. Hutter, J. T. Armstrong, E. K. Baines, J. Clark, K. Newman, S. R. Restaino We are working on a project to carry out stellar surface imaging at the Navy Precision Optical Interferometer (NPOI). The project is recently funded by the NSF, and will extend the baseline bootstrapping capability of the NPOI to 6-station observations in each of the three arms of the NPOI Y-configuration array. The project requires the commissioning of one telescope station beyond what is already in place or in the process of commissioning, and upgrades to the data acquisition and fringe-tracking system. 6-station bootstrapping is not possible with any other existing interferometer and the number of image elements is directly related to the length of the bootstrapping chain. Additionally we expect to take advantage of wavelength bootstrapping for additional resolution at short wavelength. Here we will provide an update on the project and also discuss some modeling results showing the kind of imaging resolution that will be possible and amount of observing time required to produce an image.

Auroral Radio Emission from Late L and T Dwarfs: A New Constraint on Dynamo Theory in the Substellar Regime

Melodie Kao[1]

[1] *Caltech*

Abstract. We have observed 6 late L and T dwarfs with the newly upgraded Jansky VLA to investigate the presence of quiescent or pulsed radio emission, associated with large-scale auroral currents. We present measurements of surface magnetic fields in the mid-L to late-T spectral range, pro-

viding the first firm constraints on dynamo theory in the mass gap occupied by low mass brown dwarfs.

Maps of brown dwarf atmospheres

T. Karalidi[1]

[1]*Steward Observatory, University of Arizona*

Abstract. Based on the composition and radius of brown dwarfs we would expect their atmospheres to be comparable to those of directly detected giant exoplanets. Fitting of models to observations though, suggest that brown dwarf atmospheres have different cloud structure than giant exoplanet atmospheres. Here, we present a new code to map the atmospheres of exoplanets and brown dwarfs. Our code is built within the frame of the "Extrasolar Storms" Spitzer Exploration Science project, that observes brown dwarfs with Spitzer and Hubble Space telescopes. With our code we can compare the cloud coverage of brown dwarfs and directly detected giant exoplanets and explore how cloud distribution changes with time and altitude for the first time. We validate our code against observations of previously mapped planets and present first maps of the atmospheres of brown dwarfs observed within the Storms project.

V4046 Sgr: Touchstone to Investigate Spectral Type Discrepancies for Pre-main Sequence Stars

Joel Kastner[1]

[1]*Rochester Institute of Technology*

Abstract. The potential for significant discrepancies between optical and near-IR spectral type determinations for a given late-type, pre-main sequence (pre-MS) star clearly has profound implications for astronomers' ability to ascertain the fundamental properties of such stars (i.e., effective temperatures, surface gravities, masses, and ages). To address this important issue, we have obtained near-IR spectroscopy of the nearby, close binary T Tauri system V4046 Sgr AB with the NASA Infrared Telescope Facility (IRTF) SPEX spectrometer. The V4046 Sgr system provides an important test case in this regard, due to the stringent constraints on its mass (a total of 1.8 Msun, with roughly equal-mass components) that are imposed by interfer-

ometric CO imaging of its extended circumbinary disk combined with its relatively well-determined age (12-21 Myr) and distance (73 pc). The IRTF data indicate that the composite near-IR spectral type for V4046 Sgr AB is significantly later than the (K5+K7) composite type previously determined from optical spectroscopy. We discuss the implications of these results for studies that rely on near-infrared spectroscopy to infer the photospheric temperatures and, hence, the ages and masses of pre-MS stars via placement on pre-MS evolutionary tracks.

New Brown Dwarf Companion to a Young, Low Mass Star

Kendra Kellogg[1]

[1] *Western University*

Abstract. Studying substellar and planetary-mass companions to young stars is important in determining stellar system formation mechanisms as well as providing a basis for understanding extra-solar planet characteristics. We present evidence for a young, brown dwarf companion to the Upper Scorpius member, ScoPMS 214. This object was previously rejected as being a companion to ScoPMS 214 based on its comparison to model isochrones. With additional spectra, we have obtained a new estimation of the age of the candidate companion (10Myr) which is consistent with being a member of the Upper Scorpius association. The spectra also show strong indications of youth. These pieces of evidence, along with the common proper motion, allow us to confirm that ScoPMS 214 'B' is a brown dwarf companion to ScoPMS 214 in the young Upper Scorpius association.

Gyrochronology of Low-mass Stars - Age-Rotation-Activity Relations for Young M Dwarfs

Benjamin Kidder[1]

[1] *University of Redlands*

Abstract. We aim to investigate the utility of gyrochronology as a means of determining the ages of low-mass stars. New stellar rotation periods for 48 young (¡300 Myr), early-M dwarfs within 25 parsecs were measured using photometric data collected with telescopes at Lowell Observatory during 2012 and 2013. An additional 25 rotation periods for members of the same

sample were found in the literature. Ages were derived from H? and X-ray emission, lithium absorption, surface gravity, and kinematic association of members of known young moving groups (YMGs). We compare rotation periods with the stellar ages with the intention of strengthening and testing age-rotation relationships for young, low-mass stars. We compare ages and rotation periods of our target stars to cluster members and field stars spanning 1 Myr5 Gyr. Measured rotation periods at every age exhibit a large scatter, with values typically ranging from 0.2 to 15 days. This suggests that gyrochronology for individual field stars will be difficult without a better understanding of the underlying mechanisms that govern angular momentum evolution. Yet, on average, the data still support the predicted trends for spin-up during contraction and spin-down on the main sequence, with the turnover occurring at approximately 150 Myr for early Ms. This suggests that rotation period distributions can be helpful in evaluating the ages of coeval groups of stars. This conclusion has led us to dedicate more observing time to known YMG members, and compare the rotation period distribution at the age of each YMG. We are continuing to measure rotation periods for the low-mass members of 6 YMGs, ages 10-650 Myr to help strengthen the correlation between rotation period distribution and age in coeval clusters.
We would like to thank the National Science Foundation for their support through the Research Experience for Undergraduates Grant AST- 1004107.

High-Resolution Spectroscopy of Hipparcos Cool Dwarfs

Bokyoung Kim[1]

[1]*Ewha Womans University*

Abstract. We present a preliminary result from high-resolution and high signal-to-noise spectroscopic survey of 170 G and K dwarfs in the Hipparcos catalog. We describe basic properties of our sample stars and provide preliminary estimates of stellar parameters ([Fe/H], Teff, logg). Using these parameters, we test the accuracy of stellar isochrones that have previously been calibrated against observations of well-studied open cluster systems. Finally, we provide a preliminary analysis of the luminosity of young field

stars, which may hold a clue to understanding a short Pleiades distance from the Hipparcos parallax.

Rotation period - X-ray activity relations based on ASAS and ROSAT data

Marcin Kiraga[1]

[1] *Warsaw University Observatory*

Abstract. There is ongoing search for periodic variability of stars related to ROSAT X-ray sources in the ASAS photometric data. We present rotation period - X-ray activity relations for all coronally active variable stars found so far in our project (more than 3500) and for different luminosity classes of stars selected using known spectroscopic data and known parallaxes (main sequence, subgiant and giant stars).

Dynamical Masses of Pre-Main-Sequence Binary Systems

Rainer Koehler[1]

[1] *MPI for Astronomy*

Abstract. The mass is probably the most important parameter for the structure and evolution of a star. Therefore, empirical mass determinations are crucial for our understanding of stellar astrophysics. Binary stars are the only way to measure stellar masses directly, without relying on theoretical models. They are therefore valuable test cases for theoretical pre-main-sequence tracks. We present results of our ongoing monitoring program for orbital motion of T Tauri binaries. Their companions were discovered in the 1990s. With projected separations of 15 - 40 AU, the expected orbital periods range from 60 to 250 years. We have collected observations using speckle interferometry, adaptive optics, and lucky imaging. About 15 companions have clearly moved since their discovery, about 9 of them show signs of

curvature characteristic for orbital motion. For a few of them, it is already possible to solve for a preliminary orbit solution.

CO Fluorescence and 2D Atmospheric Models of two Cool Stars

Rachel Koncewicz[1]

[1] *Oxford*

Abstract. Infrared absorption spectra of CO have been well observed in cool stars and the Sun, and used to estimate filling factors of active regions. UV emission lines were observed in IUE spectra, and, following GHRS observations, identified as fourth positive lines, pumped by the O I (uv2) resonance triplet (McMurry & Jordan 2000). The O I triplet itself is a product of pumping by H Ly β. Here, we present new calculations of CO UV emission lines in α Tau and α Boo using O I profiles calculated including full Partial Redistribution (PRD) in the hydrogen lines (Koncewicz & Jordan 2007). We use these results to produce new two-dimensional models of the chromospheres of α Tau and α Boo.

The metallicities of Arcturus and mu Leo from z-, Y-, and J-bands spectra with the high resolution spectrograph, WINERED

Sohei Kondo[1]

[1] *Koyama Astronomical Observatory, Kyoto Sangyo University*

Abstract. We present the metallicities of two bright and well studied K-giants, Arcturus and mu Leo with iron lines in the short NIR region (0.9-1.35 um). We obtained these high resolution spectra (R=28,300) using the infrared echelle spectrograph, WINERED, attached to the 1.3 m Araki Telescope in Japan. WINERED can provide a wide spectral coverage of entire z-, Y-, and J-bands in a single exposure, which provides an advantage for the chemical abundance study of stars. We identify 85 unblended FeI lines in the spectra of these two objects with the excitation potentials from 2.176 eV to 6.320 eV. The metallicity of each line is estimated by least squared fitting to the synthetic spectra by SPTOOL software package (Takeda 1995). We assume (Teff, log g)=(4275, 1.70) for producing the synthetic spectra of Arcturus and (4550, 2.10) for that of mu Leo (Smith et al. 2013). The mi-

croturbulence velocities, which are significant parameters, are determined to be 1.2 km/s and 1.0 km/s for Arcturus and mu Leo, respectively, with the same method using the expected line strength "X" proposed by Gratton et al. (2006). The resultant metallicities of Arcturus and mu Leo are e(Fe) = 6.94 pm 0.02 and 7.71 pm 0.02, respectively, which are well consistent with the previous studies using the other wavelength region (e.g., Jofre et al 2013 for the optical, Smith et al. 2013 for H-band). We conclude that we first established the method and procedure of the chemical abundance estimation in the short NIR region.

Chemical abundance of brown dwarfs as a key to formation scenario

Taisiya Kopytova[1]

[1] *MPIA*

Abstract. We present our spectroscopic study of directly imaged exoplanets and brown dwarf companions using VLT/SINFONI, and their hosts using FEROS at La Silla. We derive [Fe/H] and the C/O ratio for the companions and hosts, which helps us to distinguish between the core accretion and the disk instability scenarios for formation of the companions. Previous studies showed that metal-rich stars have more massive planets. This could be an outcome of the core accretion formation theory. The larger the metallicity of the disk, the faster the core is formed and more gas can be accreted onto it. Lower-mass planets do not accrete large amounts of gas over the timescale of core formation, therefore, they are less sensitive to the disk metallicity. Due to different condensation temperatures of carbon and oxygen, the C/O ratio is different at different parts of a protoplanetary disk and depends on the disk temperature profile. Therefore, the C/O ratio of a companion formed by core accretion can vary and will reflect that of the part of the disk where it formed. Conversely, companions formed by disk gravitational instability are expected to have C/O ratios consistent with their host stars. We present the very first study using this approach and put constraints on the applica-

tion of this method for testing formation scenarios of exoplanets and brown dwarfs.

Polarimetry of transiting exoplanetary system HD 189733.

Nadiia Kostogryz[1]

[1] *Kiepenheuer-Institut fuer Sonnenphysik*

Abstract. We present and discuss a polarimetric effect caused by a planet transiting the stellar disk and, therefore, breaking its symmetry and resulting in linear polarization of a partially eclipsed star. Estimates of this effect for transiting planets were made only recently. In particular, we demonstrated that the maximum polarization during transit for one of the brightest transiting planets HD189733b strongly depends on the centre-to-limb variation of linear polarization for the host star. However, observational and theoretical studies of the limb polarization have been largely concentrated on the Sun. As was shown in our previous study, we expect to observe a larger centre-to-limb linear polarization for cooler stars. Here we solve the radiative transfer problem for polarized light and simulate the centre-to-limb polarization for stars of different spectral classes taking into account various opacities.

Star-planet interaction

Tereza Krejcova[1]

[1] *Hamburg Observatory*

Abstract. Exoplanetary systems containing hot Jupiters offer an unique opportunity to study the effects of mutual star-planet interaction. While the stellar high-energy radiation field is widely believed to influence the planetary atmosphere, e.g., by driving mass loss, it remains controversial whether close-in orbiting planets also influence the level or behavior of stellar activity through tidal or magnetic interaction. We present a study of changes of the chromospheric activity in stars with close-in exoplanets. In particular, we analyze various activity-sensitive spectral lines such as the Ca II H and K lines, H alpha, and the Ca II infrared triplet, examine their temporal variation and mutual relation, and study the relation to the planets. The special attention in this work will be paid to the transiting exoplanetary

system HD 189733. It consists of a hot Jupiter orbiting an active K type star, which makes it a suitable object for study of the interaction in between the star and the planet.

Cool stars as tracers of multiple stellar populations in the Galactic globular cluster 47 Tuc

Arunas Kucinskas[1]

[1] *Vilnius University, Lithuania*

Abstract. We use spectroscopic abundances of lithium, oxygen, and sodium in the main sequence turn-off (TO) stars to study the formation history of Galactic globular cluster 47 Tuc. Our data shows that this cluster consists of at least two stellar generations, each marked with its own distinct properties, and with the older having enriched the younger generation stars with light elements, such as sodium. We briefly discuss the implications of our findings in the context of possible formation scenarios of this and other Galactic globular clusters.

OH infrared lines as indicators of oxygen abundance in the atmospheres of cool stars

Arunas Kucinskas[1]

[1] *Vilnius University, Lithuania*

Abstract. We determine oxygen abundance in three extremely metal poor red giant stars, utilising for this purpose infrared OH lines. The analysis was performed using state-of-the-art 3D hydrodynamical model atmospheres and allowed us to obtain a good agreement between the oxygen abundances inferred from [OI] line at 630 nm and infrared OH lines. We briefly discuss the physical reasons that lead to different role of convection in the formation of [OI] and molecular lines, and provide further suggestions for the use of 3D

hydrodynamical model atmospheres in the studies of extremely metal-poor stars.

Meridional flows and their role in stellar differential rotation and dynamos

Manfred Kueker[1]

[1] *Leibniz Institute for Astrophysics Potsdam*

Abstract. The current flux transport dynamo models of the solar activity cycle depend critically on the meridional flow. This slow, large-scale motion pattern has proven hard to observe even on the Sun and is largely unknown for stars. Mean field models reproduce the solar differential rotation remarkably well and their predictions for the lower main sequence are in good agreement with observations, especially recent data from the Kepler spacecraft. We discuss the role of the meridional flow in stellar rotation models, the predictions made by these models for low mass main sequence stars and giants, and the implications for stellar dynamo models.

Starspot evolution on the red giant star XX Triangulum

Andreas Knstler[1]

[1] *Leibniz-Institut fr Astrophysik Potsdam (AIP), Germany*

Abstract. The importance of a spot decay timescale is that it relates to the magnetic diffusivity which itself is a driving parameter for the prediction of activity cycle periods of an ??-dynamo. Our current view of sunspot evolution prefers a linear area decay law dA(t)/dt = D. Furthermore it seems that the bigger the sunspot the stronger is its decay, as well as that the timescales of spot emergence are much shorter than for spot decay. To investigate the evolution of spots on other stars we need time-series of surface temperature maps (Doppler-Images). Since 2006 XX Triangulum (HD 12545) has been observed continuously with the STELLA Echelle Spectrograph. This red giant star of spectral class K0III is a RS CVn binary with a rotational and orbital period of 24 days. By now we have collected about 700 high-resolution spectra which cover 36 rotational periods. To reconstruct temperature maps of XX Tri we use our own Doppler-Imaging code iMap. During this timeframe we observe various spot phenomena such as spot de-

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cay and spot emergence, as well as spot fragmentation and spot merging, which allow us to determine area decay and growth rates. The longitudinal spot distribution enables us to detect active longitudes, which are in correlation to the appearence of the component star. Furthermore we determined a weak signal of differential rotation. We will present preliminary results of starspot evolution on XX Tri obtained from time-series Doppler-Images, including decay and growth rates of spot area, active longitudes, differential rotation and a so-called butterfly diagram.

The VVV proper motion survey

Radostin Kurtev[1]

[1] *Valparaiso University, Chile*

Abstract. We developed an automatic method to search the Vista Variables en Via Lactea (VVV) Cambridge Astronomical Unit (CASU) survey catalogs for proper motion (PM) objects. The method is VVV self consistent and is based on cross-matching photometric Ks-band CASU catalogs obtained for 4 different epochs, including the first and the last one. The candidates were visually inspected on VVV, 2MASS and SuperCOSMOS images for final confirmation. We have examined ?100% of the VVV area to a limiting magnitude of Ks=13.5 and have detected ?2000 objects with proper motion higher than 0.05 arcsec per year. Because of the extreme crowding the VVV area was never systematically searched until now. Our sample includes dozens of completely new high proper motion stars and common proper motion pairs, some common proper motion companions of previously known high proper motion stars, and the first spectroscopically confirmed VVV brown dwarf. During the visual inspection of SuperCOSMOS images we have also identified 3 white dwarf common proper motion companions of previously known high proper motion stars. In this work we also demonstrate

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that the VVV CASU catalog coordinates are very precise and are suitable for parallax determinations to distance of about 40-50 pc.

Magnetic fields on brown dwarfs

Oleksii Kuzmychov[1]

[1] *Kiepenheuer-Institut fr Sonnenphysik Freiburg, Germany*

Abstract. We analyze the spectra of two brown dwarfs, which were obtained with the low resolution polarimeter LRIS (Keck observatory) in August 2012, in order to infer their magnetic properties. For doing this, we model polarimetric spectra of diatomic molecules - CrH, FeH, and TiO - and atomic lines. The objects observed exhibit transient but periodic radio pulses that are possibly driven by electron-cyclotron maser (Hallinan et al. 2007, 2008). For this mechanism to work, a few kG magnetic field is however required. In order to examine whether these objects possess such a strong magnetic field, we employ molecular spectropolarimetry (Berdyugina et al. 2000, 2005; Afram et al. 2008; Kuzmychov & Berdyugina 2013), that allows us to explore the magnetic fields in cool atmospheres of brown dwarfs and exoplanets. We are able to constrain the magnetic field strengths in these objects.

A study of magnetic fields in Intermediate Mass T-Tauri Stars

Alexis Lavail[1]

[1] *Uppsala University*

Abstract. Intermediate Mass T-Tauri Stars (IMTTS) are the precursors of the pre-main sequence Herbig Ae/Be stars, themselves the likely precursors of the main sequence A/B stars. About 10% of A/B stars and also Herbig Ae/Be stars host strong and organised fossil magnetic fields which origin is uncertain. It is believed that they could either be the result of the galactic magnetic field being captured during stellar formation, or generated by dynamo processes during stellar formation. By studying magnetic fields in IMTTS, we intend to improve our understanding on the origin of these fossil magnetic fields. IMTTS possess convective envelopes and are at the transition between fully-convective and fully/partially radiative regimes. It

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is expected that IMTTS magnetic properties evolve with their age, and that they can present either dynamo fields (complex, rapidly evolving) or strong and stable organised fields. We use high-resolution infrared spectra in the H and K bands, acquired at the VLT with the CRIRES spectrograph to study a sample of 10 stars with effective temperatures ranging from roughly 4000 K to 6000 K. We aim to detect magnetic fields and determine their strengths using Zeeman broadening of magnetically sensitive spectral lines.

The Disk and Planets of the Solar System Analogue tau Ceti

Samantha Lawler[1]

[1] *University of Victoria*

Abstract. tau Ceti is a nearby, mature star very similar to our Sun, with a massive Kuiper belt analogue (Greaves et al. 2004) and possible multiplanet system (Tuomi et al. 2013) that makes its comparison to our Solar System very appropriate. We present infrared and submillimeter observations of the debris disk from the Herschel Space Observatory and the James Clerk Maxwell Telescope (JCMT). We find the best model of the disk is a wide annulus ranging from 5-55 AU, inclined from face-on by 30 degrees. Tuomi et al. (2013) report 5 possible super-Earths tightly nestled inside 1.4 AU and we model this planetary system and place dynamical constraints on the inner edge of the disk. We find that due to the low masses and fairly circular orbits of the planets, the disk could reach as close to the star as 1.5 AU, with some stable orbits even possible between the two outermost planets. The photometric modelling cannot rule out a disk inner edge as close to the star as 1 AU, though 5-10 AU produces a better fit to the data. Dynamical modelling shows that the 5 planet system is stable with the addition of a Saturn-mass planet on an orbit outside 5 AU, where the Tuomi et al. analysis was not as sensitive. Though higher-resolution observations are required to better determine the inner disk edge, these Herschel observations add credibility to the proposed planetary system, and provide weak evidence for

at least one additional planet, increasing the similarity between the tau Ceti planet/disk system and our own Solar System.

Revised spectroscopic distances and kinematics of local field M dwarfs and M subdwarfs.

Sebastien Lepine[1]

[1] *Georgia State University*

Abstract. We combine parallax measurements from the literature to optical spectroscopy of 1459 M dwarfs and M subdwarfs to update the calibration of the spectroscopic distance relationships, and in particular their dependence on metallicity subclass (dM, sdM, esdM, usdM). We use the revised calibration to calculate distances and transverse motions for 4525 spectroscopically confirmed M dwarfs, 183 subdwarfs (sdM), 134 extreme subdwarfs (esdM) and 105 ultrasubdwarfs (usdM) in the solar vicinity (d¡200pc). Results demonstrate again the clear association of esdM and usdM stars with the Galactic halo population. The velocity-space distribution shows substructure in the local disk population consistent with previous studies, including the Coma, Sirius, and Hercules streams. However, we find no evidence for dynamical substructure in the local thick disk and halo populations.

Determination of the orientation of stellar spin axis

Anna-Lea Lesage[1]

[1] *Leiden Observatory*

Abstract. We present an observing method that permits the determination of the absolute stellar spin axis position angle based on spectro-astrometric observations for slow rotating stars. This method is complementary to current interferometric observations that determine the orientation of stellar spin axis for fast rotating stars. Spectro-astrometry enables us to study phenomena below the diffraction limit, at a milli-arcsecond scale. It relies on the wavelength dependent variations of the centroid position of a structured source in a longslit spectrum. A rotating star has a slight tilt in its spectral lines, which induces a displacement of the centroid position, unique by its shape. By monitoring the amplitude of the displacement for

varying slit orientations, we can infer the absolute position angle of the stellar spin axis. We discuss the results of simulations performed to assess the feasability of the method. With a long-slit spectrograph of resolution 80 000 or higher, and a spatial resolution of less than 0.2"/pix, we could retrive the stellar spin position angle for stars of apparent diameter down to 2 milliarcseconds. We found optimal instrumental configuration for using the method, and derived a priliminary target list for tests observations. At last, we present first observation results for Capella and Aldebaran obtained with the Thringer Landesternwarte high resolution spectrograph. We show that despite a non-optimal instrumentation, we were able to retrieve Aldebaran's position angle with less than 10deg errors.

Accurate metallicity determination of M dwarfs

Sara Lindgren, Ulrike Heiter, Bengt Edvardsson and Andreas Seifahrt[1]

[1] *Uppsala university*

Abstract. Accurate knowledge of the composition of M dwarfs is essential for advancing the understanding of e.g. planet formation and the galactic evolution. However, due to their intrinsic faintness and low surface temperature these stars are a spectroscopic challenge. In the infrared the number of molecular transitions is greatly reduced, allowing an accurate continuum placement and thereby a great improvement in the reliability of the abundance determination for M dwarfs. We continue the work by nehag et al., 2012, using high-resolution spectra taken in the J band with the CRIRES spectrograph. To affirm the reliability of the method we analyzed two M dwarfs in close binary systems with hotter companion stars. The study will be extended to a sample of additionally 22 M dwarfs (not in binary systems) to get a good coverage in Teff and metallicity. With the results we aim at deriving an accurate relationship between photometric color and metallicity, covering most M dwarf subtypes and a metallicity span of approximately 0.8 dex. The final goal is to use the derived relationship and photometric data

from a large sample of M dwarfs to statistically investigate a possible planet metallicity connection.

Predicting the Extreme-UV and Lyman-alpha Fluxes Received by Exoplanets from their Host Stars

Jeffrey Linsky[1]

[1] *University of Colorado*

Abstract. Extreme-UV radiation from the chromospheres, transitions regions, and coronae of host stars (spectral types F, G, K, and M) ionize and heat the outer atmospheres of exoplanets leading to mass loss that is observed during transits. Lyman-alpha emission from host stars controls the photochemistry of water, CO2, methane, and other important molecules in exoplanet atmospheres. Both types of radiation are largely absorbed by the interstellar medium and must be reconstructed or estimated to understand the radiation environment of exoplanets. We describe several techniques for reconstructing the intrinsic Lyman-alpha radiation and for predicting the EUV flux. Solar models and satellite observations (HST, FUSE, and EUVE) provide tests for the feasibility of these methods.

Ultracool Dwarfs in the Extended Solar Neighborhood as Exoplanet Analogs

Michael Liu[1]

[1] *University of Hawaii*

Abstract. Recent identification of young field brown dwarfs has opened a new opportunity to enrich our understanding of both free-floating substellar objects and directly imaged young gas-giant planets. However, studies to date have typically focused on individual discoveries. We present a large comprehensive study of this rare and intriguing population, comprising both previously known objects and our new discoveries from the latest wide-field sky surveys (Pan-STARRS-1 and WISE). With masses now extending down to 5 Jupiter mssses, these objects directly overlap young gas-giant planets and thus are promising analogs for studying exoplanet atmospheres at high S/N and spectral resolution. We combine high-quality spectra and parallaxes to study their spectral energy distributions, luminosities, temperatures, and

ages. We demonstrate that the peculiar IR fluxes of young gas-giant planets like those around HR 8799 do occur in some young brown dwarfs, but these properties do not have a simple correspondence with age. We find young field brown dwarfs can have unusally low temperatures, but they are not underluminous, as sometimes claimed. To help provide a reference for upcoming extreme-contrast planet imaging surveys, we establish a grid of spectral standards and benchmarks, in order to calibrate gravity (age/mass) and temperature diagnostics from near-IR spectroscopy. Finally, we use our data to critically examine the possibility that free-floating objects and substellar companions may have different evolutionary histories, thereby complicating the brown dwarf-exoplanet connection.

Detecting Exoplanetary Magnetic Fields

Joe Llama[1]

[1] *University of St Andrews*

Abstract. Asymmetries in exoplanet transits are proving to be a useful tool for furthering our understanding of magnetic activity on both stars and planets outside our Solar System. Near-UV observations of the WASP-12 system have revealed asymmetries in the timing of the transit when compared with the optical light curve. A number of possible explanations have been suggested for this variation, including the presence of a magnetospheric bow shock arising from the interaction of the planetś magnetic field with the stellar wind from itś host star. Such observations provide the first method for directly detecting the presence of a magnetic field on exoplanets. The shape and size of such asymmetries is highly dependent on the structure of the host stars magnetic field at the time of observation. This implies we may observe highly varying near-UV transit light curves for the same system. These variations can then be used to learn about the geometry of the host starś magnetic field. For some systems, such as HD 189733, we have maps of the surface magnetic field of the star at various epochs. In this talk I will show how incorporating these maps into a stellar wind model, I can model

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the formation of a bow shock around the planet and hence demonstrate the variability of the near-UV transits.

An homogeneous view of the IMF across the hydrogen-burning limit in nearby open clusters

Nicolas Lodieu[1]

[1]*IAC, Tenerife*

Abstract. The latest release of the UKIDSS Galactic Clusters Survey (GCS) made public near-infrared photometry in six passbands (ZYJHK1K2) and accurate proper motions measured from the multiple epochs obtained by the GCS. The main scientific goal of the GCS is to investigate the shape and universality of the Initial Mass Function in the low-mass and substellar regimes. We analysed the photometric and astrometric data in six galactic clusters among the 10 regions surveyed by the GCS: sigma Orionis (3-5 Myr, 352 pc; Lodieu et al. 2009), Upper Scorpius (age=5 Myr, d=145 pc; Lodieu et al. 2007, 2008, 2013), IC4665 (27 Myr, 350 pc; Lodieu et al. 2011), Alpha Per (85 Myr, 170 pc; Lodieu et al. 2012b), the Pleiades (125 Myr, 120 pc; Lodieu et al. 2012), and Praesepe (590 Myr, 182 pc; Boudreault et al. 2012). We selected hundreds of member candidates in these regions in an homogeneous manner based on their positions in colour-magnitude and vector point diagrams. We derived the luminosity and mass functions for all these regions, using the latest state-of-the-art isochrones to convert magnitudes into masses. We find that all mass functions are very similar in the 0.6-0.03 Msun mass interval and in agreement with the log-normal form of the field mass function by Chabrier (2005), pointing towards a universal mass function. This talk will focus on key results from our homogeneous study and present preliminary optical spectroscopy: 1) comparison of the mass functions in the low-mass and substellar regimes 2) comparison of the cluster sequences with the most recent BT-Settl models from the Lyon group 3) comparison of the photometric binary fractions in the low-mass and brown dwarf regimes

with hydrodynamical simulations of Bate (2012) 4) discussion on the K-band variability as a function of age for low-mass stars and brown dwarfs

Near-Infrared Imaging of T and Y Dwarfs with MOSFIRE

Sarah E. Logsdon[1]

[1] *UCLA*

Abstract. We present the results of two MOSFIRE (the Multi-Object Spectrometer For Infra-Red Exploration) imaging campaigns geared to reveal and characterize late-type brown dwarfs and brown dwarf candidates. MOSFIRE, on the Keck I telescope, is not only a multi-object spectrometer, but is also a wide-field imager (6.14x6.14 FOV) with the ability to reach a limiting magnitude of J 23.5 in 15 minutes. This makes imaging with MOSFIRE a powerful tool for following up faint, late-type brown dwarfs. The first of our two imaging campaigns was designed to calibrate MOSFIREs medium band H1 and H2 filters that are optimized for methane imaging. The H1 and H2 filters split the traditional H band, isolating the strong 1.67 ?m methane absorption that is found in T and Y dwarfs, and giving these dwarfs uniquely blue H1-H2 colors. Here we present the H1-H2 color indices for 25 T5-Y0 brown dwarfs and discuss color trends and the utility of these filters for further brown dwarf studies at the latest spectral types. The second campaign has been designed to follow-up extremely red brown dwarf candidates from AllWISE by measuring their J-H colors and on-sky motion. We present preliminary results from this campaign and discuss the astrometric capabilities of MOSFIRE.

Multi-wavelength study of the young stellar population of the Orion B molecular cloud

Miguel Angel Lopez-Garcia[1]

[1] *Universidad Complutense de Madrid*

Abstract. Multi-wavelength surveys are the key to explore the mechanisms of star formation. We focused on the Orion B region, a multicore star forming region with more than 1000 young stellar objects in different stages of formation. We are carrying out a multi-wavelength study for a significant part of the Orion B molecular cloud, based on 9 XMM-Newton archival ob-

servations, infrared (Spitzer, WISE, and 2MASS) and Optical (XMM Optical Monitor and UCAC4) photometry data. This work is focused on the classification and characterization of young stellar objects and the inhomogeneity along the cloud. After filtering for the background sources, we classify the sample into 332 Classes III, 141 Classes II and 11 Classes 0/I and a dozen of brown dwarf candidates based on their infrared/optical properties. We explore the differences along the cloud and the stellar population distribution. We find 5 different regions where Class 0/I and Class II objects are located, coincident with the centre of NGC2023, NGC2024, NGC2068, NGC2071 and around V1647-Ori. In addition, we are currently carrying out an optical follow-up of the BD candidates.

The extension of the corona in classical T Tauri stars

Javier Lopez-Santiago[1]

[1] *Universidad Complutense de Madrid*

Abstract. The extension of the corona of classical T Tauri stars (CTTS) is under discussion in the Astrophysical community. The standard model of magnetic configuration of CTTS predicts that coronal magnetic flux tubes connect the stellar atmosphere to the inner region of the disk. Gas accretion from the disk by the star takes place along those magnetic tubes. Flaring events have been detected in CTTS. The weakest flares are assumed to have their origin in solar-like magnetic loops. However, strong, long-duration flares may be related to those long structures connecting the star and the disk. Such scenario is supported by some past result obtained from the use of hydrodynamic models in which the authors assumed those strong flares take place in single or small groups of loops. This assumption is slightly controversial and many authors are in disagreement with it. To disentangle this controversy, new independent measurements of the loop length are needed.

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We present a new approach for determining the length of flaring loops based on the oscillating nature of the loops after strong flares.

Fluctuations and Flares in Stellar UV Emission Observed by HST and GALEX with Implications for Exoplanet Transit Observations

Parke Loyd[1]

[1] *Center for Astrophysics and Space Astronomy, University of Colorado at Boulder*

Abstract. The intensity of ultraviolet (UV) stellar continuum and line emission varies on timescales as short as minutes or even seconds. This variability can originate from a host of physical phenomena at play in the stellar atmosphere. Stochastically fluctuating and flaring stellar emission is important because (1) it reflects the degree of magnetic turmoil in the stars atmosphere and (2) it adds uncertainty to and may prohibit (spectro)photometric measurements of exoplanet transits. This latter is especially important at the wavelengths of strong resonant absorption by species in a planets extended atmosphere. We present our recently published analysis of stochastic fluctuations and flares in the integrated C II ??1334,1335; Si III ?1206; Si IV ??1393,1402; and interspersed far-UV continuum emission of 38 F-M stars conducted with archival HST photon-event data binned to a 60 s cadence. To identify flares, we employed a cross-correlation algorithm that detected 116 events, over 50% lasting 4 min or less, occurring roughly once per 2.5 h. To quantify stochastic fluctuations, we computed the maximum-likelihood standard deviation of the lightcurve scatter above that attributable to Poisson noise, finding that it ranged from ¡ 1% to 41%. We also present the preliminary results of an analysis of GALEX broadband far-UV and near-UV photon-event data for Kepler field stars. This analysis will ultimately include an expansive stellar sample enabling several important inquiries. Among these, we will quantify the generally accepted assumption that stellar activity traces the amplitude of UV time-variability. We will also search for evidence of star-planet interactions through correla-

tions between the amplitude of a stars UV variability and the presence of closely orbiting planets.

Eruptive variable protostars: the view from VISTA and UKIDSS

Phil Lucas[1]

[1] *University of Hertfordshire*

Abstract. Until now the Milky Way has been largely unexplored territory in the time domain, especially in the infrared. A consequence of this is that it has not been possible to address the longstanding question of whether FUor/EXor type unsteady accretion is common amongst Young Stellar Objects (YSOs), with all the implications that would have for masses and ages of normal pre-main sequence stars. We present a sample of 800 high amplitude (DeltaK¿1 mag) infrared variable stars from VVV (Vista Variables in the Via Lactea), a large ESO time domain public survey with the VISTA telescope. This sample is complemented by a further 200 high amplitude variables from the UKIDSS Galactic plane survey. We show that most of these objects are YSOs, usually too obscured by extinction to be detectable in the optical. High quality spectra from Magellan/FIRE and Gemini/NIFS indicate that many of these objects are eruptive variables, although other populations are present. The SEDs indicate that we are seeing objects at an earlier stage in their evolution than most classical FUors and EXors, corresponding to a time when the average accretion rate was somewhat higher. In the course of this project we expect to be able to quantify the incidence of eruptive variability on timescales up to a few years. It is also reasonable to hope that new types of stellar variable will be discovered.

On the Detection Significance of Molecules in Exoplanets from Secondary Eclipse Observations

Jacob Lustig-Yaeger[1]

[1] *University of California, Santa Cruz*

Abstract. Armed with a now sizable list of confirmed exoplanets we are beginning to face the big question of atmospheric characterization: What are these planets made of? Currently, only a few high-resolution spectroscopic

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observations have been performed to determine the atmospheric composition of transiting exoplanets, with most observations being broadband photometry. Moreover, previous claims of molecular detection in these atmospheres using broadband photometry are rightfully being called into question. We aim to assess the detection significance of molecules in the atmospheres of several exoplanets observed in secondary eclipse. We determine the detection significance with two Bayesian hypothesis testing procedures using two different widely used atmospheric retrieval approaches. We find that the detection of molecules with broadband ground-based and space-based photometry generally fails to breach 3-sigma confidence. We extend the study by estimating the molecular detection significance expected with the proposed FINESSE/SMEX mission. Our results suggest that it is rather difficult to make robust claims about the atmospheric composition of exoplanets observed in secondary eclipse with current telescopes. We suggest that dedicated high-resolution, high signal-to-noise instruments are the only sure avenue to convincingly detect molecules, and determine their abundances, in exoplanet atmospheres.

Brown Dwarf Variability in Multi-Epoch WISE Photometry

Gregory N. Mace[1]

[1] *UCLA*

Abstract. The discussion of brown dwarf variability has shifted from initial identification to examining durations and amplitudes across the M, L, T, and Y spectral types. Rotational periods, phase shifts between infrared passbands, and variations in amplitude are all tracers of underlying physical traits that are not fully understood. We employ multi-epoch photometry from the Wide-field Infrared Survey Explorer (WISE) at 3.4 and 4.6 microns to investigate brown dwarf variability at these wavelengths. From a Sun-synchronous polar orbit, WISE observed overlapping fields on subsequent orbits and obtained about a dozen observations in 24 hours. As Earth continued in its orbit around the Sun, each patch of the sky received about a day of coverage, and over the course of 13 months WISE completed more than two all-sky passes. This provides us with roughly a dozen photometric measurements spread over a day, followed by a similar sampling roughly six months later. From a census of 1500 known brown dwarfs, we quantify variability on these timescales as a function of spectral type. We especially

discuss subsets of this census like the unusually red and blue L dwarfs and the L/T transition.

Stellar & Exoplanet Science with Precision Near-Infrared Spectroscopy

Suvrath Mahadevan[1]

[1] *Penn State*

Abstract. Precision radial velocities in the near-infrared is an emerging field this decade, geared towards the goal of detecting low mass terrestrial planets in the Habitable Zones of M dwarfs. We present results from an ongoing SDSS-III APOGEE program that follows up Kepler planet candidates and eclipsing binaries. This project illustrates the advantages of multiplexed NIR observations, even at 50-100 m/s precision, to detect binaries, false positives, and derive precise stellar properties of low mass stars. We also discuss the ongoing development path to achieving 1 m/s precision with the Habitable Zone Planet Finder (HPF) spectrograph now under construction for the Hobby Eberly telescope. Using examples we will highlight the astrophysical, technical, and calibration challenges associated with reliably detecting planetary signals at this precision, and how these challenges are being overcome.

Searching for young stars in the Solar neighborhood

Lison Malo[1]

[1] *CFHT & University of Montreal*

Abstract. We present a new method based on a Bayesian analysis to identify new members of nearby young kinematic groups (BANYAN; Malo et al. 2013). The analysis minimally takes into account the position, proper motion, magnitude and color of a star, but other observables can be readily added if desired (e.g. radial velocity, distance). It returns a probability of the star being member of a given group together with a most likely distance and radial velocity. When applied to known members, the statistical distances and radial velocities agree with the measured values within 10% and 1.9 km/s, respectively. We use this method to find new young low-mass stars in the beta Pictoris (BPMG) and AB Doradus moving groups and in the Tuc-Hor, Columba, Carina and Argus associations. Starting from a

sample of 920 K5V-M5V stars showing youth indicators such as Halpha and X-ray emission, our analysis yields more than 200 new highly probable low-mass members of the kinematic groups analyzed. To confirm membership and youth, we have initiated follow-up spectroscopic observations to measure their radial velocity (predicted by our analysis) and verify various age indicators (such as lithium equivalent width, bolometric luminosity, effective temperature). So far, we have secured the radial velocity for 130 candidate members (Malo et al. accepted in ApJ) and we have estimated the Bolometric luminosity and effective temperature for 49 stars. Combining these fundamental parameters to the Dartmouth Magnetic evolutionary models, we find that, in general, low-mass stars in the BPMG needs more than 2.5 kG magnetic field strength to reproduce the bolometric luminosity and inflated radii in an age range of 20-30 Myr. In this talk, we will briefly review the last six years of research to identify new members of young moving groups and show how our new statistical method combined to the Gaia mission will help the community to establish stars as new members of moving groups.

The Beta Pic Moving Group: Further Support for an Older Age

Eric E. Mamajek & Cameron P. M. Bell[1]

[1] *University of Rochester*

Abstract. If has been 30 years since Beta Pic was discovered to host a remarkable resolved dusty debris disk. More recently, Beta Pic was found to not only host a giant exoplanet, but that it is part of an entourage of dozens of other young, co-moving stars in the solar neighborhood: the Beta Pic Moving Group (BPMG). For most of the past decade, a kinematic age of 12 Myr for the BPMG (determined by multiple kinematic studies) has been adopted by most studies as the best available group age. Recently, Binks & Jeffries (2014) estimated a Li depletion boundary age for the BPMG of 21+-4 Myr. We conduct a new kinematic analysis of the classic BPMG membership from Zuckerman & Song (2004), using 3 different methods (measuring expansion coefficients, estimating the dispersion in past positions, times of minimum separation between BPMG members and the group centroid) on the best available astrometry and radial velocities. All three methods failed to yield a useful kinematic age with small uncertainties. We conclude that there is no longer strong support for a kinematic age of 12 Myr for BPMG. Comparison of the color-magnitude diagram positions for A/F-type stars in BPMG reveal that the A-type stars are clearly on the ZAMS (with the F0 dwarf 51 Eri being the coolest ZAMS member, defining the "main sequence turn-on"), whereas the F-type members are consistent with a pre-MS 20 Myr isochrone. We conclude that the Li depletion boundary age and the

main sequence turn-on isochronal age are in good agreement, and that the previous kinematic ages for BPMG are likely to be unreliable.

Towards a complete brown dwarf binary fraction including spectroscopic binaries

Elena Manjavacas[1]

[1] *Max Planck Institut fuer Astronomie, Heidelberg*

Abstract. The fraction of brown dwarfs binary systems is estimated to be about 20% for L and T spectral classes, nevertheless, due to selection methods, some close binaries (separation smaller than 0."1) and binaries with high excentricity will be missed. Allen et al. 2007 estimates the missing fraction at 6-7%. We used X-Shooter at VLT, to obtain high resolution spectra from 559.5 to 2480 nm of 22 brown dwarfs with peculiar spectra or different spectral type in the visible and near-infrared, which are potentially the best candidates to be close binaries. We compared our spectra with templates of well-classified spectra of mature and young brown dwarfs, as well as companions. Finally, we tested if the BT-Settl sythethic spectra 2010 and 2013 are able to reproduce our spectra in the optical and the near-infrared.

Prospecting in Ultracool Dwarfs: Measuring the Metallicities of Mid- to Late-M Dwarfs

Andrew Mann[1]

[1] *University of Texas at Austin*

Abstract. Metallicity is a fundamental parameter that contributes to the physical characteristics of a star. The low temperatures and complex molecules present in M dwarfs make it difficult to measure their metallicities using techniques that have been applied to Sun-like stars. Although there has been significant progress developing empirical methods to measure M dwarf metallicities over the last few years, these techniques have been developed to only work on early- to mid-M dwarfs. We present a method to measure the metallicity of mid- to late-M dwarfs from moderate resolution (R 2000) K-band (2.2 micron) spectra. We calibrate our formula using 44 wide binaries containing an F, G, K, or early M primary of known metallicity and a mid-

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to late-M dwarf companion. We show that similar features and techniques used for early M dwarfs are still effective for late-M dwarfs. Our revised calibration is reliable for M4.5-M9.5 dwarfs with -0.58¡[Fe/H]¡+0.56 and shows no systematic trends with spectral type, metallicity, or the method used to determine the primary star metallicity. We verify that our new formula works for unresolved binaries by combining spectra of single stars and that it gives consistent metallicities for components of M+M wide binaries. Lastly, we show that our calibration gives consistent metallicities with the Mann et al. (2013a) study for overlapping (M4-M5) stars, indicating that the two calibrations can be used in unison to determine metallicities across the entire M dwarf sequence.

The Atmospheres of Directly Imaged Planets: Where has all the Methane Gone?

Mark Marley[1]

[1]*NASA Ames Research Center*

Abstract. Methane and ammonia both first appear at lower effective temperatures in brown dwarf atmospheres than equilibrium chemistry models would suggest. This has been understood as a consequence of vertical mixing timescales being shorter than chemical equilibration timescales in brown dwarf photospheres. Indeed the eddy diffusivity has become a standard part of the description of brown dwarf atmosphere models, along with Teff and log g. While some models have suggested that methane is less favored at lower gravity, the almost complete absence of methane in the atmospheres of directly imaged planets, such as those orbiting HR 8799, even at effective temperatures where methane is readily apparent in brown dwarf spectra, has been puzzling. To better understand the paucity of methane in low gravity atmospheres we have revisited the problem of methane chemistry and mixing with an updated and complete network of the chemical reactions that link CO to CH4. We find the methane abundance at altitudes at or above the effective photosphere is a strong function of surface gravity because higher g shifts the p-T structure to higher pressures. Thus quenching in more massive brown dwarfs occurs at a lower temperature and higher pressure, both favoring CH4. We predict that in the lowest mass young giant planets, methane will appear very late, at effective temperatures as low as 600 K rather than the 1200 K seen among field brown dwarfs. This methane deficiency has important implications for the interpretation of spectra as well as methane-based planetary companion searches, such as the NICI survey. The GPI and SPHERE surveys will test these ideas and probe atmospheric chemistry and composition in an entire new range of parameter space. A caveat is that

these calculations presume that the C to O ratio is comfortably less than one.

Analysis of M and L dwarf surface gravities in the NIRSPEC Brown Dwarf Spectroscopic Survey

Emily C. Martin[1]

[1] *UCLA*

Abstract. Using previously published gravity-sensitive indices, we report on the analysis of near-infrared spectra for 200 M and L dwarfs. This allows us to disentangle the degeneracy between temperature and age for brown dwarfs of various masses. The spectra were obtained as part of the Brown Dwarf Spectroscopic Survey (BDSS) using NIRSPEC at the Keck Observatory and have a resolving power of R 2000 in the J band. By comparing a subset of the BDSS database with established gravity indices at lower spectral resolution, we demonstrate that these indices also work well for higher resolution spectra. We then apply these techniques to the entire set of M and L dwarfs in the BDSS to classify the diverse surface gravities of this large sample in a consistent manner. This analysis provides new age estimates for many M and L dwarfs, which will guide future studies of the young and old brown dwarf populations.

Dynamo modeling of the Kepler F star KIC 12009504

Savita Mathur[1]

[1] *Space Science Institute*

Abstract. The Kepler mission has collected light curves for almost 4 years. The excellent quality of these data has allowed us to probe the structure and the dynamics of the stars using asteroseismology. With the length of data available, we can start to look for magnetic activity cycles. The F star, KIC 12009504, shows a rotation period of 10.5 days and some variability that can be due to the magnetic activity of the star. Here we present recent and preliminary 3D global-scale dynamo simulations of this star with the ASH code, capturing a substantial portion of the convection and the stable radiation zone bellow it. These simulations reveal a multi-year activity cycle that appears to depend upon the width of the tachocline present in the simula-

tion. Furthermore, the presence of a magnetic field and the dynamo action taking place in the convection zone appears to help confine the tachocline.

Modeling accretion shocks with 3D MHD numerical simulations

Titos Matsakos[1]

[1] *University of Chicago*

Abstract. Authors T. Matsakos, J.-P. Chieze, C. Stehle, L. Ibgui, M. Gonzalez, L. de Sa, T. Lanz, S. Orlando, S. Bonito, C. Argiroffi, F. Reale, G. Peres Abstract The accretion process in young stars takes place through plasma streams that originate from the inner circumstellar disk and fall onto the stellar surface. The impact produces strong shocks that heat the plasma at temperatures of a few million Kelvin which in turn emits in soft X-rays. Understanding the details of the accretion shock dynamics is a key step to interpret the growing number of observations. Previous 2D numerical studies have shown that a strong magnetic field can play a critical role to the structure of the post-shock region, trapping the plasma within flux tubes which leads to the formation of fibrils. On the other hand, a weak field together with the cooling instabilities induced by optically thin radiation, generate chaotic motion and plasma mixing within the hot slab due to the inhomogeneous cooling. In this context, we present the first 3D magneto-hydrodynamical numerical simulations that model the local multi-dimensional dynamics of accretion shocks. In the framework of optically thin radiation losses, we study the evolution of the complex structure of the post-shock region as a function of the mangetic field. We discuss the relevance of our results to accretion shock observations and we set the stage for future post-processing and comparison with YSO data.

3D modeling of hydromagnetic star–planet interactions

T. Matsakos, A. Konigl, A. Uribe[1]

[1] *University of Chicago*

Abstract. Close-in exoplanets interact with their host stars gravitationally as well as through magnetized plasma outflows. In particular, stellar winds and evaporative planetary outflows carry away both angular and lin-

ear momentum, which could potentially influence the long-term evolution of the system. In this context, we perform 3D magnetohydrodynamical numerical simulations of a magnetized hot jupiter orbiting a star and study the complex physical processes involved in the star–planet interaction. We explore a wide parameter range of the magnetic coupling, such as the size and orientation of the magnetospheres and the orbital characteristics of the planet, in an attempt to model the effects and feedback this interaction may have on the stellar spin and the planetary orbit as well as on the structure of the two outflows. Potentially observable effects of this interaction are also discussed.

Characterizing the AB Doradus and Octans-Near Moving Groups via High Resolution Spectroscopy and Kinematic Traceback

Kyle McCarthy[1]

[1] *University of Kentucky*

Abstract. We present a detailed analysis of 10 proposed F and G members of the nearby, young moving group AB Doradus (ABD) and 5 proposed Octans-Near moving group stars. Our sample was obtained using the 2.7m telescope at the McDonald Observatory with the coude echelle spectrograph, achieving R 60,000 and S/N 200. We derive spectroscopic Teff, log(g), [Fe/H], and microturbulance (vt) using a bootstrap method of the TGVIT software resulting in typical errors of 33K in T_{eff}, 0.08 dex in log(g), 0.03 dex in [Fe/H], and 0.13 km/s in vt. Characterization of the groups is performed in three ways: (1) Chemical homogeneity, (2) Kinematic Traceback, and (3) Isochrone fitting. In our sample of 10 ABD stars, we identify 1 star which is a probable non-member, 3 enigmatic stars, and 6 stars with confirmed membership. We also present a list of chemically coherent stars from this

study and the Barenfeld et al. (2013) study. In the 5 Octans-Near stars, we identify 2 probable non-members and 3 probable members.

Measuring Extinction Toward Young Stars With Interstellar Lyman-alpha Absorption and Molecular Hydrogen Fluorescence

Matthew McJunkin[1]

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Abstract. Interstellar reddening corrections are essential to reconstruct the intrinsic spectral energy distributions (SEDs) of protostellar systems. The stellar SED determines the heating and chemical evolution in circumstellar disks. Measuring interstellar neutral hydrogen absorption against the Lyman-alpha emission of young stars can be used to calculate a visual extinction, assuming a grain size distribution and an interstellar reddening curve. We find visual extinctions for 31 classical T Tauri and Herbig Ae/Be stars of A_V = 0.02 - 0.72 mag, which are on average 0.6 mag lower than previous measurements in the IR and optical. High molecular fractions or large dust-to-gas ratios could explain this discrepancy. We also present preliminary work on a molecular hydrogen (H2) fluorescence model to characterize the full extinction curve along the line of sight towards a subset of these young stars. Using the Lyman-alpha radiation of the stars to pump H2 electronic transitions from the ground state, we model the flux that is re-emitted through the subsequent fluorescent cascade. By comparing the observed H2 line flux to the model of the emitted H2 line flux, we can extract the extinction over the 1100-1700 Angstrom wavelength region. The shape of the extinction curve allows us to characterize the dust grain distribution in the intervening material as well as to recover the intrinsic SED of the stars over a wide wavelength range.

Properties of 42 Solar-type Kepler Targets from the Asteroseismic Modeling Portal

Travis S. Metcalfe[1]

[1] *Space Science Institute*

Abstract. Recently the number of main-sequence and subgiant stars exhibiting solar-like oscillations that are resolved into individual mode frequen-

cies has increased dramatically. While only a few such data sets were available for detailed modeling just a decade ago, the Kepler mission has produced suitable observations for hundreds of new targets. This rapid expansion in observational capacity has been accompanied by a shift in analysis and modeling strategies to yield uniform sets of derived stellar properties more quickly and easily. We use previously published asteroseismic and spectroscopic data sets to provide a uniform analysis of 42 solar-type Kepler targets from the Asteroseismic Modeling Portal (AMP). We find that fitting the individual frequencies typically doubles the precision of the asteroseismic radius, mass and age compared to grid-based modeling of the global oscillation properties, and improves the precision of the radius and mass by about a factor of three over empirical scaling relations. We use the stellar radii and masses to test an empirical scaling relation for the frequency of maximum oscillation power, we derive new age-rotation-activity relations from the updated age estimates, we compare the bulk compositions to the expectations of Galactic chemical enrichment, and we find qualitative agreement between the derived mixing-length values and a recent calibration from three-dimensional (3D) convection simulations.

First results of the Hamburg Ca II survey with TIGRE

Marco Mittag[1]

[1] *Hamburger Sternwarte*

Abstract. The first results of the Hamburg Ca II survey with TIGRE (Telescopio Internacional de Guanajuato,Robotico-Espectroscopico) are presented. This program was started in Aug. 2013 with the monitoring of several stars. The goal of this program is to measure the short- and long term variability of stellar activity for stars of different spectral types in different spectral lines. A transformation equation of the TIGRE S-Index into the Mount Wilson S-Index was performed in order to compare our results to the vast body of S-Index measurements. Furthermore, the correlation be-

tween the S-Index and the lines of the Ca IRT was studied with absolutely simultaneous measurements.

Cool Tiny Beats Project

Zaira Modroo-Berdias[1]

[1]*IAA-CSIC*

Abstract. Cool Tiny Beats Project (CTB) is an Earth survey designed to observe a sample of M dwarfs with high-resolution and high-cadence. Data obtained with the HARPS and HARPS-N telescopes will try to resolve three fundamental aspects related with nearby M stars and their planetary systems: i) Characterization of compact planetary systems with sub-Earth mass objects, ii) Time-resolved analysis of stellar activity and its Doppler signatures, and iii) detection of pulsations and asteroseismic studies. High precision Doppler measurements are obtained with HARPS-TERRA, a new technique developed by the group which allow to improve the precision on the Radial Velocities determination. The CTB program can provide the first minimum mass determinations of sub-Earth sized objects, dynamical characterization and first population studies of these peculiar systems. Time-resolved stellar activity analyses combined with wavelength dependent Doppler measurements will provide important clues to elucidate the connection between Doppler variability, activity and stellar magnetic fields. Pulsations in M dwarfs have recently been theoretical predicted but none have been yet observed. Such detection will enable the use of asteroseismic techniques on cool stars. Here we present the first CTB program results for the HARPS-N sub-sample.

Angular Momentum Evolution in Low-Mass Stars: A Fresh Look

Subhanjoy Mohanty[1]

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Abstract. How angular momentum evolves in low-mass stars is one of the outstanding questions in stellar astrophysics, with implications for topics ranging from solar and stellar activity to the habitability of orbiting planets. The evolution is determined by a complex interplay between initial conditions

during star formation, the evolution of stellar structure, and the behaviour of stellar magnetic fields, but a detailed theory has remained elusive. We present here an analytic model to address this issue. We first show that the empirical picture of angular momentum evolution arises naturally if rotation is related to magnetic field strength instead of (as assumed in prior studies) to magnetic flux. The evolution then becomes a strong function of stellar radius, explaining the main trends in rotation observed in low mass stars from open clusters to the field at a few Gyrs. Our model is also able to reproduce the empirical Skumanich law for solar-type stars (for very different reasons than usually assumed), as well as the observed lifetime of magnetic activity in very low-mass stars. Next, we present recent modifications to the theory – more realistic wind velocities (in both the thermal and magnetocentrifugal limits, instead of the incorrect escape velocity formalism usually adopted), dipole field geometries, and core-envelope decoupling (using the most recent physically motivated analytic formulation) – which bring our theory even closer in agreement to the observations. Finally, we briefly discuss further anticipated tests of the theory, and some implications for planet habitability around M dwarfs.

Outflows in Young Brown Dwarfs - Clues from new PdBI observations

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Abstract. Young brown dwarfs (BD) play an important role in our understanding of the star and planet formation process, as a link between star and planet. Detailed studies of the circumstellar environment of young BDs can provide critical constraints to their formation mechanisms and therefore are needed to identify the dominant mechanism. In particular if BDs form like stars we expect their accretion and outflow properties to be similar to the ones observed in low mass stars counterparts. Better observations of a significant number of BDs are needed in order to properly understand their accretion/outflow properties and thus to compare to low mass stars and constrain BD formation models. In this paper, we present the results of CO(1-0) observations of 3 accreting BDs with the IRAM interferometer (MHO 5 ; FU Tau ; BD-Tau 6). These BDs are all optically visible and we assume that they are in an evolutionary stage comparable to CTTSs. They are known to be accreting and with evidence of outflow activity primarily in form of Forbidden Emission Lines. We find that at least 2 out of our 3 objects show millimeter outflow activity at the arcsec scale and with velocities of a few

km/s. We discuss the implications of these results in term of BD formation models.

Preparation of the CARMENES input catalogue. Mining public archives for stellar parameters and spectra of M dwarfs with with master thesis students

D. Montes[1]

[1] *UCM, Madrid*

Abstract. We are compiling the most comprehensive database of M dwarfs ever built, CARMENCITA, the CARMENES Cool dwarf Information and daTa Archive, which will be the CARMENES 'input catalogue'. In addition to the science preparation with low- and high-resolution spectrographs and lucky imagers (see the other posters at Cool Stars 18), we compile a huge pile of public data on thousands of M dwarfs, and anlyze them. Here we describe four specific actions carried out by master students on. They mine public archives for additional high-resolution spectroscopy (UVES, HARPS and FEROS), multi-band photometry (FUV-NUV-u-B-g-V-r-R-i-J-H-Ks-W1-W2-W3-W4), X-ray data (ROSAT, XMM-Newton and Chandra), and periods, rotational velocities and Halpha pseudo-equivalent widths. As described, there are many interdependences between all these data.

The Occurrence Rate of Giant Planets around M Dwarfs

Benjamin Montet[1]

[1] *Caltech, Harvard*

Abstract. Doppler-based planet surveys have discovered numerous giant planets but are incomplete beyond several AU. At larger star-planet separations, direct planet detection through high-contrast imaging has proven successful, but this technique is sensitive only to young planets and characterization relies upon theoretical evolution models. Recently, we have demonstrated that radial velocity measurements and high-contrast imaging can be combined to overcome these issues. The presence of widely separated companions can be deduced by identifying an acceleration (long-term "trend") in the stellar radial velocity. By obtaining high spatial resolution follow-up imaging observations, we rule out scenarios in which such accelerations are

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caused by stellar binary companions with high statistical confidence. Here, I will report results from an analysis of Doppler measurements of a sample of 111 M dwarf stars observed with a median time baseline of 11.8 years (Montet et al. 2014). By targeting stars that exhibit a radial velocity acceleration with adaptive optics imaging, we determine that 6.5% +/- 3.0% of M dwarf stars host one or more companions with masses in the range 1-13 Jupiter masses and orbital separations in the range 0-20 AU. We also find a very strong correlation between giant planet occurrence at wide separations and stellar metallicity.

Examining Flare Rates in Close M dwarf + White Dwarf Binary Pairs

Dylan P. Morgan[1]

[1] *Boston University*

Abstract. We present a preliminary study to examine the statistical flare rates for M dwarfs with a close white dwarf companion (WD+dM; typical separations ¡ 1 AU). Previous studies show a strong correlation between M dwarfs that are active (showing H? in emission) and their stellar flare rates. Our previous analysis of M dwarfs with close WD companions demonstrated that the M dwarfs are more active than their field counterparts. One implication of having a close binary companion is presumed to be increased stellar rotation through disk-disruption, tidal effects, and/or angular momentum exchange; increased stellar rotation has long been attributed to an increase in stellar activity for stars. We examine the difference between the flare rates observed in close WD+dM binary systems and field M dwarfs. Our sample consists of a subset of 202 (70 of which are magnetically active) close WD+dM pairs from Morgan et al. that were observed in the Sloan

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Digital Sky Survey Stripe 82, a transient observing mode where multi-epoch observations in the Sloan ugriz bands were obtained.

Clouds and Variability in Cool Brown Dwarfs

Caroline Morley[1]

[1] *University of California Santa Cruz*

Abstract. There is growing evidence that heterogeneous clouds cover the photospheres of brown dwarfs of many spectral types, causing photometric variability as cloudier hemispheres rotate in and out of view. In the warmer L dwarfs, these clouds are thick dusty layers of iron and silicates. At the L/T transition, these clouds form holes or dissipate; in this transitional effective temperature regime the largest variability is observed, a suggestive hint that variability is caused by the breakup of these thick cloud layers. In the cooler T dwarfs, the layers of iron and silicate clouds are below the photosphere; within the photosphere secondary condensates made of alkali salts and sulfides solidify, reddening the colors of this group of objects, which are otherwise quite blue in the near-infrared. In the coolest brown dwarfs, the Y dwarfs, more volatile species will begin to condense; the first volatile to condense is water, below effective temperatures of 400 K. We present a new grid of model atmospheres for objects from 200-450 K including water ice clouds; we find that they become optically thick in Y dwarfs cooler than 350 K and strongly influence mid-infrared spectra, with some potentially observable spectral features in the near- and mid-infrared. While the most dramatically variable brown dwarfs are found at the L/T transition, later T and Y dwarfs exhibit variability as well. To understand this variability, an initial approach is to disentangle the effects caused by heterogeneous clouds and hot spots. We present models where we predict the spectral dependence of variability caused by each of these effects, and find that these two processes have quite different spectral dependence. Broad-wavelength spectral

observational campaigns should be able to disentangle these processes and give insight into the 3D temperature and cloud structures of brown dwarfs.

Spectropolarimetry of planet-host stars

Claire Moutou[1]

[1] *CFHT*

Abstract. The stellar magnetic field plays a critical role in shaping the initial phases of planet formation, influencing the physical properties of close-in planets, and complexifying the conditions for habitability. In this work, we address these issues by characterizing the magnetic properties of planet-host stars by means of spectropolarimetry. The objective is to investigate magnetic properties of bright stars with close-in planets first. Data obtained using the optical instruments ESPaDOnS and NARVAL will be discussed -detection space, first characterized stars, comparison to stars without planets-, and prospects with the future nIR spectropolarimeter SPIRou at CFHT will be presented.

The low-mass membership of the Octans association

Simon J. Murphy[1]

[1] *ARI/University of Heidelberg*

Abstract. Thanks largely to the Hipparcos and ROSAT satellites, we now know that the immediate solar neighbourhood is bestrewn with a dozen or so sparse moving groups of young stars, including the well-known TW Hydrae, Beta Pictoris and AB Doradus associations. These groups are the evanescent products of nearby low-density star formation over the past 100 Myr. The under-studied Octans association is one of several such aggregates in the deep southern sky, well-separated from other groups in phase space. Unfortunately, none of Octans' members were observed by Hipparcos, leaving the distance, age and very existence of the group poorly constrained. To expand its membership and better determine these important parameters, we have begun a programme to identify new K and M-type Octans members in multi-wavelength all-sky surveys (e.g. SPM4, GALEX, 2MASS, WISE). By requiring candidates have proper motions and Galactic positions

in agreement with existing members, as well as GALEX near-UV colours and elevated CMD positions consistent with youth, we have identified 61 possible low-mass members at kinematic distances of 100-200 pc. Our techniques are also applicable to other nearby young moving groups lacking parallaxes. Spectroscopic observations confirm several new late-K and early-M type stars with congruent radial velocities and photospheric lithium levels indicative of youth. Using this new sample of low-mass members we present an updated definition for Octans and discuss its age, structure and circumstellar disk properties, as well as the group's relationship to other associations in the solar neighbourhood.

Mapping UCD Magnetospheres Using Spectral Tomography

Robert Mutel[1]

[1] *University of Iowa*

Abstract. We describe a innovative approach to map the locations and stability of localized active regions of UCD magnetospheres using the pulsed radio emission as a magneto-plasma probe. The key idea is that the frequency of ECM emission directly maps the magnetic field strength at the emission source, and that the rotation of the star provides time-lapsed spatial slices of its magnetic structure, provided that the source-dependent parameters (e.g. angular beaming, refraction) can be successfully modeled. The model is based on a self-consistent description of the coronal plasma and magnetic field and will take into account ECM growth rates and ray propagation.. For each star, the models free parameters (e.g., rotation and magnetic field axes orientation, magnetic field strength, frequency dependence of emission beaming angle) is adjusted for best-fit with the observations. The model accounts for frequency-dependent beaming at the emission source and refraction during propagation in the stellar corona. This technique, which we denote spectral tomography, builds on previous research in the study of ECM emission from planets We show first results for two pulsed UCDs, TVLM 0513-4656 and 2M0746+20. Wideband EVLA spectra (4 GHz 8 GHz) show several features not apparent on previously published pulses profiles, viz. drifting pulses and both high and low frequency cutoffs. Best-fit models in both cases show that the rotation axis has an inclination 70 deg.. The pulsed emission arises from localized magnetic loop structures with large field strengths (B 2 kG) on loops with L-shells between 1.2 and 2. The pulsed emission model, combined with gyrosynchrotron modeling of the continuous emission

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SED, are consistent with recent suggestions that radio-loud UCDs have weak non-axisymmetric fields with localized regions of high field strength.

Where Do Brown Dwarfs Come From? Insights From The SONYC Survey

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[1] *European Southern Observatory (ESO), Chile*

Abstract. The origin of the objects populating the substellar tail of the Initial Mass Function (IMF) is one of the major unsolved questions in star formation. A fundamental prerequisite to test the various competing theories is to establish a census of brown dwarfs (BDs) in nearby young star forming regions. Such a census allows us to probe the shape of the IMF, and yields large and homogeneous samples required to study disks, multiplicity, and accretion in the substellar regime. This is the goal of our SONYC (Substellar Objects in Nearby Young Clusters) survey program. SONYC is based on deep imaging, combined with proper motions, and followed up with extensive spectroscopic campaigns that have resulted in more than 700 spectra of candidate objects in NGC1333, Rho-Ophiuchi, Chamaeleon-I, Upper-Sco, and Lupus-3. We have identified and characterized more than 60 new young BDs, including a handful with masses close to, or below the Deuterium-burning limit. Through SONYC and similar surveys, the substellar IMF is now well characterized down to 5-10 Mjup, with the ratio of stars to BDs ranging between 2 and 5. Furthermore, our results suggest that free-floating objects with planetary masses are only a small fraction of al lBDs. We also see tentative evidence for regional differences in the efficiency of BD formation. For the first time we are now starting to explore the substellar IMF in an environment with very high stellar density and many OB stars, based on an imaging study of the young massive cluster RCW38. The comparison with the low-mass star forming regions within 500 pc provides an excellent test for variations of the IMF in the substellar regime caused by environment. In this contribution, I will give an overview of SONYC's findings, present

new results in RCW38, and outline the impact on our understanding of star formation.

Simulation of granulation and supergranulation radial velocity and photometric time series

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Abstract. Stellar variability at all time-scales strongly impacts the ability to detect exoplanets, in particular when using radial velocity (RV). Solar RV variability at time-scales of months to decades have been studied (e.g. Lagrange et al. 2010, Meunier et al 2010.), taking into account magnetic activity (spot, plages, inhibition of convection in plages). Such activity can impact the interpretation of RV data of solar-like stars. In the case of stars, part of the small-scale variability also represents an important factor (Aigrain et al. 2004 for photometry). Part of the small-scale variability can be averaged out by dedicated observational strategy (Dumusque et al. 2011). We have simulated a collection of granules or supergranules evolving in time in order to reproduce realistic solar photometric and RV time series, and studied the impact on RV observations aiming at detecting exoplanets. Long-term variability is also explored.

Constant Stars in the Kepler Database

James Neff[1]

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Abstract. We have monitored hundreds of stars at 30-minute cadence as part of a multi-year Kepler Guest Observer program. The sample was chosen largely by their GALEX colors, so we anticipated that the sample would contain a large number of spotted stars. In fact, the sample also contained pulsating A and F stars, pulsating red giants, and a substantial fraction of stars that showed no variability at all on any timescale. Visual inspection of the light curves alone generally is not adequate to determine the cause or even the level of variability, so we developed sophisticated tools to automatically classify stars using various windowing and power spectrum tests. We

present preliminary results regarding the characteristics of the constant stars and address the question whether they are very low-activity stars, stars in Maunder minima, or high-activity stars saturated with activity.

Linear Polarization and Convection in Cool Stars

Hilding Neilson[1]

[1] *East Tennessee State University*

Abstract. Convection and granulation are fundamental challenges for understanding the structures and atmospheres of cool stars, especially M-type dwarf and giant stars. Convection and convective granulation create asymmetric structures in these stars leading to linearly-polarized radiation. Hence, polarization measurements can constrain convective properties of these stars. It is also important to understand the contribution of convection on polarization as polarization can indicate the presence of disks and planets as well. In this work, we explore how linear polarization varies as a function of convective cell properties in cool giant and dwarf star using semi-analytic models.

Towards a Unified Model of Stellar Convective Dynamo Action and Magnetic Flux Emergence

Nicholas Nelson[1]

[1] *Los Alamos National Laboratory*

Abstract. Magnetic activity is now being observed in stars across the lower main sequence. Observations rely on the effects of surface magnetic fields, the strongest and largest of which are believed to be generated by large-scale dynamo action in the deep interior. Portions of these large-scale magnetic structures are then believed to rise through the convective layer, forming magnetic loops which then pierce the photosphere as starspots. Previous global simulations of 3D MHD convection in rotating spherical shells have demonstrated mechanisms whereby large-scale magnetic wreaths can be generated in the bulk of the convection zone. Our recent simulations have achieved sufficiently high levels of turbulence to permit portions of these wreaths to become magnetically buoyant and rise through the simulated convective layer by a combination of magnetic buoyancy and advection by

convective giant cells. These buoyant magnetic loops are created in the bulk of the convective layer as strong Lorentz force feedback in the cores of the magnetic wreaths dampen small-scale convective motions, permitting the amplification of local magnetic energies to over 100 times the local kinetic energy. While the magnetic wreaths are largely generated the shearing of axisymmetric poloidal magnetic fields by axisymmetric rotational shear (the ?-effect), the loops are amplified to their peak field strengths before beginning to rise by non-axisymmetric processes. This further extends and enhances a new paradigm for the generation of emergent magnetic flux bundles, which we term turbulence-enabled magnetic buoyancy.

A new Fe/H] and Teff calibration for M dwarfs in the visible: a high-precision tool to explore the star-planet relation

Vasco Neves[1]

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Abstract. We present a new technique to obtain high precision determinations of metallicity and effective temperature of M dwarfs in the optical. Our method makes use of the information of most lines in the 550-690 nm spectral region of HARPS spectra. It consists in the measurement of pseudo equivalent widths and their correlation with established scales of metallicity and effective temperature. The calibration achieves a *rms* of 0.08 dex for [Fe/H], 110 K for T_{eff}, and is valid in the (-0.89, 0.25 dex), (2650, 3900 K), and (K7, M5.5) intervals for [Fe/H], Teff and spectral type respectively. We also calculated the RMSE_V which estimates uncertainties of the order of 0.12 dex for the metallicity and of 310 K for the effective temperature. Our calibration is available online at http://www.astro.up.pt/resources/mcal. We used our calibration to study the star-planet relation of Giant and Neptunian planets around M dwarfs. We confirm the Giant planet-metallicity relation, already discovered for FGK dwarfs, as well as the non-existence of such a correlation for Neptunian hosts. We also plan to use this new high-precision

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calibration to constrain evolutionary and transit light curve models in order to obtain more precise values of stellar and planetary mass and radius.

Deep X-ray imaging of M37: a better Hyades

Alejandro Nunez[1]

[1] *Columbia University*

Abstract. Although it has been known for decades that rotation and magnetic activity in main- sequence stars evolve with age, a quantitative description of the age-rotation-activity relation (ARAR) is still a work in progress. Empirical calibrations of this relation rely critically on the coeval populations of stars in open clusters. The Hyades has been studied extensively to benchmark the ARAR at 600 Myr; for example, ROSAT observations were used to characterize coronal X-ray emission, a tracer of a stars overall magnetic activity, in middle-aged clusters. X-ray observations of the Hyades and Praesepe, another 600 Myr cluster, differ substantively, casting doubt on the universality of the age-coronal activity relation. We present preliminary results from a 450 ksec Chandra X-ray observation of M37, another Hyades-like, 500-Myr-old open cluster. To fully exploit these data and the extensive catalog of optical rotation periods measured for stars in the M37 field, we begin by revisiting the clusters membership. At a distance of 1.5 kpc, M37 is a difficult target for ground-based proper motion measurements; we therefore calculate updated membership probabilities for cluster and field stars based on their position in a color-magnitude diagram and their distance from the cluster center. We then match our list of M37 cluster members to our ACIS-I detections, focusing on those stars for which we have rotation periods. With rotation periods and X-ray detections for a substantial sample of M37 members, this study will decouple the age-rotation and rotation-activity

relationships at 500 Myr, and help determine the universality of the 500-600 Myr ARAR.

Subaru IRD-Doppler survey: A search for Earth-like planets orbiting late-M dwarfs

Masashi Omiya[1]

[1] *Tokyo Institute of Technology*

Abstract. Late-M dwarfs are attractive targets to detect Earth-mass planets in habitable zone because of the low-mass host stars and their close-in habitable zones. The InfraRed Doppler instrument (IRD) to be mounted on the Subaru telescope in 2015 is composed of a stable near-infrared high dispersion echelle-spectrograph (R=70000) and a laser-frequency comb as a precise wavelength calibrator covering the wavelength range of 0.97-1.75 micron. Using IRD on the Subaru 8.2 meter telescope, we are proposing to conduct a Doppler (radial velocity) survey of more than 100 late-M dwarfs to search for Earth-like planets around low-mass stars. We have performed a detailed survey simulation and selection of appropriate target stars for this survey. In this poster, we present our survey strategy and discuss expected detectable planets with our IRD-Doppler survey.

Searching for Binary Y dwarfs with the Gemini GeMS Multi-Conjugate Adaptive Optics System.

Daniela Opitz[1]

[1] *University of New South Wales*

Abstract. The NASA Wide-field Infrared Survey Explorer (WISE) has delivered an exceptional harvest of new ultra-cool Y-type brown dwarfs. We present results from a diffraction-limited study of the binary status of a sam-

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ple of Y dwarfs observed with the Gemini GeMS Multi-Conjugate Adaptive Optics system.

Sensitive Identication of Warm Debris Disks in the SolarNeighborhood through Precise Calibration of Saturated WISEPhotometry

Rahul Patel[1]

[1]*Stony Brook University*

Abstract. The WISE All-Sky Survey Catalog presents an opportunity to expand the number of detections of warm (¿100K) circumstellar dust in asteroid belt-analog regions. Not only would this increase in detections be useful to statistically constrain the occurrence rate of such dusty systems but imaging campaigns can use any targets in the solar neighborhood (¡75 pc) as optimal targets to spatially characterize the morphology of the dust population. However, WISE bands saturate at relatively bright magnitudes, effectively removing bright stars from WISE excess searches. In this study we identify 220 Hipparcos stars within 75 pc with mid-infrared excesses arising from warm optically thin circumstellar dust at the W3 (12 um) and W4 (22 um) bands. For the first time, we are able to detect small excesses even around bright solar neighborhood stars by deriving and applying corrections to the fluxes of saturated stars in WISE. For optimal sensitivity, we use the stars contemporaneously measured shorter-wavelength fluxes at W1 (3.4 um) and W2 (4.6 um) to identify excesses at W3 and W4. These systematic corrections, together with careful inspection of other possible sources of contamination (e.g., interstellar cirrus, unresolved companions, scattered moonlight), enable us to increase by 45% the number of stars with warm dusty excesses within 75 pc of the Sun, even in the light of several recent studies on WISE. Our findings include five new stars with tenuous but significant W3 excesses, adding new members to the small population of known exozodi within 75 pc. Altogether, we have expanded the number of known debris disks (with excess at any wavelength) within 75 pc of the Sun by 29%. As a result of our WISE study, the number of debris disks with known 1030um excesses within 75 pc (379) has now surpassed the number of disks

with known ¿30um excesses (289, with 171 in common), even if the latter have been found to have a higher occurrence.

Rotation Periods for Kepler Stars with Planets and KOI

Francisco Paz-Chinchn[1]

[1] *UFRN, Federal University of Rio Grande do Norte, Brazil*

Abstract. We analyzed the current sample of Kepler Confirmed Planetary Host Stars and Kepler Objects of Interest (KOI) lists, to compute new photometric rotation periods and study their specific angular momentum. LombScargle periodograms and wavelet maps were analyzed for 82 planetary host confirmed sources of which rotational modulation was identified for a final sample of 46 stars, 10 of which still not have rotational measurements in the literature. KOI list was also analysed in order to cover the entire candidate list. Based on published masses and evolutionary tracks, the smaller sample (confirmed planetary hosts) is composed of M to Ftype stars (0.51 to 1.53 M?), with rotation periods covering a range between 2 and 43 days. These periods shows an excellent agreement with values for stars in common with previous works, and the observed $P_{\rm rot}$ distribution strongly agrees with expected theoretical predictions. Finally, for the 46 confirmed host sources considered here the specific angular momentum provides an important generalization of Krafts relation, based on photometric rotation periods.

Status of known T-type objects towards the Sigma Orionis cluster.

Karla Pea Ramrez, Mara Rosa Zapatero Osorio, Victor Bjar[1]

[1] *Pontificia Universidad Catlica de Chile*

Abstract. The complete characterization of the lowest mass candidate members in a star forming region is crutial to derive a relaible mass function. In the line of sight of the Sigma Orionis cluster it has been identified three T type sources that at the age and cluster distance would be some of the lowest cluster mass members. By assesing (or not) their cluster membership, the planetary mass bin of the cluster mass function can provide us key insights about the opacity limit by fragmentation in star forming regions being these

sources benchmark dwarfs with low surface gravities and planetary masses. We have obtained J band spectroscopic (ISAAC/VLT) data for candidate SOriJ053804.65-021352.5 and used public HST spectroscopic data (1.08-1.70 um) for SOri70 and SOri73 candidates. We have used methane imaging (LIRIS/WHT) of SOri70, SOri73 and SOriJ053804.65-021352.5 and we have conducted an astrometric analysis of the three T type dwarfs. We have estimated that SOriJ053804.65-021352.5 has a spectral type of T5(0.5) from its near infrared spectra and methane filters. The KI doublet (1.25 um) in its spectrum, as well as its infrared and methane colors, are similar to the ones from field dwarfs of the same spectral type. Our results from methane imaging for Sori70 and Sori73 are consistent with their known photometric and spectroscopic data. We have analyzed the proper motion of the three T type sources finding that their proper motion values are 2.8-9.7 sigma away from the canonical Sigma Orionis motion. The magnitudes, spectral types and astrometric measurements of the three T type dwarfs in the line of sight of the Sigma Orionis cluster are incompatible with their simultaneous cluster membership. The current panorama of the T type sources that have been identified towards the cluster seems to reinforce an apparent lack of T type members indicating that either the cluster substellar mass function may has a turnover at around 4Mjup, cluster T type objects are fainter than predicted by theoretical models or the search and identification of cluster T type dwarfs based on the photometric properties of field T type dwarfs requires a revision in the different star forming regions.

Multi-wavelength analysis of short period eclipsing M-dwarf binaries

Volker Perdelwitz[1]

[1] *Hamburg Observatory*

Abstract. Tight eclipsing binaries are ideal laboratories to study orbital evolution by magnetic breaking, stellar evolution and activity on the low-mass end of the main sequence. Until recently there were only two known M-dwarf eclipsing binaries, YY Gem and CM Dra. With the advent of numerous extrasolar planet searches such as DWARF, OGLE, TrES, WASP, NSVS etc., a substantial number of these new eclipsing low-mass binaries have been identi

ed. We present the fi

rst results of our multi-wavelength investigation into the properties of the eclipsing M-dwarf binary systems known to have the shortest periods, covering photometry and spectroscopy in both the X-ray and optical regime.

A study of non-thermal emission from RSG passing through the ISM during different life stages

Vctor Pereira Blanco[1]

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Abstract. Runaway O- and early B-type stars moving supersonically (¿ 30 km/s) through the ISM may produce bow shocks by the interaction of their strong winds and the dust. Theoretical models predict the production of high-energy photons by non-thermal radiative processes originated in the bow shock region, which can serve as particle acceleration sites. Massive stars undergo fast transitions from blue supergiant BSG) to cool red supergiant (RSG) at late evolutionary stages, and vice versa. During the RSG phase, the moment of the wind decay. However, high velocity stars (v ¿ 100 km/s) may transfer enough energy to the ISM to trigger non-thermal photons. The transition from the fast BSG to the slow RSG winds and the evolution of the bow shock during the evolutionary track of Betelgeuse have been recently modeled by Mackey et al. (2012). We apply our non-thermal model to the different RSG stages considered in that work to check for the suitable conditions that can lead to high-energy emission in each stage.

Understanding the Wide Main Sequence Through Our Low Mass Neighbors

Tiffany D. Pewett[1]

[1] *Georgia State University*

Abstract. The RECONS (REsearch Consortium On Nearby Stars, www.recons.org) team has compiled the highest quality astrometric (parallaxes) and photometric (most importantly, VRIJHK) data currently available for over 3000 stars within 25 parsecs. This allows us to create an exquisite map of the main sequence in the H-R Diagram from A stars through M stars. Careful analysis of the H-R Diagram reveals a curious thing — the main sequence is widest, by up to 2.5 full magnitudes in Mv, in the region of

low mass K and M dwarf stars. This corresponds to a factor of almost 10 in luminosity among stars of the same temperature. A detailed understanding of the causes of this width still remains elusive and complex. Given that temperature and radius determine the observed luminosity of a star, stars with identical temperatures must have radii differing by up to a factor of three to account for the width of the main sequence. In order to determine the underlying causes of the different radii, we have embarked on a project to measure the properties of a large sample of the nearest low mass stars. So far this includes investigations of variability, radii, surface gravities, and metallicities. We compare the main sequence stars to nearby young stars and cool subdwarfs with similar colors to map the complex interplay of these many factors. Here we present initial results from the photometric variability data and recently obtained spectra. This effort is supported by the NSF through grants AST-0908402 and AST-1109445, and via observations made possible by the SMARTS Consortium.

The activity of stars hosting hot Jupiters

Ignazio Pillitteri[1]

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Abstract. The activity of stars harboring hot Jupiters could be influenced by the close-in planets. Some cases of enhanced chromospheric activity are reported in literature that hint a magnetic origin. In X-rays, HD 189733 shows high features of activity that can be ascribed to the influence of the magnetic field of its planetary companion. I will report on the characterization of the corona of HD 189733 based on what we learned from three XMM-Newton observations. Through a wavelet analysis of a flare, we inferred a long magnetic loop of 2 R* to 4 R* and a local magnetic field of strength 40-100 G. The size of the flaring loop suggests a role of the hot Jupiter in triggering this kind of X-ray variability. HST-COS spectra of HD 189733 shows temporal variations in intensity and Doppler shifts of Si III and Si IV lines that can be ascribed to plasma flowing from the planetary atmosphere at well determined planetary phases. In another system, WASP-18, the very close hot Jupiter has likely suppressed any magnetic activity of the host star through strong tidal interaction with the upper layers of the stellar convective zone. In summary, star planet interaction can act in opposite directions enhancing or destroying the stellar activity, depending

on different parameters, like star-planet separation, mass ratios, and inner stellar structure.

A Survey of Auroral Emission from Ultracool Dwarfs

J. Sebastian Pineda[1]

[1] *Caltech*

Abstract. The discovery of pulsed radio emission from brown dwarfs has expanded our understanding of the magnetic phenomenon associated with ultracool objects spanning spectral types M9 to T6. The proposed emission mechanisms necessitate the presence of energetic electron populations cascading down into the upper atmosphere. In Jupiter this magnetospheric interaction leads to auroral emission lines in the ultraviolet, optical and infrared. Recent studies have suggested that similar mechanisms operate in the magnetospheres of cool brown dwarfs. We present preliminary results from our ongoing survey with the Keck telescopes examining the prevalence of optical and infrared aurorae in ultracool dwarfs looking for H-alpha emission in a volume limited sample of T dwarfs and looking for H3+ emission from known radio brown dwarfs.

A tale of two exoplanets: X-ray studies of the Hot Jupiters HD 189733 b and CoRoT-2 b

Katja Poppenhaeger[1]

[1] *Harvard-Smithsonian Center for Astrophysics*

Abstract. Planets in close orbits around their host stars are subject to strong irradiation. Especially high-energy irradiation, originating from the stellar corona and chromosphere, is responsible for the evaporation of exoplanetary atmospheres. Observations at short wavelenghts are therefore a prime tool to study the planetary mass loss. We have conducted multiple X-ray observations of transiting exoplanets in short orbits to determine the extent and heating of their outer planetary atmospheres. In the case of HD 189733 b, we find a surprisingly deep transit profile in X-rays, indicating an atmosphere extending out to 1.75 optical planetary radii. We will also report

on observations of the Hot Jupiter CoRoT-2 b from our Large Program with XMM-Newton, which was conducted recently.

Masses, Mass Ratios, Models: the Utility of Young Spectroscopic Binaries

Lisa Prato[1]

[1] *Lowell Observatory*

Abstract. Young spectroscopic binaries with fully characterized orbits provide a precise dynamical approach to the determination of young star masses, distances, and binary mass ratios. These properties drive more accurate models of young star evolution and binary formation. Yet for only about 80 pre-main sequence spectroscopic binaries have some orbital properties been determined. Of these, only about 60% are double-lined systems, yielding mass ratios. In this poster I provide an overview of spectroscopic binary statistics and measurements to date and the potential for doubling the sample over the next few years. I will highlight some particularly interesting systems, such as long-period binaries accessible to high-angular imaging techniques, and emphasize the impact of GAIA on this sample.

Magnetic Activity and Accretion in Three Nearby, Nearly Edge-on Pre-MS Star-disk Systems

David Principe[1]

[1] *Rochester Institute of Technology*

Abstract. We investigate, via contemporaneous X-ray and optical/IR observations, the nearby, pre-main sequence star/disk systems T Chamaeleontis (T Cha; D 110 pc, age 3-5 Myr) and TWA 30A and 30B (D 40 pc; age 8 Myr). All three of these systems present opportunities to probe pre-main sequence (pre-MS) star-disk interactions during late-stage circumstellar disk evolution. The classical T Tauri star T Cha is the closest known example of a nearly edge-on, actively accreting, solar-mass star/disk system; furthermore, T Cha may be orbited by a low-mass companion or massive planet that has cleared an inner hole in its disk. We analyze near-simultaneous Chandra high-resolution X-ray and optical H-alpha spectroscopy observations of T Cha to search for correlations between X-ray and optical emission

signatures of accretion, and to infer the X-ray absorbing properties of the T Cha circumstellar disk. We also present contemporaneous XMM-Newton X-ray and optical/IR spectroscopic observations of the nearby, actively accreting, very low-mass (mid-M) pre-MS star/disk/jet systems TWA 30A and 30B. Like T Cha, each component of this wide binary is viewed through a nearly edge-on circumstellar disk. Both TWA 30A and 30B display large near-IR variability, suggestive of (respectively) variable obscuration of the stellar photosphere and a possible disk-rim warp. The proximity and edge-on viewing geometries of the TWA 30 pair afford a unique opportunity to investigate the composition of circumstellar disks orbiting pre-MS stars near the H-burning limit. We investigate potential X-ray accretion signatures, and compare the levels of magnetic activity in TWA 30A and 30B to those of other nearby, low-mass pre-MS stars.

CARMENES

Andreas Quirrenbach[1]

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Abstract. CARMENES is a next-generation radial-velocity instrument under construction for the 3.5m telescope at the Calar Alto Observatory by a consortium of eleven Spanish and German institutions. It consists of two separate chelle spectrographs covering the wavelength range from 0.55 to 1.7 ?m at a spectral resolution of R = 82,000, fed by fibers from the Cassegrain focus of the telescope. CARMENES passed its final design review in February 2013. We discuss critical design decisions, present the final design, and report on the ongoing MAIV phase of the project. CARMENES will conduct a radial-velocity survey of 300 M dwarfs with a precision sufficient for detecting Earth-like planets in their habitable zones. A data base of M stars (dubbed CARMENCITA) has been compiled from which the CARMENES sample can be selected. CARMENCITA contains information on all relevant properties of the potential targets. Dedicated imaging, photometric,

and spectroscopic observations are underway to provide crucial data on these stars that is not available in the literature.

As the Dust Settles: continuous monitoring of L/T transition brown dwarfs with Spitzer

Jacqueline Radigan[1]

[1]*STScI*

Abstract. Recent observations of cool brown dwarfs in the time-domain have revealed large-amplitude variability at near-infrared wavelengths for a subset of objects spanning the transition between cloudy L-dwarf and clear T-dwarf spectral types. This quasi-periodic variability is indicative of patchy clouds and evolving weather patterns. We present the results of an intensive monitoring campaign where 5 highly variable L/T transition brown dwarfs were were followed up with Warm Spitzer. Light curves spanning several consecutive rotations were obtained, with our longest observation of the highly variable T1.5 dwarf 2MASS 2139+02, spanning 48 hours. Strong variability is confirmed in all targets, demonstrating persistence of variability over months and years. For all but one target, the dominant temporal component of the variability can be associated with rotation. Further changes in light curve shape are observed from rotation to rotation, demonstrating that cloud features evolve on timescales of hours. The observed amplitudes of variability are similar in the [3.6] and [4.5] Spitzer channels, but tend to be smaller on average than those found in the near-infrared. We present our attempt to model the observed light curves as a function of time and wavelength, and discuss possible interpretations based on current dynamical and spectral models of brown dwarf atmospheres.

Characterizing the Coolest Atmospheres: Exoplanets to Brown Dwarfs

Abhijith Rajan[1]

[1]*Arizona State University*

Abstract. We present the results of two complementary Brown dwarf Atmosphere Monitoring (BAM) programs characterizing planetary temperature sub-stellar L, T, and Y-dwarfs. The BAM-I project uses the SofI camera

on the 3.5 m NTT to conduct an extensive Js-band monitoring survey of an unbiased sample of 69 brown dwarfs spanning the L0 and T8 spectral range. A total of 14 brown dwarfs were identified as variables with amplitudes ranging from 1.7% to 10.8% over the observed duration. Approximately half of the variables show sinusoidal amplitude variations similar to 2M2139, and the remainder shows aperiodic variations similar to SIMP0136. The survey was designed to test the hypothesis that the L/T transition has a higher degree of variability due to the presence of patchy clouds. The measured variability frequency for the BAM-I transition region variables is indistinct from that of the non-transition region brown dwarfs. In the BAM-II project we conducted a pilot study monitoring an initial sample of five ultracool T6.5 to Y0 brown dwarfs for infrared photometric variability using the SWIRC camera on the 6.5m MMT. T/Y transition objects with temperatures ranging from 500 900 K are expected to have salt and sulfide clouds form and breakup. One of the targets in the survey shows large amplitude peak-to-trough variations as high as 23% in our data, making it the highest amplitude variable brown dwarf detected outside the L/T transition region. With an effective temperature of 600 K, it is the coldest variable brown dwarf detected to-date. We are currently following-up all our candidate variables with multi-wavelength monitoring using a variety of ground-based telescopes. These brown dwarf variables will provide an invaluable dataset that will serve as a benchmark comparison to directly imaged planets and intensely irradiated Hot Jupiters and to synthetic atmospheric models incorporating different physical processes.

The Sun as a template of accretion impacts on young stars

Fabio Reale[1]

[1] *University of Palermo, Italy*

Abstract. The Sun has recently offered an interesting opportunity to study impacts similar to those of accretion flows from circumstellar disks onto young stars (Reale et al. 2013, Science, 341, 6143, 251). After the eruption of a dense filament triggered by an energetic flare on June 7, 2011 part of the ejected material falls back onto the solar surface. The impact of the downfalling plasma was imaged by the Atmospheric Imaging Assembly (AIA) on-board the Solar Dynamics Observatory (SDO). Hydrodynamic simulations confirm that the high energy emission is produced by the impact of high-density plasma at the highest free-fall speeds and show the importance of the absorption in reducing the X-ray emission and of fragmentation in explaining the line broadenings. Impacts such as these present a laboratory

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for stellar astronomers to study the impact of dense (accreting) circumstellar material in unique detail.

YSOVAR: Young Stellar Variability on 6-7 Year Timescales

Luisa Rebull[1]

[1] *Caltech*

Abstract. YSOVAR (Young Stellar Object VARiability) is the name given to a group of Spitzer Space Telescope programs (PI: J. Stauffer) all aimed at time-series monitoring of young stars. We have extensive mid-infrared (3.6, 4.5 um) time-series photometry of a dozen star-forming regions on a variety of timescales ranging from minutes to years. This poster will summarize our results for variability on the longest timescales to which we are sensitive, 6-7 years.

Proto-brown dwarfs identified with WISE and JCMT

Basmah Riaz[1]

[1] *Uni. of Hertfordshire, UK*

Abstract. We present an optical to sub-millimeter multi-wavelength study of two proto-brown dwarfs identified in a UKIDSS+WISE cross-correlated survey of the sigma Orionis cluster. We have looked into the various classification schemes, and both the observed properties and physical characteristics for the targets indicate a Class I classification. Both objects are detected at a ¿5-sigma level in the SCUBA-2 850um band, with the corresponding dust condensation masses of 20-40 MJup. The spectra for both sources exhibit prominent emission in the accretion-associated Halpha and Ca II infrared triplet lines, and the forbidden emission lines of [OI], [SII], and [NII], indicating the presence of an outflow. The accretion and outflow rates determined from multiple line diagnostics are comparatively higher than Class II brown dwarfs, and the ratio of the outflow to accretion rate is more in line with Class I low-mass stars. Given the membership of these objects in a relatively evolved cluster of 1-3 Myr of age, we consider an alternate formation mechanism for brown dwarfs, in the context of the hybrid model of disk fragmentation, followed by ejection of a gaseous clump. The measured

accretion rates can be explained either within the framework of episodic accretion or early formation phase of proto-brown dwarf disks. We also discuss the possibility of a prolonged Class I lifetime for substellar objects.

Accretion disks around Brown Dwarfs and Very Low Mass stars: the ALMA view

Luca Ricci[1]

[1] *Caltech*

Abstract. Accretion onto very low mass stars and brown dwarfs is mediated by young disks made of gas and dust. Observations of these disks can shed light on the physical mechanisms proposed to form these cool objects, as well as on the potential of finding rocky or giant planets around them. I will present recent results from an ongoing ALMA and CARMA project aimed at investigating the physical structure of these disks, the early stages of solids growth toward the formation of planetesimals in these systems, their mass function and rotation curve. Our results show that dust growth to mm/cm pebbles is as efficient in these systems as in more massive disks around young stars, and the disk radii are also similar to those found for T Tauri stellar disks. The ALMA easy detection of CO molecular gas in 3 out of our 4 disks show the potential of ALMA to constrain the rotation curve for these disks and estimate dynamical masses for single young brown dwarfs. I will discuss the implications of these fi

ndings on models of solids evolution in protoplanetary disks, on the main mechanisms proposed for the formation of brown dwarfs and very low mass stars, as well as on the potential of

finding rocky and giant planets around these very low mass objects.

Spectral & Photometric Analysis of Blue and Red L Dwarfs

Emily Rice[1]

[1] *College of Staten Island, CUNY*

Abstract. L type brown dwarfs have a range of near-infrared colors at a given optically-defined spectral subtype, which is variously attributed to differences in gravity, metallicity, and dust/cloud properties. For a limited number of these objects, diagnostic spectral features indicate low surface

gravity (red, young objects) or low metallicity (blue, subdwarfs), but for most of the objects the cause of the extreme color is unknown. We explore the photometric and spectral properties of color outliers using multi-resolution near-infrared spectra, WISE mid-infrared photometry, parallaxes, and kinematics to explore underlying physical and atmospheric properties. The analysis is anchored by optical spectra (as a proxy for effective temperature) and benchmarks such as confirmed young objects, subdwarfs, and companions. This is the largest, most diverse observational dataset of red and blue L dwarfs assembled to date.

Precise Masses of Low-Mass Eclipsing Binaries

Andrew Riddle[1]

[1] *University of Texas at Austin*

Abstract. We present new and updated mass measurements for a sample of low-mass eclipsing binaries using Keck archival data and new observations taken on the 2.7 m telescope at McDonald Observatory. We explore multiple methods for precisely measuring radial velocities, including multi-dimensional correlation functions as well as rotational broadening functions. Precise mass determinations for these stars are the first phase of a project to study low-mass eclipsing binaries with IGRINS. By adding additional stellar parameters to the mass-radius relation (e.g. metallicity, rotation), we aim to resolve the discrepancy that exists between observations and models of low mass stars.

The Triumphs and Perils of Young Star Kinematics

Adric Riedel[1]

[1] *CUNY-Hunter College*

Abstract. Kinematics are a commonly used tool in the toolkit of cool star researchers looking for young objects. It is a useful tool, relying on positions, proper motions, parallaxes, and radial velocities; all readily available in the modern age of Hipparcos and high precision spectroscopy. As we prepare to take a leap into the revolutionary new world of Gaia astrometry, it is important to consider both the power and the limitations of what we can

do with kinematics, and what Gaia will make possible. I will discuss the strengths and weaknesses of the currently used kinematic implementations and the prospects for using more advanced techniques like kinematic tracebacks to increase our knowledge of stars, the nearby young moving groups themselves, and the characteristics of the gas clouds that formed them.

Cloud Formation, Quenching and Chemistry in Electrified Brown Dwarf Atmospheres

Paul B. Rimmer[1]

[1] *University of St Andrews*

Abstract. Paul B. Rimmer, Christiane Helling, Craig R. Stark, Camille Bilger Brown dwarf atmospheres are dynamic, engaged in a complicated interplay between gas-phase chemistry, dust and cloud formation, and bombardment by electromagnetic radiation and energetic charged particles. Variable X-ray and radio emission in some brown dwarfs suggests that the atmosphere may be periodically electrified, making way for various hypothetical atmospheric discharge processes. In this presentation, we discuss how cloud formation in DRIFT-PHOENIX model atmospheres is found to enhance the C/O ratio within the cloud layer, and we predict that chemical quenching can transport the carbon-rich chemistry above the cloud top. Atmospheric electrification, whether by cosmic rays and ultraviolet photons in the upper atmosphere, dust-dust collisions in the cloud layer or Alfvn ionization, results in the formation of various ions, and opens up pathways for ion-neutral non-equilibrium chemistry. We predict that atmospheric electrification by cosmic rays can enhance the abundances of complex hydrocarbons and ammonia. These abundances will in turn affect the radiative transfer, the resulting temperature profile, and therefore cloud formation. Progress toward a self-consistent non-equilibrium chemical model will be presented at the end.

Modeling Sources of Variability in Brown Dwarf Spectra

Tyler D. Robinson[1]

[1] *NASA Ames Research Center*

Abstract. A number of brown dwarfs are known to be variable with observed amplitudes as large as 10-30% at some wavelengths. A combination

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of dynamical effects, temporally- and spatially-varying clouds, and associated atmospheric temperature fluctuations is likely responsible for the observed variability. Using a newly-developed one-dimensional, time-stepping model of atmospheric thermal structure, we explore the evolution of thermal perturbations in a T-dwarf atmosphere. We demonstrate that thermal perturbations occurring deep in the atmosphere can be communicated to the upper atmosphere through radiative heating via the windows in near-infrared water opacity. The atmospheric response timescale depends on where a thermal perturbation is introduced. For certain periodic perturbations, we show that the emission spectrum can have complex, time- and wavelength-dependent behaviors, including phase shifts in times of maximum flux observed at different wavelengths. Since different wavelengths probe different regions of the atmosphere, observed variations track, in part, a complex, wavelength-dependent set of radiative exchanges happening between different atmospheric levels. We conclude that thermal fluctuations should be considered as an important contributor to brown dwarf spectral variability, and discuss the potential feedbacks between these fluctuations and clouds.

X-rays from the solar neighborhood

Jan Robrade[1]

[1] *Hamburger Sternwarte*

Abstract. Magnetic activity is an ubiquitous phenomenon in cool stars and the solar neighborhood is most suited to explore the X-ray fainter members of the stellar population. Probed targets include older G and K stars, but also A stars and very late M dwarfs, addressing activity in the regime of shallow convection zones to fully convective stars. I present X-ray studies of

activity cycles in nearby solar-like stars from a decade of observations and report on the coronae of the hottest and coolest magnetically active stars.

New Results from the GALEX Nearby Young-Star Survey

David R. Rodriguez[1]

[1] *Universidad de Chile*

Abstract. The last few decades have seen the discovery of many 10-100 Myr-old stars in moving groups within 100 parsecs of Earth. The present membership of these groups, however, is still incomplete at the lowest masses. We have initiated a program, the GALEX Nearby Young-Star Survey, or GALNYSS, to search for these missing M-stars. GALNYSS has combined ultraviolet data from GALEX with near-IR surveys (WISE and 2MASS), as well as kinematic information, in order to identify over 2000 candidate young low-mass stars near Earth. Spectroscopic followup is ongoing, and results thus far confirm the youthful nature of many stars among the GALNYSS sample. This suggests that our technique is capable of revealing the populations of low-mass stars that are presently missing from the nearby young moving groups. We present an overview of our survey to date, including the characteristics of the GALNYSS sample and highlights from the latest contributions to our knowledge of the number and membership of nearby, young stellar associations. This work is supported by NASA Astrophysics Data Analysis Program award NNX12AH37G to RIT and UCLA and Chilean FONDECYT grant 3130520 to Universidad de Chile.

M dwarf search for pulsations and flare studies within Kepler Guest Observer program

C. Rodriguez-Lopez[1]

[1] *Instituto de Astrofisica de Andalucia (IAA-CSIC)*

Abstract. We have done time-series analysis to search for pulsations in a sample of five M dwarfs observed in short-cadence within Kepler Guest Observer program. High cadence sampling is essential to detect the shortest pulsations predicted theoretically in the 20 minute range and to enable high time-resolution analysis of flares. Three of the targets present stellar activity and two rotational modulation. We find that white light flares are present

in the M dwarfs with rotational periods less than 20 days, and that their energy-frequency relations are comparable to traditional flare stars. The rapidily rotating M4 star GJ 1243 shows the strongest and most frequent flares. Pulsations have not been found to a detection limit of several parts per million.

Investigating the flare activity of the spotted Kepler star KIC 5110407

Rachael Roettenbacher[1]

[1] *University of Michigan*

Abstract. With four years of precise, nearly-continuous photometry from the Kepler satellite, we used a light-curve inversion algorithm to reconstruct the stellar surface of KIC 5110407, a rapidly-rotating, spotted star. While the evolving starspots showed no indication of periodicity, the flares serendipitously observed in the light curve of KIC 5110407 showed potential evidence for an activity cycle. Additionally, the full sample of detected flares does not show a correlation with the location of starspots; however, we found a possible connection for the strongest flares occurring when the largest starspot groups faced Kepler. With the analysis of our complete data set and archival Kepler data, we further investigate individual systems for periodic flare activity and correlations to starspot location.

Color Metallicities for SUPERBLINK Early M Dwarfs

Brbara Rojas-Ayala[1]

[1] *CAUP*

Abstract. The metallicity of M dwarf stars provides insights on the enrichment history of the Galaxy, on planet formation, and can aid to the identification of low-mass members of nearby stellar associations. While spectroscopic techniques are preferred to accurately estimate stellar parameters of stars, a larger amount of low-mass stars are accessible with current photometric surveys. We present color based techniques to estimate the metallicity of early M dwarfs from public available photometric catalogs. The techniques are based on photometry from $WISE$, $UCAC4$, and $2MASS$ surveys and are calibrated with common proper motion systems,

consisting on a FGK stars with reliable metallicities and M dwarf companions. Our techniques are qualitatively validated by synthetic models and by M+M common proper motion systems, and return expected metallicities of young associations/moving groups from kinematically likely low-mass members.

M dwarfs in the b201 tile of the VVV survey

Brbara Rojas-Ayala[1]

[1] *CAUP*

Abstract. The intrinsically faint M dwarfs are the most numerous stars in the Galaxy, have main-sequence lifetimes longer than the Hubble time, and host some of the most interesting planetary systems known to date. Their identification and classification throughout the Galaxy is crucial to unravel the processes involved in the formation of planets, stars and the Milky Way. The ESO Public Survey VISTA Variables in the Vi?a La?ctea is a deep near-IR survey mapping the Galactic bulge and southern plane. The VVV b201 tile, located in the border of the bulge, was specifically selected for the characterisation of M dwarfs. We identified 23,345 objects in VVV b201 with colours consistent with M dwarf stars. We provided M spectral types (modulo 1 subtype) and expected distances from photometry for all M dwarf candidates. In the range 12¡ks

MHD simulations of magnetospheric accretion, waves in the disk and associated variability

Marina Romanova[1]

[1] *Cornell University*

Abstract. I will discuss results of the global 3D MHD simulations of accretion onto young magnetized stars with a dipole or more complex magnetic fields and will describe properties of the funnel streams and shapes of the hot spots. In the case of a dipole field, the simulations show that magnetized stars may accrete either in a stable regime, where matter flows towards a star in two ordered funnel streams, or in an unstable regime, where matter accretes either in several chaotic "tongues" (which form chaotic spots on the surface of the star), or in 1-2 ordered tongues which rotate with the angular

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frequency of the inner disk, and therefore their frequency varies with the accretion rate. These regimes of accretion determine the variability patterns of young stars, which range from periodic in the stable regime, to chaotic or quasi-periodic in the unstable regime. A star with a tilted dipole magnetic field excites density and bending waves in the inner disk. The density waves produce density enhancements in the inner disk and may determine position of the funnel streams and unstable tongues. On the other hand, bending waves may be responsible for obscuration of stellar light and AA Tau type light-curves.

First Zeeman Doppler imaging of a cool active star using all four Stokes parameters

Lisa Rosn[1]

[1] *Uppsala University*

Abstract. Magnetic fields in cool stars are ubiquitous but can still be challenging to characterize due to their complexity and relatively low strength. The polarization signatures are proportional to the field strength, and current studies of cool star magnetic fields are using circular polarization only since linear polarization is even weaker. However, circular polarization is only sensitive to the line-of-sight component of the magnetic field, meaning that a lot of structural features are not recovered or misinterpreted when only circular polarization is used for reconstruction of stellar magnetic topologies. Linear polarization, on the other hand, is sensitive to the transverse component of the magnetic field and would provide a more complete picture of the magnetic field topology if combined with circular polarization. We have identified a first suitable cool star, II Peg, for which linear polarization has been systematically detected with current instrumentation at a level sufficient for magnetic mapping. Here we present the very first temperature

and magnetic field maps reconstructed for a cool star using all four Stokes parameter spectra.

A First Look at Differential Rotation in Kepler Open Clusters NGC 6811 (1 Gyr) and NGC 6819 (2.5 Gyr)

Steven Saar[1]

[1]*SAO*

Abstract. Open clusters are ideal targets for controlled studies of stellar properties, since members are coeval and have the same abundances. We present the first results of measurements of surface differential rotation (SDR) in two clusters of different ages in the Kepler field. We compare results for single stars with known binaries, and how differential rotation varies with mass and rotation. All of these are found to have an effect on the average SDR rate.

Membership and Dynamics of the Chamaeleon I star forming region with the Gaia-ESO Survey

Germano Sacco[1]

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Abstract. The Gaia-ESO Survey (GES) will provide radial velocities, projected rotational velocity and stellar parameters of 10^5 Milky Way stars in the field and in clusters. One of the main goals of the survey is to investigate the formation and the evolution of young clusters, by the analysis of their internal kinematic. We will present the results obtained from the analysis of the GES observations of the young cluster Chamaeleon I. Specifically, we will present a new membership selection, the structural and dynamical prop-

erties of cluster, and we will discuss our results in the context of the current theoretical scenario on the early evolution of young cluster.

Astrometric planet search around southern ultracool dwarfs

Johannes Sahlmann[1]

[1]*European Space Agency*

Abstract. I will present the results obtained from the first two years of our ground-based survey of 20 nearby M8-L2 dwarfs using FORS2/VLT. The average astrometric accuracy is 150 micro-arcseconds and I will show how we use this data to determine trigonometric parallaxes with uncertainties of 0.1 mas, to discover tight ultracool binaries, and to constrain the occurrence of giant planets at intermediate separation around M8-L2 dwarfs

Variablility of the large-scale magnetic field of young sun HN Peg

Sudeshna Boro Saikia[1]

[1]*IAG, University of Goettingen*

Abstract. We investigate the variability of the large-scale magnetic field of the G0 dwarf HN Peg by using spectropolarimetric observations. The large-scale magnetic field topology is reconstructed using Zeeman Doppler Imaging over seven years comprising six observational epochs. The chromospheric variations were also measured using three activity indicators: Ca II H&K, H-alpha and Ca II IRT lines. The magnetic field topology of HN Peg exhibits a variable and complex geometry. The poloidal component exhibits a stable positive polarity magnetic region at each observational epoch. Surprisingly the toroidal component is strongly variable in strength, where a positive polarity toroidal band undergoes significant variations through out the observational timespan. HN Peg exhibits a weak longitudinal magnetic field over the epochs of this analysis, with no significant long term trend. The chromospheric activity indicators exhibit more long-term variations over our

time span of observations, where the variability in Ca II H & K and Hα proxies exhibit a long-term correlation.

Spectroscopic characterisation of tidally interacting binaries

Lalitha Sairam[1]

[1] *Tata Institute of Fundamental Research*

Abstract. The RS CVn binaries are the class of system typically composed of a chromospherically G- or K-type stars with a late-type subgiant or main-sequence companion. They are tidally locked close binaries, they are also fast rotators. In this talk, I will present our ongoing work in the context of systematic study of coronal X-ray emission from a young pre-main-sequence RS Cvn system–HD 155555. This system is composed of a G5 IV primary and a K0 IV secondary and has an orbital period of 1.68 d. We reconstruct the emission measure distribution (EMD(T)) using spectral line analysis and consequently obtain the elemental abundance from EMD(T). Furthermore, we investigate the line broadening by analysing the strong line profiles. In order to provide a better insight into the line broadening we also carried out a comparative study between HD 155555, BY Dra binaries and Algol.

The Young Solar Analogs Project: Observational and Analytical Methods

Jon Saken[1]

[1] *Marshall University*

Abstract. Since 2007 we have been conducting spectroscopic monitoring, in Ca II H & K and the G-band, of a sample of 31 YSAs in order to better understand their activity cycles and variations, as well as the effects of young stars on their solar systems. The targets cover the spectral range of stars most likely to contain Earth analogs, F8-K2, and a broad enough range of ages, 0.3 Gyr - 1.5 Gyr, to investigate how activity level changes with stellar age. In 2011 we began monitoring these stars photometrically in Stromgren-v, Johnson-Cousins B, V, and R, and narrow-band H-alpha. To complement these efforts we recently started high-cadence, high-S/N spectroscopy of our program stars with the Vatican Advanced Technology Telescope, along with high-cadence photometry in order to detect and characterize flares. This

poster will describe both our observational methods and specialized reduction techniques, as well as the strategies used to determine periodicities and variations in the stars' activity. A searchable database of both the reduced data and reduction parameters is being developed for eventual release to the astronomical community. Early results from this project will be presented at this conference by the co-authors.

Spitzer Space Telescope Infrared Spectrograph Studies of the Properties of Circumstellar Dust around Oxygen-Rich Asymptotic Giant Branch and Red Supergiant Stars

Benjamin Sargent[1]

[1] *Rochester Institute of Technology*

Abstract. We analyze the dust emission features seen in Spitzer Space Telescope Infrared Spectrograph (IRS) spectra of Oxygen-rich (O-rich) asymptotic giant branch (AGB) and red supergiant (RSG) stars. The spectra come from the Spitzer Legacy program SAGE-Spectroscopy (PI: F. Kemper) and other archival Spitzer-IRS programs. The broad 10 and 20 micron emission features attributed to amorphous dust of silicate composition seen in the spectra show evidence for systematic differences in the centroid of both emission features between O-rich AGB and RSG populations. Radiative transfer modeling using the GRAMS grid of models of AGB and RSG stars suggests that the centroid differences are due to differences in dust properties. We show recent modeling using different dust opacities that we use to investigate differences in dust composition, size, shape, etc that might be responsible for these spectral differences. We explore how these differences may arise from differing physical conditions in the different circumstellar environments of RSG and O-rich AGB stars. BAS acknowledges funding from NASA ADAP grant NNX13AD54G.

Orbital Motion in Pre-Main Sequence Binaries

Gail Schaefer[1]

[1] *Georgia State University*

Abstract. We present results from our ongoing program to map the visual orbits of pre-main sequence binaries in the Taurus star forming region using

adaptive optics imaging at the Keck Observatory. We combine our results with measurements reported in the literature to analyze the orbital motion for each binary. We present preliminary orbits for DF Tau, T Tau S, and ZZ Tau. Seven additional binaries show curvature in their relative motion; currently we can place lower limits on their orbital periods. Five other binaries show motion that is indistinguishable from linear motion. We suspect that these systems are bound and might show curvature with additional measurements in the future. These observations lay critical groundwork toward the goal of measuring precise masses for low-mass pre-main sequence stars.

The CASTOFFS Survey: High-Resolution Optical Spectroscopy of Bright Southern Targets

Joshua E. Schlieder[1]

[1] *Max Planck Institute for Astronomy*

Abstract. The census of young stars near the Sun is incomplete, particularly at low-masses. Many constituents of the known sample are members of nearby, young moving groups (NYMGs); loose associations of coeval stars with common Galactic kinematics. By mining astrometric and photometric catalogs, new candidates of the under-sampled young, low-mass star population can be found via their association with NYMGs. We have therefore developed the Cool Astrometrically Selected Targets Optimal For Follow-up Spectroscopy (CASTOFFS) survey to identify and characterize previously unrecognized young, low-mass stars. We combine astrometry, photometry, and activity to identify candidates and use dedicated spectroscopic follow-up to verify their youth and NYMG kinematics. We are now 2 years into CASTOFFS and present results from spectroscopic follow-up of 85 southern hemisphere targets with $V_¡$=14. Our results reveal many high probability members of NYMGs, isolated young field stars, and new wide, visual, and

spectroscopic binaries. We also briefly detail statistics from the survey so far and provide a future outlook.

Towards an Age/Activity Relationship for Ultracool Dwarfs

Sarah Jane Schmidt[1]

[1] *Ohio State University*

Abstract. Despite the large fraction of ultracool dwarfs that show chromospheric activity, the relationship between spectral type, age, and activity at these spectral types is poorly understood. We investigate the chromospheric activity of a large sample of ultracool dwarfs with optical spectra from the Sloan Digital Sky Survey (SDSS). Of the over 12,000 M7-L3 dwarfs with SDSS data, 6000 have sufficient S/N to classify their activity using the presence and strength of the H? emission line. We find fraction of active ultracool dwarfs increases from 60% at M7 to 90% at L0, then declines to 70% at L3. We combine these detections of H? emission with kinematic indicators of age (both Galactic height and three-dimensional velocities) to examine the relationship between activity and age for M7-L3 dwarfs. Our initial results indicate that ultracool dwarfs probably remain active longer than early- to mid-M dwarfs.

Mass determination of young directly imaged brown dwarf and planetary companions of cool G to M stars

Tobias Schmidt[1]

[1] *Hamburger Sternwarte, Germany*

Abstract. About 25 sub-stellar companions with large separations (¿ 50 AU) to their young cool primary stars and brown dwarfs are confirmed by both/either common proper motion and late-M to late-L type spectra. The origin and early evolution of these objects is still under debate. While often these sub-stellar companions are regarded as brown dwarfs, at least few of them are likely massive planets, the mass estimates are very uncertain so far. They are companions to late-type primary stars or brown dwarfs in young associations and star forming regions like Taurus, Upper Scorpius, the TW Hya association, Beta Pic moving group, TucHor association, Lupus, Ophiuchus, and Chamaeleon, hence their ages and distances are well

known, in contrast to free-floating brown dwarfs. Here we present how mass estimates of such young directly imaged companions can be derived, using not only evolutionary models, which are currently almost uncalibrated by direct mass measurements of young objects. An empirical classification by medium-resolution spectroscopy is hard, as there is an apparent mismatch between spectra of old field type objects and young low-mass companions at the same effective temperature, hampering a determination of temperature and surface gravity independent from models. We show that from spectra of the objects, using the advantages of light concentration by an AO-assisted integral field spectrograph, temperature, extinction, metallicity and surface gravity can be derived using non-equilibrium radiative transfer atmosphere models as comparison and that this procedure as well allows a mass determination in combination with the luminosities found by the direct observations. We show that uncertainties of log g of 0.2 dex can be reached at the deuterium burning limit. Further to spectra of known objects we plan to present a new sub-stellar companion, whose data analysis for confirmation is currently under way.

The Angular Diameters of Alpha Scorpii and Lambda Aquarii at High Spectral Resolution

Paul Schmidtke[1]

[1] *Arizona State University*

Abstract. Time-resolved, high-resolution spectra of the cool stars alpha Scorpii (M1.5 Iab-b) and lambda Aquarii (M2 III) have been obtained during a series of lunar occultations, with the goal of measuring the atmospheric extension of prominent photospheric lines. The spectral ranges include both the Na doublet (D lines) and Ca II near-infrared triplet. Using a uniform-disk

model, the measured extension relative to continuum light is about 55-115% (depending on line) for alpha Sco and 15-25% for lambda Aqr.

el TIGRE: A new robotic spectroscopy telescope

Jrgen Schmitt[1]

[1] *Hamburger Sternwarte*

Abstract. "el TIGRE" is a fully robotic 1.2m-telescope operated by Hamburger Sternwarte, the Universidad de Guanajuato, and the Universite de Liege at the La Luz site in central Mexico. The telescope feeds a fibre-couple echelle spectrograph providing a spectral resolution in excess of 20000 in the wavelength range between 3900 - 8800 A in two arms. The system works fully autonomously, can be fexibly scheduled, can obtain hundreds of spectra per night and reaches observing efficiencies above 90%. The Balmer lines up to Hepsilon, CaII HK and the CAII IRT triplet are covered simultaneously, thus the system is well suited for longterm activity monitoring. In the poster the el TIGRE hardware and software system is described and its performance is demonstrated by specific cool star examples.

Investigating the T/Y Boundary with HST/WFC3

Adam Schneider[1]

[1] *University of Toledo*

Abstract. The coolest brown dwarfs are indispensable touchstones for ultracool model atmospheres and are a vital component of the volume-limited sample of stars and brown dwarfs in the solar neighborhood. In the last few years, the Wide-field Infrared Survey Explorer (WISE) has uncovered hundreds of nearby cool brown dwarfs, including members of the new Y spectral class. Using the Wide Field Camera 3 (WFC3) aboard the Hubble Space Telescope (HST), we have extended the spectral coverage for a significant sample of the known late-type T and Y dwarfs to include the Y, J, and H bands. Here I present our complete sample of late type dwarfs for which we have obtained HST grism observations (23 total). The increased wavelength coverage allows us to 1) search for spectroscopic features predicted to emerge at low effective temperatures (e.g. ammonia bands), 2) construct a smooth

spectral sequence across the T/Y boundary, 3) derive improved estimates of the the atmospheric properties of the brown dwarfs, and 4) begin to place tighter constraints on the field mass function.

Solar cycle 24 UV radiation is lowest since decades

Klaus-Peter Schrder[1]

[1] *Universidad de Guanajuato*

Abstract. Using spectra taken by the robotic telescope "TIGRE" and its mid-resolution (R=20.000) HEROS double-channel echelle spectrograph, we present our measurements of the solar Ca II H+K chromospheric emission, using moonlight. For a direct comparison with historic observations since the early 1960ies, we derive Mount Wilson S-indices from the calibration given by O.C. Wilson and colaborators. Our measurements probe the double-peaked, weak activity cycle 24 at representative phases: in its inter-peak plateau and during its 2nd peak (last winter). Our respective S-values suggest that this maximum has the lowest chromospheric emission since at least 60 years - following the longest and deepest minimum since a century. These observations suggest a similar long-term (on a scale of decades) low of the far-UV radiation, which should be considered by the next generation of climate model. The current, very interesting activity behaviour calls for a concerted effort on long-term solar monitoring.

The Surface Brightness Contribution of II Peg: A Comparison of TiO Band Analysis and Doppler Imaging

Hakan Volkan Senavci[1]

[1] *Ankara University*

Abstract. We investigate the surface brightness contribution of the very well known active binary II Pegasi, in terms of the starspot filling factor and the spot temperature parameters. In this context, 53 time series spectra of the system taken over 8 nights in September - October of 1996 are used to perform TiO band analysis with a model atmosphere approximation using ATLAS9 and with proxy stars observed with the same instrument (2.1m Otto Struve Telescope equipped with SES at the McDonald Observatory). We also Doppler image our dataset using the appropriate version

of DoTS and discuss the comparison of results, in order to better reveal the surface inhomogeneities of the system together with the robustness of both techniques.

Modelling the observed photometric trends in Sun-like stars variability

Alexander Shapiro[1]

[1] *PMOD/WRC*

Abstract. The Sun and stars with low magnetic activity levels become photometrically brighter when their activity increases. Magnetically more active stars display the opposite behavior and get fainter when their activity increases. We reproduce this phenomenon with a model that attributes the variability of the stellar radiative energy flux to the imbalance between the contributions from dark starspots and bright faculae. Our approach is based on the assumption that the solar paradigm is also valid for Sun-like stars, i.e. we can describe stellar variability by extrapolating from solar activity and brightness variations. The general success of the model in reproducing the behavior of Sun-like stars is a clear indication that the photometric variability of more active stars has the same basic causes as the Suns.

Modelling of spectro-polarimetric properties of stellar surfaces

S. Shelyag[1]

[1] *Monash University*

Abstract. Small-scale convective motions in the outer envelopes of low-mass stars induce variations and radial velocity shifts in stellar spectral line profiles. These variations, known as stellar jitter or astrophysical noise, are of the order of few meters per second. They make it difficult to confirm Earth-like exoplanets, which generate Doppler shifts of the order of centimeters per second. Understanding the physical processes involved in generation of astrophysical noise and its properties requires detailed modelling of the time-dependent photospheric thermal stratification, flows, oscillations and magnetic fields. In my presentation, I will describe a numerical technique for synthesis of spectro-polarimetric properties of full time-dependent stellar sur-

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faces. The technique is based on radiative magneto-hydrodynamic modelling of magnetised photospheres with MURaM code and spectro-polarimetric diagnostics of the simulated photospheric models, which takes into account inclination of line-of-sight with respect to the normal to the stellar surface at different positions of stellar disk. The simulated models of stellar surfaces will be used in parameterisation of stellar jitter and in development of techniques of noise reduction in exoplanetary observations, which are more efficient than the current ones.

HAZMAT I: The Evolution of Ultraviolet Emission from Early M Stars

Evgenya Shkolnik[1]

[1] *Lowell Observatory*

Abstract. With the recent discoveries of several super-earths orbiting M dwarfs well within their habitable zones (0.1 to 0.4 AU), and with many more such planets to come, it is critical to assess the evolution of the high-energy radiation environment of these systems. We have begun the HAZMAT (HAbitable Zones and M dwarf Activity across Time) program by first measuring the drop in near-UV and far-UV flux in early M stars from 10 Myr to several Gyr using photometry from NASA's Galaxy Evolution Explorer (GALEX). We focus this study on the confirmed low-mass members of nearby young moving groups, the Hyades cluster, and old field stars. We show a relatively slow decline in UV flux up until at least 650 Myr with a sharper drop in the old M dwarfs. Yet without confirmed M dwarfs in nearby star clusters with ages of 1-2 Gyr, mapping the precise evolution at these older ages is not currently possible. The UV data also provide much-needed constraints to M dwarf upper-atmosphere models, which are currently insufficient for predicting UV emission from M dwarfs. Our analysis will aid empirically motivated upper-atmospheric modeling for the young and old M stars, which can then be used to predict the extreme-UV fluxes most critical to the evolution of

a planetary atmosphere. The HAZMAT program is the first comprehensive study of the UV history of M stars.

Precise properties of exoplanet host-stars from asteroseismology

Victor Silva Aguirre[1]

[1] *Aarhus University, Denmark*

Abstract. The Kepler mission has detected thousands of exoplanet candidates orbiting various types of stars. Validation as well as characterization of these planet candidates depend critically on our knowledge of the host star properties, which are often poorly constrained. Asteroseismology has been extremely successful in providing accurate masses and radii of Kepler targets, helping in better determining occurrence rates and sizes of planets. In this talk, I present the results of an ongoing programme whose objective is to derive robust and precise stellar properties, including ages, for a large sample of G-type asteroseismic targets. Having ages for an ensemble of planetary host stars will allow us to comment on theory of planet formation. I discuss the results in the context of characteristics of main-sequence exoplanets host-stars, as well as temporal constraints of processes such as evolution of eccentricity, orbital synchronization and circularization, efficiency of resonances, and obliquities.

Gaia-ESO Survey: the first release from the analysis of UVES spectra of FGK-type stars

Rodolfo Smiljanic[1]

[1] *Nicolaus Copernicus Astronomical Center, Torun, Poland*

Abstract. The Gaia-ESO Survey is an ambitious public spectroscopic survey that is observing more than 100000 stars with the FLAMES multi-fiber facility at the VLT. High-resolution (R 47000) UVES spectra is being obtained for a sample of about 5000 FGK-type stars. The stars are mainly FG-type dwarfs in the solar neighborhood (within 2 kpc) and clump giants in a sample of old and intermediate-age open clusters. Some giants in the bulge, and in the inner and outer regions of the disk are also observed. The first public release of advanced data products is expected for mid-2014.

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Results from the analysis of the UVES spectra will include atmospheric parameters and abundances for about 20 different elements for more than 1500 stars. This sample of high-resolution spectra of FGK-type stars is among the largest ones of its kind analyzed in a homogeneous way. In this presentation, I will introduce the Survey and its goals, with emphasis on the analysis of UVES spectra of FGK-type stars. I will discuss the analysis of the spectra and the data products that will be made available to the community in public releases. Finally, I will also present some examples of early science results obtained with Gaia-ESO data.

A Near-Simultaneous Calibration of Near-Infrared Accretion Indicators for Classical T Tauri Stars

Sarah Margaret Smith[1]

[1]*Northern Arizona University/Lowell Observatory*

Abstract. Classical T-Tauri Stars are cool, young stars surrounded by disks of dust and gas. Material from the inner disk is channeled along magnetic field lines onto the central star with in-fall rates that can vary on timescales as short as hours. Near-infrared (NIR) hydrogen lines are particularly useful accretion diagnostics for the youngest, most heavily extinguished young stars, but these features have primarily been calibrated using non-simultaneous measurements of excess continuum emission at ultraviolet (UV) wavelengths. We present Pa?, Pa?, Pa? and Br? line strengths for 71 classical T-Tauri stars, which we have calibrated against accretion luminosities measured by Herczeg & Hillenbrand from near-simultaneous ultra-violet/optical spectra (separation time ¡ 1 hour). We compare our new calibrations to those previously reported in the literature, while giving

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particular attention to the residuals of the linear fits to quantify the effects of using non-simultaneous data to calibrate the NIR indicators.

Born Different: How Rapid Rotation on the Pre-Main Sequence Inhibits Lithium Destruction in Cool Stars

Garrett Somers[1]

[1] *The Ohio State University Astronomy Department*

Abstract. We explore the origins of the zero-age main sequence (ZAMS) open cluster lithium pattern, including the Li dispersion in young, cool stars of equal mass, age and composition. We first demonstrate that standard stellar models (SSMs) accurately predict the Li abundance of solar analogs at the ZAMS within theoretical uncertainties. We then argue that a radius dispersion in stars of equal mass, during the epoch of pre-MS Li destruction, is responsible for the spread in Li abundances in cooler stars, most well known in the Pleiades. Inflated radii have been observed in detached eclipsing binaries and in single star interferometric measurements, and are seen to increase with faster rotation. The base of the convection zone is cooled when a star is inflated, greatly suppressing the rate of Li depletion during the pre-MS. This causes suppressed Li destruction in rapid rotators, resulting in a dispersion at fixed mass, and a correlation between Li and rotation at the ZAMS. We calculate stellar models, inflated to match the upper envelope of observed radius anomalies, and the resulting range of Li abundances accurately reproduces the empirical patterns of several young clusters. We discuss ramifications for pre-MS evolutionary tracks and age measurements of young clusters, and suggest an observational test. Furthermore, we use our validated SSMs to measure the rate of Li destruction during the MS, by subtracting the [Fe/H]-dependent ZAMS Li pattern from several MS open clusters and comparing the resulting data. With this method, we identify strong mass trends in the rate of MS Li depletion, and study the emergence

of dispersion in Li abundances at fixed effective temperature, which is found to be a general feature of open clusters.

Coulomb explosion of cloud particles in substellar atmospheres: a source of patchy cloud cover?

Craig Stark[1]

[1] *University of St Andrews*

Abstract. Recent observations of Brown Dwarf spectroscopic variability in the infrared infer the presence of patchy cloud cover. The cause of this inhomogeneous coverage could be due to the depletion of cloud particles through Coulomb explosions. The LEAP group focuses on the influence of ionization processes on cloud formation, atmospheric chemistry, meteorology and electromagnetic emission in order to develop an observational diagnostic of atmospheric phenomena such as non-uniform cloud coverage. Ionization processes such as lightning, cosmic ray and Alfvn ionization can produce large-scale volumes of atmospheric plasma in substellar atmospheres. Cloud particles that are immersed in such plasmas become negatively charged and are susceptible to Coulomb explosions, where the electrostatic stress of a body holding a net charge exceeds its mechanical tensile strength, resulting in it breaking up. Our calculations show that charged dust below a critical particle size will be broken up having a significant impact on the distribution of particle sizes as a function of atmospheric pressure. We discuss how such disruption affects the dust cloud particle size distribution, the opacity of the cloud and its ultimate implications for observations.

Possible Detection of Dust in the Accretion Columns of YSOs in NGC2264

John Stauffer[1]

[1] *Caltech*

Abstract. We have identified a half dozen YSOs in the NGC 2264 star-forming region whose optical (CoRoT) light curves are dominated by short-duration, shallow, often nearly gaussian-shaped, periodic flux dips. The flux dips have FWHM generally less than one day, depths almost always less than 15%, and periods consistent with the keplerian rotation period of the inner

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disk wall (P ¡ 7 days). The flux dips vary considerably in their depth from epoch to epoch, but are usually persistent for several weeks and in two cases were present in data collected on successive years. Presumably these flux dips are due to clumps of material in or near the inner disk wall, passing through our line of sight to the stellar photosphere. In general, these dips are also present in simultaneous Spitzer IRAC light curves at 3.6 and 4.5 microns but with lower amplitudes. We characterize the properties of these dips, and compare the stars whose light curves exhibit this behavior to other classes of YSOs in NGC 2264. One possible physical explanation for the flux dips is that they are due to dust entrained in the accretion columns connecting the inner disk to the stellar photosphere.

A UCAC4 Trawl for New Nearby Red Dwarfs

John Subasavage[1]

[1] *U. S. Naval Observatory*

Abstract. We present 16 photometric color-Mk relations using the U. S. Naval Observatory fourth CCD Astrograph Catalog (UCAC4). These relations estimate distances to nearby red dwarfs at the 15% accuracy level using photometry from the Two-Micron All-Sky Survey (2MASS) and the AAVSO Photometric All-Sky Survey (APASS). A sample of nearby stars from the Research Consortium On Nearby Stars (RECONS) group along with a supplemental list of very red stars all having accurate trigonometric parallaxes are used to generate the relations. Color, proper motion, and existing literature sources are used in an attempt to attain a clean sample of red dwarfs while limiting the amount of contamination from background giants. From this sample, we find 1775 candidate nearby M-dwarfs estimated to be within 25 pc. Of this sample, 338 have no previously known published parallax or distance estimate and five of these are estimated to be within 10 pc. The nearest distance estimate of 5.93 pc was found for a star with a V magnitude

of 10.5. This and other discoveries during this effort suggest that yet more nearby stars remain undiscovered, even at relatively bright magnitudes.

Using the 2.1 meter telescope and Phoenix to Search for Exoplanets around Cool Stars

Angelle Tanner[1]

[1] *Mississippi State University*

Abstract. I will report on a pilot study to collect multiple epochs of KPNO 2.1-m Phoenix radial velocity (RV) measurements for a sample of nearby, low-mass stars. Our goal was to identify new very-low mass companions and to assess the planet search capability of Phoenix on this telescope. Our sample consists of 17 M dwarfs with: 1) astrometric perturbations signaling the presence of a low-mass stellar companion, 2) infrared excesses which could indicate the presence of a planetary system, or 3) newly determined high metallicities which correlate with planets around solar-type stars. With an anticipated 50 m/s RV precision and the number and spacing of the observations in our programs design, we are sensitive to 1.5 and 5 MJup giant planets with periods of 3 and 10 days as well as any stellar or brown dwarf companions. The observationally intensive nature of exoplanet RV surveys makes them ideal for smaller telescopes like the KPNO 2.1 meter. I will address whether additional efforts should begin to enhance the planet detection capabilities of the Phoenix spectrograph and efforts to keep the telescope available for research in light of impending funding issues.

An Open Catalog of Nearby Stars

Angelle Tanner[1]

[1] *Mississippi State University*

Abstract. Ironically, while astronomers are quite good at collecting multiple data points about any given star - temperature, composition, size, rotational velocity, mass, distance, etc. - we are still bad at organizing all that data into one cohesive, user-friendly archive. There are on-line stellar catalogs like SIMBAD, however, this archive suffers from inaccuracies (Stauffer et al. 2010) and lacks critical information relevant to exoplanet searches like rotational velocity, composition and multiplicity. The NASA

Star and Exoplanet Database, was shuttered due to funding issues, was not user-friendly (there was no batch mode) and was slow to ingest public data due to strict formatting requirements. I propose to develop a group edited on-line archive of the physical and observational properties of all stars within 100 light years. The archive will allow you to download all the data for a list of stars (batch mode) and for stars of a given property (rank mode). The archive will utilize existing plotting tools. Most importantly, the archive will follow the model of the Kepler Community Follow Up Program and the Open Exoplanet Catalogue and allow users to contribute ancillary data, images and spectra themselves! The archive team will populate the majority of the initial data from SIMBAD, NStED and large published surveys like RECONS but then we will encourage authors to contribute to the archive under the supervision of the archive team. Like the Kepler CFOP, all data will be included in the archive with the most agreed on values flagged by the community. It is this community policing and data entry aspect that will be key in giving us an unprecedented picture of the stars in our stellar neighborhood as well as critical a tool for all future exoplanet searches.

A near-infrared spectroscopic survey of 1000 nearby M dwarfs

Ryan Terrien[1]

[1] *Penn State*

Abstract. The development of empirical calibrations for the stellar parameters of M dwarfs has paved the way for a reliable en masse characterization of these stars. A compelling application for these techniques is the characterization of targets for upcoming exoplanet surveys, many of which will focus on M dwarfs (e.g. the Habitable-zone Planet Finder, CARMENES). We have obtained R 2000 near-infrared spectra of 1000 nearby M dwarfs, in order to obtain empirical measurements of their metallicities, masses, radii, and luminosities. These parameters also enable our calculation of the Habitable Zone for each star, based on up-to-date stellar and planetary atmospheric models. These stellar parameters will both inform target selection and lay the foundation for interpretation of the results of these surveys. We present the results and implications of our analysis of these stars. We also discuss the spectral library itself, which will provide the largest published collection of near-infrared M dwarf spectra, and will provide a rich dataset for studies of nearby M dwarfs. The stellar abundances in this library have already provided insight into a small number of targets, constraining the properties

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of the low-mass eclipsing binary CM Draconis, and the membership of the nearby open cluster Coma Berenices.

WISE Infrared Excess Detections for SDSS M Dwarfs: Cool Field Stars with Evidence of Warm Circumstellar Material

Christopher Theissen[1]

[1]*Boston University*

Abstract. We investigate the mid-infrared properties of low-mass field dwarfs, combining M dwarfs from the SDSS DR7 spectroscopic and DR10 photometric catalogs with photometry from the AllWISE source catalog. For the spectroscopic sample, we developed SDSS and WISE color-color selection criteria to select 300 M dwarfs (from the 70,841 in the DR7 catalog) that exhibit infrared flux above typical M dwarf photosphere levels at 12 and/or 22 ?m. We also find 30 stars within the footprint of the Orion OB1 association that have not been previously identified. Using synthetic photometry, we characterize the dust populations inferred from each infrared excess, and find high fractional infrared luminosities (0.01 L?) and orbital distances within the snow line (¡ 1 AU). Using the SDSS spectra, we measure surface gravity dependent features, and examine tracers of youth (H?, UV emission, and Li absorption). Less than 6% of our sample shows a reliable indication of youth, implying a stellar population with ages ¿ 1 Gyr. Our results imply that, due to the orbital distances of our inferred dust populations and the penchant for low-mass stars to create terrestrial planets, the most likely cause of dust in these systems is planetary collisions. A similar result has been used to explain the dust population observed around the older field star BD+20 307 (? 1 Gyr; Weinberger et al. 2011). We also present preliminary results using the DR10 photometric M dwarf sample. This sample, consist-

ing of millions of M dwarfs, allows us to examine the phenomena of field M dwarfs exhibiting infrared excesses in a Galactic context.

The FunnelWeb Survey of the Southern Sky

Chris Tinney[1]

[1] *UNSW*

Abstract. The FunnelWeb survey will employ a revolutionary new spectrograph on the UK Schmidt Telescope at Siding Spring Observatory to carry out a spectroscopic survey over a 3 year period of *every* southern star down to I=12, and every candidate M-dwarf down to I=14. This survey is enabled by the ability of the Starbug-fed TAIPAN spectrograph to reposition its 150 fibres in under 5 minutes, making the creation of a digital update to the HD Catalog possible for the first time in half a century. FunnelWeb will produce a publicly available database that will allow spectral characterisation of every TESS input catalogue star, as well as identifying tens of thousands of new stars younger than 100My old suitable for use as targets for next-generarion exoplanet imagers.

SED analysis of class II M-type objects in Cha I

Jonathan Tottle[1]

[1] *Imperial College London*

Abstract. The class II stage of a T Tauri star is characterised by the disappearance of the gaseous envelope and the presence of a primordial circumstellar disk. The shape of the SED from observations has strong implications for the geometry, structural evolution and physical conditions within the disk. We model the IR SEDs (using photometry over 2 - 24 microns) of 67 class II M-type objects in Cha I using an MCMC evaluation coupled to the radiative transfer code of Whitney et al. (2003). We find that just over half of the objects appear to host 'standard' accretion disks. These cases explain the majority of class II SEDs, in which we observe both the unobscured star and the strong IR signature of its surrounding disk. Roughly a quarter of the objects appear edge-on, in which the short wavelength emission is suppressed by outer disk occlusion of the central object and inner disk; the outer

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disk often also occludes accretion signatures arising close to the star in these sources, leading to spuriously low accretion rate estimates. A few objects in our sample show evidence for transition disks with either large inner holes or gradual disk clearing, due to either photo-evaporation from the central star and/or planet formation within the disk. The remaining objects are categorised as 'odd'-looking objects with highly unusual SEDs. A few of these may be explained by errors in the data, but for the majority it is most likely due to either variability or exotic disk geometry. We finish by exploring the relation between estimated accretion rates and disk properties; one expects reduced accretion rates at the end of the class II stage to be accompanied by the gradual flattening of the dusty disk.

The mixing-length and $T(\tau)$ relations from a grid of 3D convection simulations

Regner Trampedach[1]

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Abstract. Cool stars are endowed with convective envelopes, determining the structure of a significant fraction of the star, and extending across the photosphere that we observe. I have therefore built a grid of 3D simulations of convective atmospheres, that include realistic radiative transfer and atomic physics, for use in theoretical modeling, as well as interpretations of "classic", as well as seismic observations (Trampedach et al. 2013). I present a calibration of the free parameter, α, of the mixing-length convection formulation by Böhm-Vitense. This is carried out by matching 1D envelope models to the deep part of the averaged simulations. The procedure also demands the use of $T(\tau)$ relations in the atmospheres of the 1D models, as derived from the 3D simulations. I present a new consistent formulation for

the calculation and implementation of such $T(\tau)$ relations. I will present applications to Kepler targets.

DKIST: Observing the Sun at High Resolution

Alexandra Tritschler[1]

[1] *National Solar Observatory, AURA Inc.*

Abstract. Co-Authors: T. E. Berger, T. R. Rimmele, F. Woeger, D. Elmore, K. P. Reardon, R. Casini, J. R. Kuhn, H. Lin, W. Schmidt The 4-m aperture Daniel K. Inouye Solar Telescope (DKIST) formerly known as the Advanced Technology Solar Telescope (ATST) and currently under construction on Haleakala (Maui, Hawaii) will be the largest solar ground-based telescope and leading resource for studying the dynamic Sun and its phenomena at high spatial, spectral and temporal resolution. Specifically,to provide precise and accurate spectropolarimetric observations at high-spatial resolution throughout the solar atmosphere including the corona is a high priority and a major science driver. The DKIST first-light instruments will include: a Visible Broadband Imager (VBI) for high spatial and temporal resolution imaging of the solar atmosphere; a Visible Spectropolarimeter (ViSP) for sensitive and accurate multi-line spectropolarimetry; a Fabry-Perot based Visible Tunable Filter (VTF) for high-spatial resolution spectropolarimetry; a fiber-fed Diffraction-Limited Near-Infrared Spectropolarimeter (DL-NIRSP); and a Cryogenic Near-Infrared Spectropolarimeter (Cryo-NIRSP) for coronal magnetic field measurements and on-disk observations at 4.7 microns. We will provide an overview of the solar science that the DKIST will be able to address and detail its unique capabilities to perform spectroscopic and spectropolarimetric measurements of the solar atmosphere using the DKIST's instrumentation suite.

Simulations of magnetized outflows from close-in gas giant exoplanets

A. Uribe, A. Koenigl, T. Matsakos[1]

[1] *University of Chicago*

Abstract. Gas giant exoplanets in close-in orbits are exposed to strong stellar irradiation, leading to a possible photoevaporative outflow from the

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outer planetary atmosphere. For transiting planets, spectroscopy can probe the planet's atmosphere by measuring the absorption of stellar light during transits. In the case of the exoplanet HD 209458b, the measured Ly-alpha absorption implies velocities as high as 100 km/s away from line center, which were suggested to correspond to outflowing planetary gas. We present 2.5D magnetohydrodynamic models of the photoevaporative wind from a magnetized hot Jupiter. We study the 2D structure of the outflow from equator to pole and the dependence of the wind properties on the relevant physical parameters, including the irradiating flux and the planet's magnetic field strength and rotation rate, but we neglect the possible influence of a stellar wind. We investigate whether the observed high velocities can in fact originate in a planetary wind and consider other potential observational signatures of the planetary magnetosphere and outflow.

Generating Asymmetric Line Profiles with 1D Models

Jeff A. Valenti[1]

[1] *STScI*

Abstract. Dynamic 3D stellar atmosphere models have been in use for 3 decades, increasing in sophistication until today they represent the state of the art. For practical reasons, the vast majority of investigators (including me) still use static 1D model atmospheres, despite many published warnings from the 3D community. For static 1D model atmospheres, synthetic line profiles are symmetric about line center. Observed solar and stellar line profiles are markedly asymmetric. Line profiles reflected about line center differ from the original profile by 1% of the continuum for moderately strong lines. Inability to model line asymmetries is the largest error in static 1D model atmospheres, leaving aside atomic data errors that also affect 3D models. This suggests that the static assumption may be the main weakness of typical 1D studies, rather than the plane parallel approximation. We generate asymmetric line profiles with 1D models by relaxing the static assumption in Spectroscopy Made Easy (SME). Initially, we combine a warm ascending component and a cool descending component. Unlike most previous studies (but see Frutiger et al. 2000; Borrero and Bellot Rubio 2002), we allow vertical velocity to be a function of depth in the atmosphere. With these additional useful degrees of freedom, we dramatically improve agreement between observed and synthetic line profiles. We quantify how opacity smearing in a kinematic 1D model affects microturbulence, macroturbulence, line equivalent width, and abundance. More study is needed to relate physical

results from dynamic 3D models to the parameters of kinematic 1D models, which are likely remain a useful approximation for another decade at least.

Determining stellar properties from planetary transits

Adriana Valio[1]

[1] *Mackenzie University, Brazil*

Abstract. During the eclipse of a star by its orbiting planet, spots and other features on the surface of the host star may be occulted. This will cause small variations in the star light curve. Detailed analysis of these variations during planetary transits provides a wealth of information about starspot properties such as size, position, temperature (i.e. intensity), and magnetic fields. When multiple transits are detectable, it may be possible to detect the same spot on different transits and thus determine the stellar rotation. Assuming a rotation profile of the star with latitude, for example solar-like, it may also be possible to estimate stellar differential rotation. By simulating the passage of a planet (dark disk) in front of a star with multiple spots of different sizes, intensities, and positions on its surface, the stellar properties are determined. The light curves of known planets detected by the CoRoT and Kepler satellite are analyzed and the estimates of the starspots physical characteristics and the host star rotation and differential rotation presented.

Gyrochronology in Context: Rotation and Age for Realistic Stellar Populations

Jennifer van Saders[1]

[1] *Ohio State University*

Abstract. The technique of gyrochronology uses the observed relationship between rotation period, stellar color, and age to date old field stars based on two key assumptions: 1) that all targets can be treated as single main sequence stars that spin down as a function of time, and 2) that the relations can be calibrated on systems of solar age and younger and extrapolated to old stars, where data has traditionally been sparse. We examine the validity of each of these assumptions. Realistic stellar populations are not composed solely of single dwarfs, but contain several backgrounds: we theoretically pre-

dict that hot stars, synchronized binaries, and subgiants should all obey very different period-age relationships than cool, single, main sequence stars. We use data from the Kepler satellite and population models to demonstrate that these background sources are significant in number, and confirm that they do not obey the standard relationship between period and age. Accounting for them is therefore critical for proper population modeling. We also use a sample of old Kepler field stars with measured periods and independent asteroseismic ages to critically evaluate the performance of gyrochronology extrapolations against the actual behavior of stars at late times.

Mid-IR Photometry of the Benchmark Brown Dwarf Binary HP Bootis

Amali Vaz[1]

[1] *Steward Observatory, University of Arizona*

Abstract. Photometry in the mid-infrared, and in particular in the region from 3-5 um, provides us with empirical insight into the physical and chemical properties of substellar objects. We present LBT adaptive optics images of the benchmark binary L-dwarf companion to HP Boo in eight filters: seven narrow bands spanning 3-4 um, plus the wider M band. These data allow us to constrain models of HP Boo's atmosphere and prepare for exoplanet imaging at JWST wavelengths.

Accretion variability in the young open cluster NGC 2264

Laura Venuti[1]

[1] *Institut de Planetologie et d'Astrophysique de Grenoble*

Abstract. We present the results of an extensive u-band accretion survey of the young open cluster NGC 2264 (3 Myr). Performed at CFHT/MegaCam as a part of an international coordinated monitoring campaign (involving Spitzer, CoRoT, CFHT, VLT/Flames and several other instruments), the survey provided simultaneous UV+optical photometric monitoring over two full weeks for about 750 young stars (of which about 40% accreting) within the cluster, in order to probe accretion from the direct diagnostics of the UV excess, measured over the reference flux level of non-accreting cluster members. We investigate accretion properties over the stel-

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lar mass range 0.1-1.5 Mo and infer evidence for a huge variety of accretion regimes, with a significant spread in Macc values around an average correlation of Macc with stellar mass. Little contribution to this spread arises from stellar variability over week timescales; we explore and discuss the origin of this large intrinsic spread in accretion properties, which may take contribution from an intrinsic evolutionary spread throughout the cluster, and additionally be associated to a multiplicity of accretion mechanisms, as well as to a diversity in the initial properties of individual systems.

Magnetism in cool stars: empirical trends with age and rotation

Aline Vidotto[1]

[1] *University of Geneva*

Abstract. We investigate how the large-scale surface magnetic fields of cool dwarf stars, reconstructed using the Zeeman-Doppler Imaging technique, vary with age, rotation period, Rossby number and X-ray emission. Our sample consists of 104 magnetic maps of 76 stars, from accreting pre-main sequence to main-sequence objects, spanning ages from 1 Myr to 10 Gyr. For non-accreting dwarfs we empirically find that the unsigned average large-scale surface magnetic field relates to age as $age^{-0.655\pm0.045}$. This relation has a similar power dependency to that identified in the seminal work of Skumanich (1972). We also find in our data evidence for a linear-type dynamo, in which the surface field is linearly dependent on the rotation rate. The trends we find for large-scale stellar magnetism from ZDI studies are consistent with the trends found from Zeeman broadening measurements, which are sensitive to the unsigned large- and small-scale magnetic field. These similarities indicate that the fields recovered from both techniques are coupled to each other, suggesting that small- and large-scale fields could share the same dynamo field generation processes. Our results are relevant

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for investigations of rotational evolution of low-mass stars and give important observational constraints for stellar dynamo studies.

Exploring a Threat to Foreign Worlds: Detecting Coronal Mass Ejections on Nearby Stars

Jackie Villadsen[1]

[1] *California Institute of Technology*

Abstract. Coronal mass ejections (CMEs) likely play a significant role in the mass loss from active stars, and may significantly affect exoplanetary magnetospheres and atmospheres. However, there have been no definitive detections of CMEs outside our own solar system. Broadband dynamic spectroscopy has long been used to study coherent radio emission associated with solar CMEs (known as Type II bursts), but such emission has not been detected from other stars. Type II bursts sweep downwards in frequency on timescales of tens of minutes, tracing the motion of a CME outwards through the stellar atmosphere into progressively lower plasma densities. I will present JVLA observations of UV Ceti showing two Type II-like radio bursts, which sweep upwards in frequency. We interpret these bursts as either bulk plasma motion downwards in the stellar atmosphere or polar radiation modulated by rotation. I will also present plans for the Starburst program, a 3-year nightly observing program using two 27-meter telescopes at the Owens Valley Radio Observatory (the equivalent of a JVLA baseline). The Starburst program will survey stellar coherent radio bursts in order to characterize the rate and energetics of CMEs on nearby stars, combined with complementary observations to image and characterize the detected CMEs.

Characterizing the Parents: Exoplanets Around Cool Stars

Kaspar von Braun[1]

[1] *MPIA*

Abstract. The large majority of stars in the Milky Way are late-type dwarfs, and the frequency of especially low-mass exoplanets in orbits around these late-type dwarfs appears to be high. In order to characterize the radiation environments and habitable zones of the cool exoplanet host stars, stellar radius and effective temperature, and thus luminosity, are required. It

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is in the stellar low-mass regime, however, that the predictive power of stellar models is often limited by sparse data quantity with which to calibrate the methods. We show results from our CHARA survey that provides directly determined stellar parameters based on interferometric diameter measurements, trigonometric parallax, and spectral energy fitting. In particular, we focus on empirical stellar diameters and effective temperatures of a few exoplanet systems around cool stars.

Improved Parallaxes and Near-Infrared Photometry of L- and T- Dwarfs From The US Naval Observatory Infrared Astrometry Program

Frederick Vrba[1]

[1] *U.S. Naval Observatory*

Abstract. In 2004 USNO published one of the first comprehensive studies of high-quality parallaxes and proper motions of 40 L- and T-dwarfs based on near-infrared observations obtained with ASTROCAM at the Flagstaff Station's 1.55-m telescope. Since that time additional observations of the original 40 objects along with another 19 objects have greatly improved the astrometric results. In this paper we present the parallax results, along with new near-infrared photometry, in the form of spectral type versus absolute magnitude and color-color diagrams.

The Behavior of the Paschen and Balmer Lines in Cepheids

George Wallerstein[1]

[1] *University of washington*

Abstract. In 1939 Struve, Wurm and Henyey recognized that the forbidden transition from the 2s to the 1s level in hydrogen may result in the overpopulation of the 2s level and would enhance the strength of the Balmer lines in stellar atmospheres. The effect should be greatest in low density atmospheres where collisional redistribution is least effective. In the same year Lyman Spitzer found that the Balmer lines in the M supergiant Alpha Orionis required an excitation temperature of 12,000 K though the effective temperature of the star was known to be 3400 K. Cepheid variables are high luminosity stars with low density atmospheres so departures from LTE in

the population of the 2s level should be evident by comparing the profiles of the Balmer and Paschen absorption lines. Hence the modelling of a cepheid's atmosphere should be constrained by the line profiles as the pulsation waves move through. I have assembled velocity curves and line profiles for Delta Cep and 10 cepheids with periods between 10 and 20 days over their pulsation cycles. In my talk I will show the data and discus the problem of modelling dynamic atmospheres rather than just attaching a standard model with the appropriate Teff and logg and letting it rise and fall with the pulsation cycle.

Sub-Stellar Mass Objects in Orion OB1b

Frederick M Walter[1]

[1] *Stony Brook University*

Abstract. Our moderately-deep near-IR survey of Orion OB1b (the belt of Orion) revealed a large number of candidate substellar mass objects based on the JHK photometry alone. I have obtained followup near-IR spectroscopy of a subset of these candidates. I will present the spectra, and report on spectroscopic gravity indicators present in these spectra. Substellar mass objects at an age of 2 million years resemble M6-M7 stars, but are expected to have lower surface gravities and other indicators of youth.

Hot Jupiters in Close Binaries: A Kepler Story

Ji Wang[1]

[1] *Yale University*

Abstract. We will present our results in searching for hot Jupiters in close-in binaries with separations smaller than 100 AU in the Kepler and K2 field of view (FOV). It is known that planet formation is affected in binaries with separations smaller than 300 AU, but the extent of the influence is unclear. A direct search for plants in binaries will address this issue straightforwardly. However, direct surveys using the radial velocity technique suffered severe flux contamination, and are not very efficient. Kepler and its extended mission provides a big FOV and an unprecedented precision. 80 close binaries are within the FOV of the main mission and 220 are within the K2 mission

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K0 field. We will discuss our searching results, incompleteness simulation, and their implications to the occurrence rate of hot Jupiters in close binaries.

Cool and Cooler: A Volume-Limited Companion Survey of Local M-dwarfs

Kimberly Ward-Duong[1]

[1] *Arizona State University*

Abstract. M-dwarfs constitute the major fraction of stars within both the solar neighborhood and nearby star-forming regions, and their binary properties present observational tests of the star formation process. Key M-dwarf companion characteristics – including multiplicity fraction, mass ratios, and separation distributions – hold important implications for the universality of star formation, dynamical interactions, and the origin of the Galactic field stars. We present results of a large-scale, comprehensive M-dwarf companion study covering separations from 1 to 10,000 AU, based on a volume-limited survey of 250 M-dwarfs within 15 pc. Diffraction-limited infrared archival data were analyzed from the Very Large Telescope, Canada-France-Hawaii Telescope, and MMT Observatory to detect nearby companions to M-dwarfs from 1 to 100 AU. To supplement the high-resolution data, digitized wide-field archival plates were searched for companions with separations of 100 to 10,000 AU. The survey is fully sensitive to companions at the bottom of the main sequence over an unprecedented survey separation range of 2 to 10,000 AU, and the deepest images also reveal a number of substellar candidates. With multiple AO and wide-field epochs, follow-up observations have allowed us to confirm or reject companion candidates detected during our analysis. This provides confirmation of common proper motions, minimizes background contamination, and enables comprehensive statistics for M-dwarf binaries. We find a stellar multiplicity fraction of approximately 30%, the shape of the companion separations fit by a log-normal distribution with mean of 18 AU, and a mass ratio distribution exhibiting a very shallow rise toward systems with components of similar mass. Characterizations of the binary and multiple star frequency for M-dwarfs provide crucial insights into the low-mass star formation environment, and hold additional

implications for the frequency and evolutionary histories of their associated disks and planets.

Atmospheric dynamics and magnetic activity of M-type dwarf stars

Sven Wedemeyer[1]

[1] *University of Oslo, Norway*

Abstract. Three-dimensional radiation magnetohydrodynamic simulations of M-type dwarf stars feature atmospheres with a very dynamic and intermittent structure on small spatial and temporal scales and a wealth of physical processes, which by nature cannot be described by means of one-dimensional static model atmospheres. The presented time-dependent 3D models have different initial magnetic field strengths and thus represent regions with different activity levels, which can be combined into synthetic full stellar disks. A large number of synthetic spectro-polarimetric diagnostics are calculated by using each of these models as input for detailed radiative transfer calculations. These diagnostics, like, e.g., Halpha, Ca II lines, or the continuum intensity from the UV into the millimeter wavelength range, sample various properties of the dynamics, thermal and magnetic structure of the photosphere and the chromosphere and thus provide measures of stellar activity, which can be compared to observations. The complicated magnetic field structure and its imprint in synthetic diagnostics may have important implications for the understanding and characterization of stellar activity and with it possibly for the evaluation of planetary habitability around active M-dwarf stars.

IC4756: Cluster Membership and Stellar Rotation

Joerg Weingrill[1]

[1] *Leibniz Institute for Astrophysics (AIP)*

Abstract. IC4756 is an open cluster in the CoRoT field, and with an age of 800 Myr neatly splits the difference in age between the well-studied Hyades (625 Myr) and NGC 6811 (1 Gyr) clusters. Consequently its rotation periods should lie between those of the Hyades and NGC 6811, independent of an theoretical model, if rotation is indeed a well-defined function of stellar age

and mass. Therefore we have performed precision time-series photometry of the IC4756 field for almost 73 days with the CoRoT satellite, and derived 348 main sequence rotation periods in the cluster region. Radial velocity measurements taken with WIYN+Hydra together with multi-color Strmgren photometry using the STELLA robotic telescopes on Tenerife allowed us to identify about 200 cluster members and to compare age-determinations stated by different theories. To date, the cluster member rotation periods indeed lie between those of the Hyades and NGC 6811. The corresponding cluster age is 720 Myrs. We will also present photometry and rotation periods from the Stella Open Cluster Survey (SOCS) from several clusters including NGC 1647, NGC 2281 and M 48.

Low-mass Wide Binaries from Kepler: Stellar Rotation Periods, Ages and Planetary Occurrence Rates

Kolby L. Weisenburger[1]

[1]*Boston University*

Abstract. Using the Kepler Input Catalog and the fourth U.S. Naval Observatory CCD Astrograph Catalog, we have identified 1509 common proper motion binaries in the Kepler field of view and have verified their fidelity using a Galactic model and follow-up astrometric observations. We highlight a subset of this sample where at least one component is a low-mass companion and, as these pairs were initially targeted for a gyrochronology analysis, present measurements of stellar rotation periods and preliminary estimates of stellar ages. Two separate subsets of this sample are essential to understanding the properties of coeval systems and calibrating current gyrochronology models for cool stars. First, binaries with equal-mass components provide direct constraints on the intrinsic spread of stellar rotation and help refine current gyrochronology models since we expect both stars to share the same formation and evolutionary history. Second, pairs with one M dwarf and a higher mass companion allow us to infer the systems age from the primary (where ages from isochrone fitting or gyrochronology are better calibrated) and independently calibrate the gyro method for low-mass stars. We will also highlight binary systems with orbiting planet candidates, or

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Kepler Objects of Interests, and discuss future techniques that can be used to identify additional low-mass binaries from Kepler.

The emergence of aurorae in ultra-cool stars: insights from radio variability

Peter K. G. Williams[1]

[1] *Harvard*

Abstract. Although early studies suggested that magnetism fades out in very cool stars and brown dwarfs ("ultra-cool dwarfs": UCDs), radio observations have demonstrated that at least some of these objects can generate stable, large-scale, kilogauss-strength magnetic fields. Periodic, polarized radio bursts strongly suggest the emergence of aurorae in some objects with spectral types later than M7, raising several profound questions. What is the origin of the energized auroral particles? What is their effect upon the outer layers of the stellar atmosphere? The answers to these questions have implications not only for the chemistry and dynamics of UCD atmospheres, but also for the nature of the poorly-understood underlying dynamo process. I will present new results from a detailed VLA study of 2MASSW J1047539+212423, which at a spectral type of T6.5 is the latest-type object yet detected in the radio. Its radio bursts are indeed periodic, adding it to the roster of likely auroral emitters. I will place these results in the context of our recent work to clarify the relationship between rotation and magnetic activity, as traced by radio and X-ray emission, in the ultra-cool regime. The recent upgrade of the VLA provides a powerful new instrument for pursuing these studies.

Non-Magnetocentrifugal Protostellar Jets Created by the Magnetorotational Instability in Thick Accretion Flows

Peter Todd Williams[1]

[1] *Agilent Technologies, Inc.*

Abstract. The dominant models for the creation of jets in a variety of astrophysical systems, including protostellar systems, include magnetocentrifugal acceleration by large-scale poloidal magnetic fields. This is true whether the material is thought to originate in a disk-wind, at an interme-

diate x-point, or from the star itself. Many alternative scenarios have been suggested in the literature however. Here we focus on what in our model is the manifestly non-magnetocentrifugal creation - that is, confinement, powering, launching, and collimation - of protostellar jets by turbulence driven by the magnetorotational instability (MRI). We re-examine our previous work on this matter in light of recent developments. Our scenario for MRI-driven protostellar jets requires that the dynamically-significant part of the accretion flow, where the jet is launched, completely envelop the nascent star. The star itself is completely surrounded by a flow separatrix that divides flow that is ultimately accreted onto the star from flow that is not. Power coupling to the outflow occurs by radially-outward viscous and thermal transport through the separatrix. Most of the power comes from the innermost regions of accretion, including the so-called boundary layer of the accretion flow. In this respect this mechanism differs from jet-launching mechanisms that rely upon thin-disk accretion. Inasmuch as geometrically-thick accretion correlates with high accretion rates, FU Ori objects are among the best candidates for this type of jet-production. One consequence of this model would be that the magnetic field in the jet-launching region be largely toroidal. Secondly, since the magnetic field is turbulent and tangled in nature, the field strength can decay faster with respect to axial distance from the central star than in magnetocentfiugal mechanisms. Finally, since the MRI saturates at a finite plasma beta, this model places lower limits on the gas pressure in the jet-launching region.

Our Southern Neighbors: Distances to 1800 Nearby Red Dwarfs

Jennifer Winters[1]

[1]*RECONS & Georgia State University*

Abstract. The nearest stars are key targets for stellar astrophysical studies, provide the foundation for the primary rung in the cosmic distance ladder, and are the ideal locations to search for planets and life beyond our Solar System. As a population, these stars are crucial to our understanding of the stellar luminosity and mass functions in the Milky Way and beyond, and provide context for our Sun's place in the Cosmos. Here we present trigonometric, photometric, and photographic distances to 1758 southern (DEC ¡ 0 degrees) red dwarf systems with proper motions greater than 0.18"/yr. Of these, 1409 are believed to lie within 25 parsecs of the Sun and therefore comprise the fundamental list of southern stars to investigate for a variety of astronomical efforts. The stars have V = 6.67-21.38 and 3.50 ¡ (V-K) ¡ 9.27, covering the entire M dwarf spectral sequence from M0.0V through M9.5V. Roughly one-third of the 1758 systems, each of which has a red dwarf primary, have high quality parallaxes that we have culled from the lit-

erature, including 179 from the RECONS (www.recons.org) astrometry program (with several hundred more soon to be published). For the remaining systems, we offer photometric distance estimates that have well-calibrated errors. The bulk of these (700) are based on new VRI photometry acquired at the CTIO/SMARTS 0.9m telescope, while the remaining stars (500) have photographic plate distances estimated using SuperCOSMOS BRI photometry. For both distance estimating techniques, the optical data are combined with JHK data from 2MASS to provide distances reliable to 15% (VRIJHK) and/or 26% (BRIJHK). This effort has been supported by the NSF through grants AST-0908402 and AST-1109445, and via observations made possible by the SMARTS Consortium.

GJ 832c: A super-earth in the habitable zone

Rob Wittenmyer[1]

[1] *UNSW Australia*

Abstract. We report the detection of GJ 832c, a super-Earth orbiting near the inner edge of the habitable zone of GJ 832, an M dwarf previously known to host a Jupiter analog in a nearly-circular 9.4-year orbit. The combination of precise radial-velocity measurements from three telescopes reveals the presence of a planet with a period of 35.68+/-0.03 days and minimum mass (m sin i) of 5.4+/-1.0 Earth masses. GJ 832c moves on a low-eccentricity orbit (e=0.18+/-0.13) towards the inner edge of the habitable zone. However, given the large mass of the planet, it seems likely that it would possess a massive atmosphere, which may well render the planet inhospitable. Indeed, it is perhaps more likely that GJ 832c is a "super-Venus," featuring significant greenhouse forcing. With an outer giant planet

and an interior, potentially rocky planet, the GJ 832 planetary system can be thought of as a miniature version of our own Solar system.

Infrared Variability in Several Star Formation Regions

Scott Wolk[1]

[1] *Harvard-Smithsonian CfA*

Abstract. We present an analysis of mid-infrared time-series photometry for several clusters taken as part of the Spitzer Young Stellar Object variability program (YSOVAR). In the clusters L1688, IRAS 20050-2720 and GGD 12-15 we identify variability in several hundred stars ranging from Class I to Class III. The data have with photometric uncertainty better than 0.05 mag down to [4.5] 15.5. We study the light curves and color trajectories of the sources in the monitored fields in detail. We investigate the variability and periodicity of the YSOs and find that they divide into observational classes which at a minimum include: 1) stochastic variables, 2) long-term variables, 3) periodic stars which vary in frequency of amplitude and 4) stars with periodic variability stable over long timescales. Some YSO variability defies simple classification. We describe how this variability may be due to both dynamic and rotational changes in inner disk structure and accretion rate.

Searching for rocky worlds around cool stars

Duncan Wright[1]

[1] *University of New South Wales*

Abstract. Finding Earth-like planets orbiting in the habitable zone of other stars is one of the major goals of modern astronomy. Indications from both Doppler planet searches and Kepler are that rocky planets around low-mass stars are very common. With modern high-precision spectrographs it is possible to detect these planets using the Doppler velocity technique. A search for habitable-zone exoplanets orbiting mid-late type M Dwarfs dwarfs on the Anglo-Australian Telescope began in late 2012. This program operates in the red (500-1000 nm) to obtain high signal-to-noise precision velocities. This presentation outlines the new instrumentation and reduction

techniques developed specifically for this project and the current results from this survey.

Optical Photometry of CT Chamaeleontis B with Magellan AO System

Ya-Lin Wu[1]

[1] *University of Arizona*

Abstract. We used the Magellan adaptive optics system (MagAO) to image the young brown dwarf companion CT Chamaeleontis B at visible wavelengths. We detected it at i', z', and Ys, but not at r', indicating that it has no significant accretion. With our new optical photometry, we are able to better estimate the extinction and the companion's mass and size. Finally, the astrometry also rules out the possibility that CT Cha has a second companion.

Spontaneous formation of cool polar-spots in global numerical simulations

Rakesh K. Yadav[1]

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Abstract. Sunspots are one of the most remarkable manifestations of the Sun's magnetic field. Their properties have played an instrumental role in shaping our understanding of the solar dynamo. Observational techniques have revealed that other cool stars also harbor cool spot-like features on their surface. But, unlike the sunspots, coolspots on other stars appear on a wide range of latitudes. Some cool stars, especially the rapidly rotating ones, exhibit coolspots very close to (or at) the rotational poles, sometimes forming the so called "polar-caps". Flux-tube models, which have been developed to explain the sunspot properties, have been extended to explain such high-latitude coolspots. Although such models show some agreement with the observations, several underlying simplifications do not allow a self-consistent treatment of dynamo mechanism and coolspot formation. Many have argued that the dynamo mechanism in rapidly rotating stars might be fundamentally different from the solar case. A distributed dynamo, operating throughout the stellar convection zone, has been proposed for such

stars. To explore the plausibility of such dynamo mechanism we simulate magnetic field generation in a density-stratified rapidly rotating spherical shell. Due to rapid rotation helical convection develops in the interior and maintains a strong large-scale magnetic field. Granular-type convection in the outer layers, promoted by the strong density contrast, collects the magnetic flux in convergent downwellings. In some regions where the magnetic flux concentration is large enough, convection is highly quenched, leading to the formation of coolspots. Sizable coolspots form at high-latitudes due to the distribution of the magnetic field. Our simulations demonstrate that a distributed dynamo can spontaneously generate coolspots at high latitudes.

New Insights into Cloud Properties of L Dwarf Atmospheres

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Abstract. At effective temperatures between 1400 K and 2000 K, L-type brown dwarfs have significant cloud coverage in their atmospheres. The physical and chemical characteristics of these condensate clouds are essential to our understanding of the ultracool atmospheres of brown dwarfs and giant planets. We present analysis of HST WFC3 G141 grism spectra of two L dwarfs, which are the first results from the Extrasolar Storms program. The time-resolved spectroscopic data allow us to study the evolution of their light curves at multiple wavelengths and on timescales ranging from a few hours to a few weeks, probing cloud properties at different pressure levels and different latitudes and providing constraints for atmospheric models of these ultracool objects.

Cool Star Beginnings: YSOs in the Perseus Molecular Cloud

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Abstract. Low-mass stars like the Sun are formed in a wide range of different environments from isolated cores to large, dense clusters. Nearby molecular clouds, where there is considerable evidence of ongoing star formation, provide the best opportunity to observe stars in the earliest stages

of their formation. The Perseus molecular cloud contains two young clusters, IC 348 and NGC 1333, and several small dense cores of the type that produce only a few stars. Perseus is often cited as an intermediate case between quiescent low-mass and turbulent high-mass clouds, making it perhaps an ideal environment for studying typical low-mass star formation. We present an infrared study of the Perseus molecular cloud with data from the Spitzer Space Telescope as part of the From Molecular Cores to Planet Forming Disks (c2d) Legacy project (Evans et al. 2003). By comparing Spitzers near- and mid-infrared maps, we identify and classify the young stellar objects (YSOs) in the cloud and eliminate reddened background galaxies. Virtually all of the YSOs in Perseus are forming in the clusters and other smaller associations at the east and west ends of the cloud with very little evidence of star formation in the midsection. We present analysis of the visual extinction and distribution of the YSOs across Perseus. Evans, N. J. II, et al. 2003, PASP, 115, 965

Horizontal-Branch Stars in SDSS: Fiducial Sequences in ugriz and RGB Mass Loss in Open Clusters

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Abstract. We present a set of fiducial sequences of horizontal-branch stars in bright Galactic globular clusters, which have previously been observed in the Sloan Digital Sky Survey (SDSS). We derive fiducial lines on color-magnitude diagrams in multiple color indices (g-r, g-i, g-z, and u-g), and use them to test theoretical predictions from various groups. In addition, we compare various sets of theoretical models to color-magnitude diagrams of M67 and NGC6791 to estimate their red-clump masses, and find that red-

clump stars in NGC6791 have lost almost half of their initial masses while ascending the red giant branch. We discuss implications of our finding.

A close look at a cool star in a triple system.

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Abstract. Algol binaries have cool secondary stars which exhibit magnetic activity, eclipses and have accretion streams. In addition to their optical variability they are radio and x-ray sources as well. Their relative optical brightness and radio emission makes them useful sources for registering the optical and radio astrometric reference frames. Here we report on observations with the Navy Precision Optical Interferometer (NPOI) and a variety of optical telescopes of the triple star b Per which is thought to host an Algol close binary. Our goal is to determine the evolutionary state of the cool star and to improve the optical orbit to aid the optical-radio reference frame astrometric registration.

Atmospheric circulation of Brown Dwarfs: jets, vortices, and time variability

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Abstract. Under the conditions of fast rotation, strong radiative dissipation and no external stellar flux, brown dwarfs occupy a unique corner of the parameter space of atmospheric dynamics theories. Here we ask: do the atmospheres of the brown dwarfs exhibit east-west jets pattern as exist on both the gas giants in our solar system and the close-in extra-solar giant planets, or are they dominated by isotropic turbulence and vortices instead? The answer is crucial for the interpretation of observed time variability of L/T dwarfs as well as being of fundamental theoretical interest. We used a global two-dimensional (2D) shallow-water model to investigate the dominant atmospheric features during the continuous transition from gas giants to brown dwarfs. We show that the existence and properties of the jets crucially depend on several key parameters including the energy injection rate and radiative damping timescale. Under conditions of strong internal

heat flux and weak radiative dissipation, east-west jets spontaneously emerge from the interaction of atmospheric turbulence with the planetary rotation. When the internal heat flux is weak and/or radiative dissipation is strong, turbulence injected into the atmosphere damps before it can self-organize into jets, leading to a flow dominated by isotropic turbulence and vortices instead. We present a scaling law as a quantitative criterion for the emergence of jets versus vortices on gas giants and brown dwarfs. The long-time integration of the shallow water system provides a new tool to understand the effect of atmospheric dynamics on the observed light curve variations in both short and long timescales. Our simulated light curves capture the important features in recent infrared observations, such as an amplitude variation of a few percent and multi-peak shapes. This work is supported by the NSF and by a Bisgrove Scholar Program in the University of Arizona.

Characterizing metal-deficient brown dwarfs

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Abstract. Metal-deficient brown dwarfs are kinematically assosiated with the Galactic halo and thick disc. Our knowledge of halo brown dwarfs are limited due to the lack of known L subdwarfs and well tested low-metallicity atmospheric models. There are only 20 L subdwarfs (some are d/sdL) been published in the literature (see Kirkpatrick et al. 2014). I started to search for mid-late type L subdwarfs in UKIDSS and SDSS in 2010, and have confirmed 20 new L subdwarfs with spectra so far, including five (e)sdL6+ (e.g. Zhang et al 2013b). Wer are expecting more new L subdwafs in our GTC/OSIRIS run in 2014A. I will summarize the current sample of mid-late type subdwarfs, and discuss responses of L subdwarf spectra to changes of metallicity and effective temperature (mass). Then disscuss the spectroscopic indicators for L subdwarfs and halo brown dwarfs. I found that the substellar subdwarf gap is likely between (e)sdL4 and (e)sdL6 (Zhang et al. 2013a). I will also compare our L subdwarf sample with Drift (Witte et al. 2009) and BT-settl (Allard et al. 2009) model spectra to support my conclutions. Then I will discuss how future facilities will help us to understand halo brown dwarf population, and how halo brown dwarfs could help us to understand the evolution of brown dwarfs and Galactic halo.

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