A Lowell Observatory Workshop:

Star Formation in Dwarf Galaxies

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Abstracts

J. Sanchez Almeida (Talk) -- *Why do extra-metal poor galaxies have cometary shape?*

Extremely metal-poor (XMP) local galaxies are primitive objects attending to their chemical composition. They are rare, but we have already identified more than a hundred dwarf galaxies with a metallicity ten times smaller than the solar value. Their morphology presents the striking feature of being comet-like (Papaderos et al 2008, Morales Luis et al. 2011), with a star-forming bright head and a faint diffuse tail. The origin of this shape is unknown but cometary shapes are very common at high redshift, and they are usually interpreted as primitive disks in the process of being assembled (Elmegreen et al. 2005,2102). It is thinkable that local XMP galaxies are not only primitive from a chemical point of view, but also primitive from dynamical point of view. They may represent disks being assembled today in the local universe and, if so, they offer a unique laboratory to study disk formation. I will detail the evidences that we have for the XMP being primitive disks. In addition, I will summarize the mechanisms that have been put forward to explain cometary shapes, ranging from gravitational instabilities in turbulent disks, to the signature of gas stripping forced by the interaction with an external medium.

Ricardo Amorin (Talk) -- *Extreme star formation and feedback in dwarf galaxies: New insights from GTC, HST and WHT observations*

We study a subset of rapidly star-forming dwarf galaxies at z~0.1-0.3, known as “Green Peas” (GP). They provide a unique environment to study the triggering and regulation of vigorous star formation under physical conditions approaching those in galaxies at higher redshifts. In this presentation, we will share new insights from two recent observational studies. Firstly, we will present a detailed spectrophotometric study for a sample of GPs based on GTC-OSIRIS and HST observations. Its results provide new constraints to: (a) their star formation history, from both a combined approach of evolutionary and population synthesis models and their photometric structure, and (b) their chemical evolution, from the accurate determination of physical properties and chemical abundances. Secondly, we will present a deep, high resolution long-slit spectroscopy survey of GPs, conducted at the WHT. Its main goal is to study the ionized gas kinematics and the chemo-dynamics of these starbursting dwarfs. A detailed multi-component analysis show remarkably complex line kinematics, including strong broad and (multiple) narrow emission. First results will be discussed in terms of the possible mechanisms of star formation e.g., interactions/mergers and internal processes, and the effects of stellar feedback.

Yago Ascasibar (Talk) -- *Gas flows and chemical evolution in dwarf irregular galaxies*

The presence of strong galactic winds and their possible effect on the evolution of dwarf galaxies have been hotly debated over the last decades. In particular, it is still unclear whether these objects are able to retain most of their gas, or by the contrary there is a significant outflow that expels the material out of the galaxy. In this talk, we will discuss this issue from the point of view of chemical evolution, and it will be shown that dwarf galaxies, especially dwarf irregulars, seem to be fully consistent with a weak-wind scenario, where star formation is mostly regulated by the infall of gas from the intergalactic medium and the formation of molecular hydrogen on dust grains. We argue that photodissociation, rather supernova-driven winds, is the main physical process that is responsible for stellar feedback.

Trisha Ashley (Poster) -- *Star Formation In Blue Compact Dwarf Galaxies*

Blue compact dwarf galaxies (BCDs) exhibit an extreme case of star formation: the star formation rate is so high that if continued it would deplete the gas reservoir within ~10^9 years (Gil de Paz & Madore 2005). The reasons for this are not well understood. In this study the sample consists of six blue compact dwarf galaxies that all have high angular resolution (6 arcsec) and high velocity resolution (2.6 km/s or 1.3 km/s) HI data taken with the Very Large Array (VLA) telescope, along with a variety of other data at various wavelengths in the optical, ultraviolet (UV), and infrared (IR). These data are used to study star formation in the extreme case of BCDs.

Giuseppina Battaglia (Talk) – *A wide-area view of one of the rare transition type dwarf galaxies in the Local Group*

Dwarf irregular/ dwarf spheroidal transition type galaxies offer the opportunity to study the existence of possible evolutionary links between the late- and early- type dwarf galaxies, since the properties of dTs suggest that they may be dwarf irregulars in the process of transforming into dwarf spheroidals (dSphs).

In this contribution I will present results from a wide-area VLT/FORS photometric survey of the Phoenix dwarf galaxy, one of the rare transition type galaxies (dTs) of the Local Group. This is the only photometric survey whose depth and spatial extent enable us to study both the overall structure of Phoenix and to explore in a very direct way how the stellar population mix varies across the face of the galaxy.

Similarities are found between Phoenix and the close-by, gas-less, Milky Way dSphs such as stellar population gradients, with a more and more centrally concentrated spatial distribution of stars, the younger the stellar population.

The differences in morphology and spatial distribution observed for the stars in various age ranges suggest that the youngest stars still retain the imprint of the gas distribution from which they were born, while older stars have diffused from that location and have become more sensitive to the overall potential of the galaxy. The displayed behaviour is strikingly similar to what observed in the only Milky Way dSph which contains a sizable population of young stars and hints to some amount of radial migration at play in both systems.

Kenji Bekki (Talk) -- *Dwarf galaxy mergers and the formation of blue compact dwarfs*

We investigate how interacting/merging low surface-brightness, gas-rich dwarf irregular galaxies can be transformed into BCDs based on chemodynamical numerical simulations. We find that dwarf galaxy merging can trigger central starbursts in the central regions of the merging dwarfs whereas the old pre-existing disks can be dynamically heated up to form thick disks or spheroidal components depending on the parameters of merging. The young compact starburst components surrounded by old stellar ones can be observed as BCDs. The rotation curve profiles can change from slowly rising ones from steeply rising ones during dwarf merging. Owing to strong feedback effects from prompt type Ia supernovae (SNe Ia) and type II ones (SNe II), the formation of very compact stellar nucleus can be severely suppressed in the BCDs. The formation of massive star-forming knots, which could be the progenitor stellar clumps of young globular clusters, can be developed in the BCDs formed

from merging. The stellar and gaseous metallicities can increase during dwarf merging owing to rapid chemical enrichment due to prompt SNe Ia and II. Based on these results, we discuss the origins of differences in physical properties (e.g., HI distributions and surface-brightness) between dwarf irregulars and BCDs.

Gurtina Besla (Talk) -- *The Role of Dwarf Galaxy Interactions in Shaping the Magellanic System and Implications for Magellanic Irregulars and Dwarf Spheroidals*

I will present a new numerical model of the evolution of the Milky Way's largest satellite galaxies, the Large and Small Magellanic Clouds (LMC/SMC), in which their current internal structure and kinematics and large-scale gas morphology are dictated by their mutual tidal interactions, rather than interactions with the Milky Way. This picture is consistent with the recent HST proper motions of the LMC (Kallivayalil et al. 2006) - using cosmologically motivated models for the Milky Way, these new proper motions imply that the Clouds have not made multiple passages about the Milky Way. In particular, the LMC's peculiar off-center bar and one-armed spiral morphology is a natural by-product of a recent direct collision with the SMC. This scenario may shed light on the dynamical state of a class of dwarf galaxies known as Magellanic Irregulars (de Vaucouleurs & Freeman 1972), which, like the LMC, are asymmetric spirals with off-center bars, but are rarely associated with massive spirals. As a result of its collision with the LMC, the simulated SMC is left in a highly disturbed state where its older stellar population does not display a pronounced rotation curve, as observed. The SMC may thus represent an object in transition from a dwarf Irregular galaxy to a dwarf Spheroidal. This process is expected to occur ubiquitously in small groups of low mass galaxies and may represent a generic mode of dwarf galaxy evolution that is independent of proximity to a massive host.

Alberto Bolatto (Invited Talk) – *Observations of Molecules in Dwarf Galaxies*

It has been known for the last few decades that dwarf galaxies are deficient in molecules relative to their atomic gas mass and their star formation rates. During the last few years, however, we have learn a wealth of new information that I will review. In particular, I will discuss the abundance and distribution of H2 in these galaxies as well as the correlation between molecular gas and star formation activity.

Frédéric Bournaud (Invited Talk) – *Star Formation in Dwarf Galaxies: Cosmological Implications*
While cosmological models often focus on understanding the star formation history of massive galaxies, the observed cosmic downsizing phenomenon implies that dwarf galaixes are the closest relics of the most active epochs of star formation at redshift z>1. This review will highlight the cosmological implications on the process of star formation in nearby dwarves, focusing on three key questions:
-Are nearby dwarf galaxies representative or different from Milky Way progenitors at high-redshift and what can we learn about high-redshift galaxies from local studies?
-Is there a downsizing of star formation from massive galaxies toward dwarf galaxies with cosmic time, ad can it be fully explained?
-Is feedback efficient at regulation star formation in dwarf galaxies, and is there still a "missing dwarfs problem" to be solved?

Elias Brinks (Poster) -- *A spatially resolved cross-correlation method applied to multi-wavelength imaging of NGC 2403*

We are developing an objective, automated method to compare multi-wavelength images based on 2–D pixel-by-pixel cross-correlations. We introduce a measure for the degree of correlation, Ccoef, which takes values from 1 (perfect correlation) to –1 (perfect anti-correlation). This we applied to NGC 2403, in a pilot project. We produce spatially resolved cross-correlation maps, on scales of 250pc to 1000pc and radial profiles of the cross-correlation coefficients. We find that i) all dust tracers, 8μm–70μm, are well correlated (Ccoef> 0.7) at all scales; ii) all star formation tracers are well correlated at scales larger than 500pc (Ccoef> 0.6); iii) at 250pc scale, FUV correlates poorly (Ccoef ~ 0.3) with any dust tracer, a direct consequence of the absorption of FUV photons by dust; and iv) neutral atomic hydrogen is tightly correlated with 8μm emission (Ccoef ~ 0.6), illustrating the fact that HI is mixed with PAH's.

Charlotte Christensen (Talk) -- *Inefficient Star Formation in a Simulated Dwarf Galaxy*

The exceptionally low stellar mass fractions of dwarf galaxies are presumed to result from a combination of lower molecular gas fractions and greater mass loss from UV background radiation and stellar feedback. We examine the importance of halo mass in determining the stellar mass fraction using cosmological simulations of galaxy formation with UV radiation, supernova feedback, non-equilibrium molecular hydrogen abundances, and molecular hydrogen-based star formation. In order to isolate the effect of mass from that of a specific formation history or environment, we compared a dwarf irregular galaxy and a low-mass spiral galaxy that had been simulated from the same initial conditions, the latter scaled up by a factor of eight in mass and two in distance. Both of the resulting galaxies have rising rotation curves and realistic stellar masses and gas fractions. Comparing them illustrates the relatively inefficient star formation of dwarf galaxies. We find that the dwarf galaxy has both greater efficiency of supernova-driven gas loss and lower metallicity than the spiral galaxy. Even when the dwarf galaxy's metallicity and mass fraction of disk gas were similar to those of the spiral galaxy, though, the molecular hydrogen fraction and star formation rate of the dwarf galaxy were substantially smaller. We find that above a small threshold metallicity, the mid-plane gas pressure is the dominant factor in determine the molecular fraction and, therefore, the star formation rate.

Jiwon Chung (Poster) -- *Probing the Merging Blue Compact Dwarf Galaxies from Element Abundances and Star Formation Rate*

We present elemental abundances of 91 blue compact dwarf galaxies (BCDs) at z=0.2~0.35 using Sloan Digital Sky Survey (SDSS) DR7. We derive various element abundances using Te method. We found that nitrogen to oxygen abundance of BCDs showing disturbed features are more enriched than normal BCDs due to the contribution of W-R stars and fast rotating young massive stars in the galaxy. On the other hand, oxygen abundances for disturbed BCDs are slightly lower than the normal BCDs. This might be resulted from the dilution by metal-poor gas infall during the interaction. We estimate Hα , NUV star formation rate (SFR) from the GALEX GR6 and SDSS DR7 data. Disturbed BCDs also show systematically lower Hα to NUV SFR ratio. Considering element abundance anomalies and distinct SFR ratios, we suggest that disturbed BCDs experience prolonged star formation histories due to the episodic dynamical event with neighboring object

Phil Cigan (Poster) -- *Star Formation in LITTLE THINGS: A First Look with Herschel*

Far infrared atomic and molecular lines from Photodissociation Regions (PDRs) provide us with the means to probe for 'hidden H_2', or molecular hydrogen not detected via the usual relation with CO. Having a good grasp on the available H_2 reservoir in a galaxy is important for determining its star formation properties. We present a first peek at Herschel spectroscopy of five very metal-poor dwarfs in the LITTLE THINGS survey. These targets have metallicities of 12+log(O/H) = 7.4 to 7.8. We have maps of [C II] 158 μm, [O I] 63 μm, [N II] 122 μm, and [O III] 88 μm - the major FIR cooling lines - to probe the relation between atomic and molecular gas at low metallicities.

Michele Cignoni (Talk) -- *Star Formation History in dwarf galaxies: from the SMC to Ultra Faint Dwarfs*

Albeit separated by several magnitudes in absolute magnitude, the Small Magellanic Cloud (SMC) and the Ultra Faint Dwarf Leo T succeeded to maintain a prolonged star formation up to now. We present the star formation history in both galaxies using deep HST/ACS and WFPC2 colour-magnitude diagrams. We find that the SMC Bar experienced a negligible star formation activity in the first few Gyr, followed by a dramatic enhancement from 6 to 4 Gyr ago and a nearly constant activity since then. On the other hand, Leo T shows a complex star formation history dominated by two enhanced periods about 1-3 and 8-10 Gyr ago.

Annelies Cloet-Osselaer (Talk) -- *The degeneracy between star-formation parameters in dwarf galaxy simulations and the Mstar-Mhalo relation or Starbursts in simulated blue compact dwarfs*

Recently, Guo et al. (2010), using a combination of simulations and observations, derived the relation between the stellar mass and the dark-matter mass of galaxies. This relation steepens dramatically in the dwarf galaxy regime and predicts that stars in dwarfs are outnumbered by dark matter by a factor of 1 to 105. That raises the question why dwarfs would be so inefficient at forming stars. As a first step, we investigated the role of internal processes related to star formation and supernova feedback. Using a modified version of the Gadget-2 N-body/SPH code, we ran a suite of simulations of isolated dwarf galaxies. First, we investigated the degeneracy between the supernova feedback efficiency (i.e. the fraction of the energy released by supernovae that is absorbed by the ISM) and the star-formation density threshold (i.e. the gas density above which star formation is possible). If both parameters are varied together it is possible to produce simulated dwarf galaxies that lie on the observed kinematical and photometric scaling relations. E.g., a suitable increase of both parameters leads to smaller, fainter, more metal poor galaxies. However, galaxy properties do not change significantly for density thresholds higher than 50 amu/cm^3. Our models with high density thresholds and maximal supernova feedback efficiencies are also the faintest, most dark-matter dominated ones. Still, at a given dark halo mass, their stellar masser are a factor of $\sim$10^3 higher than predicted by the Guo et al. relation. Remarkably, we are able to reproduce the slope of the Guo et al. relation. Our results are, moreover, in good agreement with those of the Aquila Simulation (Sawala et al. 2011). This shows that, if the Guo et al. Mhalo-Mstar is correct, dwarf galaxies must furthermore lose large quantities of baryons through external processes. We discuss several such processes and whether they can produce dwarf galaxies that lie on the observed scaling relations.

David Cook (Poster) -- *The ACS Nearby Galaxy Survey Treasury. X. Quantifying the Star Cluster Formation Efficiency of Nearby Dwarf Galaxies*

We study the relationship between the field star formation and cluster formation properties in a large sample of nearby dwarf galaxies. We use optical data from the Hubble Space Telescope and from ground-based telescopes to derive the ages and masses of the young (t_{age} < 100 Myr) cluster sample. Our data provides the first constraints on two proposed relationships between the star formation rate of galaxies and the properties of their cluster systems in the low star formation rate regime. The data show broad agreement with these relationships, but significant galaxy-to-galaxy scatter exists. In part, this scatter can be accounted for by simulating the small number of clusters detected from stochastically sampling the cluster mass function. However, this stochasticity does not fully account for the observed scatter in our data suggesting there may be true variations in the fraction of stars formed in clusters in dwarf galaxies. Comparison of the cluster formation and the brightest cluster in our sample galaxies also provide constraints on cluster destruction models.

Diane Cormier (Talk) -- *Gas cooling in nearby low-metallicity dwarf galaxies with Herschel*

Far-Infrared spectroscopy with Herschel has opened a new window for understanding the interstellar medium (ISM), in particular of dwarf galaxies. I will present results on the multi-phase modeling of the starburst galaxy Haro11, the most intensely star-forming dwarf galaxy in the local universe, and therefore the most extreme object of the Herschel Dwarf Galaxy Survey (DGS, PI: S.C. Madden). With LTIR~1.5e11Lsun, it hosts several super star clusters, has luminous Halpha but is not detected in HI and CO(1-0). However it is very bright in the infrared Spitzer/IRS and Herschel/PACS lines, which is evidence of the presence of molecular gas fueling star formation. I will present a systematic approach for comparing Cloudy models to the numerous observational constraints. We methodically model the ionized, neutral, and molecular phases, and derive their physical conditions (density, radiation field, mass). We find that the ionized gas dominates the emission of the galaxy, and that the ISM structure is very clumpy, with at most 50% of the [CII] emission associated with the dense PDRs.

These findings will be placed in the broader context of the DGS by presenting observations of the dominant FIR fine-structure lines (OIII88 μm, CII158 μm, OI63 μm) in a sample of 45 local dwarf galaxies with the Herschel/PACS spectrometer. We also obtained CO ground-based observations for 4 of these dwarf galaxies, including Haro11. [CII] is detected in 3/4 of the sample. It is the most extended line, brighter than the [OI] 63 μm, dominating the cooling in the warm neutral medium. The [OIII] 88 μm line traces the highly ionized medium and is the brightest of all, indicating young active star formation. The [CII]/LFIR and [CII]/CO ratios are high, as observed previously in dwarfs (Poglitsch et al. 1995, Madden et al. 1997, Madden et al. 2000, Hunter et al. 2001). The FIR lines altogether contribute to up to 1% of LTIR. This full dataset of FIR-submm observations enables us to:
- explore the correlation between the observed line intensities and ratios with global galaxy parameters, in particular metallicity, star-formation activity and star-formation history, which are notably different than in more metal-rich galaxies.
- study the physical conditions in the different ISM phases of these dwarf galaxies by comparing observations with photo-ionization and photo-dissociation models to get a comprehensive view of the dust and gas properties in the IR.
- quantify the total gas mass and investigate the role of CII and CO as calibrators of H_2 and of the molecular gas reservoir.

Sven De Rijcke (Talk) -- *New composition dependent gas cooling curves and their influence on the star-formation modes in simulated dwarf galaxies*

The venerable Sutherland & Dopita (1993) gas cooling curves are still very widely used in N-body/SPH simulations of galaxies. With the recent addition of the Maio et al. (2007) cooling curves for temperatures below 10^4 K, simulators can follow gas cooling for temperatures in the range T=10 K to $5x10^8$ K at the low computational cost of a two-dimensional interpolation on the [Fe/H]-T-plane. However, these cooling curves were compiled for elemental abundance ratios that are not suited for all purposes. E.g., the Sutherland & Dopita cooling curves, having been calculated for SNII abundance ratios for [Fe/H]<-1, significantly overestimate the gas cooling rates in low-metallicity dwarf galaxies enriched by SNIa. This overcooling introduces systematic effects in the star-formation rates and modes in these simulations. We present new composition dependent gas cooling curves which depend not only on metallicity (through [Fe/H]) but also on alpha-element enrichment (via [Mg/Fe]). Thus, the enrichment history of the gas is taken into account when calculating its cooling rate. At the relatively low cost of a three-dimensional interpolation on the [Fe/H]-[Mg/Fe]-T space, simulators can use these new curves to calculate accurate gas cooling rates for temperatures from 10 K up to 10^9 K. We discuss the physical ingredients of these cooling curves, how they compare with existing curves, and how they affect star formation in dwarf galaxy simulations.

Bruce Elmegreen (Talk) -- *Dwarf Galaxies and High-Redshift Irregulars: Similarities and Differences*

Dwarf galaxies are morphologically similar to very young galaxies in that both are highly clumpy with star formation, they are gas rich with a ratio of gas velocity dispersion to galaxy rotation speed that exceeds a few tenths, and they have no bulges. Local dwarf irregulars also tend to reside at the edges of clusters, groups, and galaxies, in environments free from ram pressure stripping and other systematic disruptions, in analogy to the nearly cluster-free environments of young galaxies in the early universe. Local dwarfs also seem to have a large ratio of dark matter to stars, and this is likely to be true for young galaxies too, during the epoch of cold flows and first disk star formation. All of these similarities make sense if the clock of galaxy evolution depends primarily on density and galaxy mass increases with density.

Dana Ficut-Vicas (Talk) -- *Two LITTLE THINGS: The case of DDO133 and DDO168*

We present the results of our pilot study of the star formation (SF) characteristics of two LITTLE THINGS dwarfs: DDO133 and DDO168. For each galaxy, we combine HI spectral line VLA radio interferometric observations in B-, C-, and D-configurations into one data set of high resolution and quality which allows an in depth investigation of their HI distribution and kinematics. We focus our interest on their SF characteristics extending current investigations of the Schmidt-Kennicutt law to the low luminosity, low metallicity regime. To do this, we combine our HI maps with GALEX ultraviolet, Spitzer infrared and, where available, CO data in order to measure the surface densities of HI, H_2 and the SFR surface density for the galaxies in our sample. We find a general lack of Spitzer 24 micron emission which fits in with our result that internal extinction is less than 0.1 mag, indicating a dust-poor ISM. Our results overlap with those published on a number of THINGS dwarfs and confirm the finding that the SF characteristics of dwarfs resemble those in the outskirts of spirals.

Verónica Firpo (Poster) -- *Chemodynamics analysis in the BCD galaxy Haro 15*

We present a detailed study of the physical properties of the nebular material in four star-forming knots of the blue compact dwarf galaxy Haro 15. Using long-slit and echelle spectroscopy obtained at Las Campanas Observatory, we study the physical conditions (electron density and temperatures), ionic and total chemical abundances of several atoms, reddening and ionization structure, for the global flux and for the different kinematical components. The latter was derived by comparing the oxygen and sulphur ionic ratios to their corresponding observed emission line ratios (the eta and eta' plots) in different regions of the galaxy. Applying the direct method or empirical relationships for abundance determination, we perform a comparative analysis between these regions. The similarities found in the ionization structure of the different kinematical components implies that the effective temperatures of the ionizing radiation fields are very similar in spite of some small differences in the ionization state of the different elements. Therefore the different gaseous kinematical components identified in each star-forming knot are probably ionized by the same star cluster. However, the difference in the ionizing structure of the two knots with knot A showing a lower effective temperature than knot B, suggests a different evolutionary stage for them consistent with the presence of an older and more evolved stellar population in the first. This is the first time that physical conditions are directly estimated for kinematical components of HII galaxies.

Yasuo Fukui (Talk) -- *Formation of super star clusters in galaxies*

Formation of high mass stars is a crucial process in the evolution of galaxies. Recent molecular observations toward super star clusters including many high mass stars have revealed that two giant molecular clouds appear to be colliding with each other and the clusters are formed in the compressed regions between the two clouds (e.g., Westerlund2, NGC3603, RCW38, M20 etc.). I will present recent results on these high mass star clusters and discuss their implications.

Jesus Gallego (Poster) -- *Metallicities and excitation conditions of a sample of low-mass star-forming galaxies at intermediate redshifts*

According to the hierarchical model accepted nowadays, low-mass galaxies represent the building blocks of the galaxy formation process, and hence, they are thought to play a critical role in galaxy formation and evolution. However, due to the difficulties in their observation and their modelation we still do not understand how dwarfs form and evolve in detail. To address this problem and shed some light on the evolution of this kind of objects we build and study the properties derived from deep VIMOS/VLT spectroscopy of a sample of low mass field galaxies located at intermediate redshift, almost on the observational limit. This way we manage to analyse the properties of what seem to be the remaining first units of galactic formation that finally did not merge or were accreted by more massive galaxies and that for being younger than those in the local universe are thought to better preserve cosmological information extremely valuable for testing models of galaxy formation and evolution. In this contribution we focus on the metallicities and excitation of a sample of low-mass star-forming galaxies at intermediate redshifts.

Daniel Harbeck (Poster) – *Intermediate Old Star Clusters in a Young Starburst: The case of NGC 5253*

We investigate the star cluster population in the outer parts of the starburst galaxy NGC 5253 using archive images taken with the Hubble Space Telescope's Advanced Camera for Surveys. Based on the F415W, F555W, and F814W photometry ages and masses are estimated for bona-fide star cluster candidates. We find three potentially massive ($\geq 10 \times 10^5$ Msun) star clusters at ages of order of 1-2 Gyr, implying, if confirmed, a high global star formation rate in NGC 5253 during that epoch. This result underlines earlier findings that the current star burst is just one episode in an very active dwarf galaxy, and shows how star clusters can play an important role in understanding the mode of star formation in a dwarf galaxy.

Volker Heesen (Talk) – *Radio continuum emission as a star formation tracer in dwarf galaxies*

Radio continuum emission in galaxies is an extinction free star formation tracer. At cm-wavelengths the radio emission consists of two components, thermal free-free emission and non-thermal synchrotron emission. Both are a consequence of massive star formation, the thermal emission being generated in the associated HII-regions and the non-thermal emission being due to cosmic ray electrons released in supernovae. We present a detailed comparison of the radio continuum emission in THINGS galaxies with other star formation tracers, namely GALEX FUV and Spitzer 24 mu emission, on a spatially resolved basis (1.2 kpc). Calibrating the resolved radio-SFR correlation, we compare our results with the well-established Condon relation. Using this preparatory work we present the deepest ever obtained radio continuum map of the dwarf irregular galaxies IC10 and IC1613. We present a spatially resolved comparison of the local SFR with the radio continuum emission and study the validity of using radio continuum as a star formation tracer. Finally, we investigate to what extent the fraction of thermal and non-thermal emission in dwarf galaxies is different to that in spiral galaxies.

Kimberly Herrmann (Talk) -- *Stellar Surface Brightness Profiles of Dwarf Galaxies*

Radial stellar surface brightness profiles of spiral galaxies can be classified into three types: the light falls off with (I) a single exponential throughout the observed extent, or with one exponential out to a break radius and then falls off (II) more steeply ("truncated") or (III) less steeply ("anti-truncated"). Single and double exponentials are also found in dwarf disk galaxies. Why should the disk light fall off exponentially? What causes the down-bending and up-bending breaks? We have been re-examining the multi-wavelength stellar profiles of 141 disk-like dwarf galaxies, primarily from Hunter & Elmegreen (2006, 2004). Each dwarf has data in up to 11 wavelength bands highlighting stellar populations of various ages: FUV and NUV from GALEX, UBVJHK and H-alpha from ground-based observations, and 3.6 and 4.5 microns from Spitzer. I will highlight results from a human-assisted computer fitting of this data set, including: (1) statistics of break locations and other fit parameters as a function of total luminosity, profile type, and wavelength, (2) color trends and radial mass distribution as a function of profile type, and (3) the relationship of the break radius to the kinematics and density profiles of atomic hydrogen gas in 40 dwarfs of the LITTLE THINGS subsample. The resulting intriguing trends, including relationships between dwarfs and spirals, may shed some light on how galaxies form and evolve. We gratefully acknowledge funding for this research from the National Science Foundation (AST-0707563).

Ana Maria Hidalgo-Gamez (Talk) -- *Star Formation Rates in dwarf spiral galaxies*

We have determined the SFR for a sample of dwarf spiral (dS) galaxies from their Halpha luminosity. The values obtained are lower than for normal spiral galaxies, including Sm. Also, their gas surface density seems to be larger for the same SFRs, indicating that dS need a larger amount of gas to form stars. In addition, the LF was determined for them, indicating that this kind of galaxies form stars of 15-30 Msolar but do not form HII regions more luminous than logL= 39, which are typical of irregular galaxies.

Leslie Hunt (Talk) -- *The Enigma of Low-Metallicity Starbursts*

Most galaxies in the Local Universe and at high redshift follow well-defined scaling relations of metallicity (Z), stellar mass (M*), and star formation rate (SFR). However, there is a class of galaxies, metal-poor starbursts -- rare locally but more common in the distant universe -- that deviates significantly from these scaling relations; they have high SFR for a given M*, and excess M* for their low metallicity Z. This presentation characterizes Z, M*, and SFR for populations of these deviant low metallicity starbursts, selected from blue compact dwarfs at redshift 0, luminous compact galaxies at redshift 0.3, and Lyman Break galaxies at redshifts 1-3. We compare deviations from the main scaling relations with new theoretical models and show that the deviations depend on the size, density, and dynamical times of the galaxies themselves and their star-forming complexes, as well as on their gas fraction. The observed deviations from the 'main sequence' of star formation and the mass-metallicity relation are thus given a new motivation, and we propose that these relations do not truly evolve, but rather are defined through selection effects by different galaxy populations at different cosmological epochs.

Deidre Hunter (Poster) -- *Comparison of gas surface density profiles and star formation in the LITTLE THINGS dwarfs*

What role does the gas play in determining the structure of the stellar disk in dwarf galaxies? To address this question, we are comparing the HI gas surface density profiles with star formation properties in the LITTLE THINGS sample, looking for correlations in the way the gas density declines with radius and properties of the stellar disk. Here we examine the relationship of the integrated star formation rate to central gas density and metallicity.

Brad Jacobs (Poster) – *Rough Estimates of the Stellar Histories of Dwarfs From HST Photometry of the Red and Asymptotic Giant Branches*

Observations of resolved stellar populations in nearby galaxies reveal detailed histories of their star formation. A favored technique for interpreting these histories involves synthesizing the observed color-magnitude diagrams, which are often based on photometry from the Hubble Space Telescope. Several hundred galaxies in the Local Volume (within 10 Mpc) have been observed with Hubble, but most do not reach sufficient depths to warrant full-scale color-magnitude diagram synthesis. However, the bright stars in a galaxy do contain meaningful information on the galaxy's stellar history. There are several types of massive stars with high luminosities that trace recent star formation, while high luminosity stars that are older than a few Gyr are mainly limited to the Red and Asymptotic Giant Branches (RGB and AGB). In this work we focus on these older stars and how their ages are

constrained by the ratio of number stars occupying the AGB and RGB. In addition to age, the metal content of these populations also influences their relative numbers at a given time. It is possible to estimate the metallicity of stars on the RGB from their colors, and thus the combination of color of the RGB and the AGB/RGB ratio provide first order estimates of their age and metallicity. We present measurements for a sample of Local Volume galaxies observed with Hubble and consider the results in the context of such factors as luminosity, morphology, and environment. In addition, we examine some systematic issues that arise in the application of these techniques.

Bethan James (Talk) -- *Exploring the Cause and Effect of Star-Formation in Blue Compact Dwarf Galaxies with IFU Observations*

An understanding of Blue Compact Dwarf galaxies (BCDs) and the star-formation occurring within their chemically un-evolved environments, is fundamental in our understanding of the early universe. Spatially resolved spectroscopic analyses of the closest systems of this kind allow us to explore their complex physical, chemical and kinematical properties with a richness of details that is not achievable at high redshift. A 2D mapping of the metal- and Balmer-line properties throughout each galaxy, identifies the cause and effect of star-formation within these systems, spatially resolves their star-formation properties, and assesses how all this affects their chemical nature. In this talk I will present a detailed integral field unit (IFU) investigation of a sample of BCDs, each known to have disturbed morphologies and anomalous chemical properties. I will show how maps of stellar population ages and star-formation rates derived from Hbeta and Halpha emission reveal signs of propagated star-formation, and how this population-age gradient can be linked to variations in chemical abundances across each system. I will demonstrate how the kinematical maps created from separated velocity profiles of these lines have provided insight into the role of galaxy interactions in star-forming episodes and chemical recycling within dwarf galaxies. I will present maps of the WR populations within two BCDs, Mrk996 and Haro11, and describe how we have isolated N enrichment to the broad velocity component gas, which is attributable to WR N-rich winds. I will conclude by showing how the strength of IFU observations can also be powerful in revealing the star-formation history of dwarf galaxies, when combined with HST-COS FUV observations that allow for a direct comparison between neutral and ionized phases of the ISM.

Steven Janowiecki (Poster) -- *The Evolutionary Status of Blue Compact Dwarf Galaxies*

We are interested in the role and context of Blue Compact Dwarf Galaxies (BCDs) in dwarf galaxy evolution, in particular whether all gas-rich dwarf galaxies could evolve to or from a BCD-like phase, or if BCDs are a permanently unique type of dwarf galaxy. For our sample of 20 BCDs, we use multi-wavelength photometry to construct Spectral Energy Distributions from the UV to IR which we fit with models to determine physical properties and star formation histories. We also fit and decompose the surface brightness profiles in multiple filters to separate the starburst and underlying components. VLA HI maps are also used to understand the structure and motion of neutral gas in these systems. With this detailed study of BCDs we will better understand their relation to other dwarf galaxies, and whether there exist evolutionary pathways between them.

Megan Johnson (Talk) – *The Stellar and Gas Kinematics of LITTLE THINGS Dwarf Irregular Galaxies NGC 1569, DDO 168, and DDO 46*

We present stellar velocities and velocity dispersions of three LITTLE THINGS dwarf irregular galaxies, NGC 1569, DDO 168, and DDO 46, and compare them to the HI kinematics. The stellar data were obtained through long-slit spectroscopic observations on the Kitt Peak National Observatory''s (KPNO) Mayall 4-meter + Echelle spectrograph. We observed each object at four position angles, the photometric major and minor axes and +/- 45 degrees from the major axis, and we determine the stellar velocities and velocity dispersions as a function of radius. These stellar kinematics are then compared to high-resolution 21 cm VLA/EVLA observations of the neutral hydrogen gas in the disks of the three galaxies. We use the HI data to determine the overall motions of the gas as well as the maximum rotation speed, V_{max}, of the galaxies. Combining V_{max} with the stellar velocity dispersion, σ_z, we obtain a measure, V_{max}/σ_z, that assesses the three-dimensional shape of the objects in our sample.

Oskar Karczewski (Poster) -- *A Multi-wavelength MOCASSIN Model of the Magellanic-type Galaxy NGC 4449*

We present a self-consistent photoionisation and dust radiative transfer model of the blue compact dwarf galaxy NGC 4449. In our model the central cluster is described by a synthetic stellar spectrum generated by STARBURST99 (Leitherer et al. 1999). We use MOCASSIN (Ercolano et al. 2003, 2005, 2008) to solve the radiative transfer for the coexisting gas and dust phases. Our best matching model of NGC 4449 reproduces the global optical emission line fluxes (Kobulnicky, Kennicutt & Pizagno 1999), the global Halpha luminosity (Hunter, van Woerden & Gallagher 1999) and the observed spectral energy distribution (SED) spanning wavelengths from the UV to sub-mm, and requires a bolometric luminosity of 6.25e9 Lsolar for the underlying stellar component, M_d/M_g of 1/680 and a mass of carbonaceous dust of 2.2e6 Msolar. The best matching input STARBURST99 spectrum suggests continuous star formation over the last 6 Gyr with a decreasing star formation activity, consistent with the findings of Annibali et al. (2008) and Gallagher, Hunter & Tutukov (1984). This modelling technique can be used to derive spatially resolved physical and chemical characteristics of dwarf galaxies. We intend to analyse the remaining galaxies in the Herschel Guaranteed Time Key Project: Dwarf Galaxy Survey (PI: Suzanne Madden) to study dust characteristics in relation to other global parameters. Where integral field unit (IFU) data exists, spatial variation in emission line intensities will be used to construct morphologically-accurate 3D representations of galaxies.

Carolina Kehrig (Talk) -- *Integral Field Spectroscopy of Blue Compact Dwarf Galaxies with Wolf-Rayet signatures*

Blue compact dwarf galaxies (BCDs) are gas-rich systems with low metal content that have experienced recent or ongoing violent star formation. The subset of BCDs whose spectra show broad emission features (e.g blue bump around 4600-4750 A) due to Wolf-Rayet (WR) stars are known as WR galaxies and represent dwarf systems with very high specific star formation rate. Our goal is to use integral field spectroscopy to analyse the spatial distribution of the properties of the ionized gas (dust extinction, gas excitation, electron density and temperature, chemical abundances, kinematics, star-forming rate) in a sample of BCDs with WR signatures, and investigate how these properties are spatially correlated with the distribution of WR stars. We will present and discuss maps of nebular

emission-lines, diagnostic emission-line ratios, star-forming rates and physical-chemical properties of the warm interstellar medium.

Amanda Kepley (Talk) -- *Uncovering Embedded Star Formation in Dwarf Starburst Galaxies*

The physics of star formation in dwarf starburst galaxies may be very different than in the Milky Way due to their low mass, low metallicities, and higher star formation rates. By studying the young star-forming regions in dwarf starburst galaxies, we can gain a better understanding of how star formation proceeds in these environments. Unfortunately, even in dwarf galaxies, young star-forming regions have copious amounts of dust and gas. Radio observations of continuum and recombination line emission can penetrate the dust and gas in these regions to reveal the gas ionized by the young massive stars. The properties of this gas reveals important information both about the properties of the massive stars, but also the properties of the gas that was ionized. I will be present state of the art observations of young star-forming regions in dwarf starburst galaxies taken with the VLA, EVLA, and GBT and what these observations reveal about star formation in dwarf starburst galaxies.

Suk Kim (Poster) -- *Extended Virgo Cluster Catalog (EVCC) using SDSS DR7 Data*

We established a new photometric and spectroscopic catalog of galaxies in the extended Virgo cluster environment using the SDSS DR7 data, the extended Virgo cluster catalog (EVCC). The EVCC covers an area 5.4 times larger (750 deg^2) than the footprint of the classical Virgo cluster catalog by Binggeli and collaborators. We focused on galaxies with available SDSS spectra and heliocentric radial velocities less than 3,000 km/sec. Our selection process secured a total of 1,332 galaxies of which 556 are not included in the VCC. Based on SDSS imaging and spectroscopic data, we introduced two complementary galaxy classification schemes. In addition to the traditional morphological classification based on optical images ("Primary Morphology"), we also characterized galaxies from their spectroscopic features ("Secondary Morphology"). For each EVCC galaxy we measured u, g, r, i, z photometric and structural parameters using a sophisticated data reduction pipeline within SExtractor. The EVCC represents a wide range in galaxy densities that is quite different from the inner cluster region. This allows to study the morphological evolution/transformation and the associated star formation activities of galaxies on their first infall into the Virgo cluster, thereby complementing ongoing or planned Virgo cluster surveys at various wavelengths.

Ged Kitchener (Poster) -- *Deep radio continuum observations of the dwarf irregular galaxy IC1613*

We present the deepest 6 cm radio continuum images ever obtained of the nearby dwarf irregular galaxy IC1613. The observations were obtained with the EVLA in D-configuration. The rms noise reached is of order 8.5 muJy/beam. The radio continuum emission at this wavelength is a mix of thermal and (predominantly) non-thermal radiation. Both mechanisms are related to recent star formation. We will compare our results with ancillary data from LITTLE THINGS that trace star formation such as Halpha and GALEX FUV images and relate the radio continuum flux density on a spatially resolved basis with the observed star formation rate.

Mina Koleva (Talk) – *Different mode of star-formation in pre-dwarf elliptical galaxies - clue from their radial star-formation histories*

We analysed the optical, 2d spectra (VLT/FORS1,2) of 19 early-type dwarf galaxies (5 transition type dwarfs, TTDs and 14 ellipticals, dEs) via fossil methods. We found that the star formation persists over longer timescales in the inner regions than in outskirts of our dwarf galaxies. The majority of our TTD galaxies have positive or slightly negative metallicity gradients, suggesting a different star formation efficiency than in the majority of the dEs. We find variety of metallicity gradients in our dwarfs (from flat to very steep profiles) which do not correlate with their luminosities, velocity dispersions, central ages or age gradients. We speculate that the dwarfs with steep metallicity gradients could have originated from blue compact dwarfs and those with flat profiles from dwarf irregulars and late-type spirals as supported by recent theoretical works.

Mark Krumholz (Invited Talk) -- *Atomic and Molecular Gas in Dwarf Galaxies*

Recent theoretical and observational results have led to two important and general conclusions about star formation: first, that stars form exclusively in molecular gas, and, second, that the transition between the atomic and molecular phases of a galaxy's interstellar medium depend critically on its metal content. In this review I discuss the evidence for these two conclusions, and their implications for low metallicity star-forming systems such as dwarfs.

Ryan Leaman (Talk) -- *The Comparative Chemical Evolution of an Isolated Dwarf Galaxy: A VLT and Keck Spectroscopic Survey of WLM*

I will present a comparison of the metallicities of RGB stars within the isolated Local Group dwarf irregular galaxy WLM with respect to the well-studied Local Group dwarf spheroidal galaxies (dSphs) and Magellanic Clouds. Despite its high gas fraction and extreme isolation, the global metal abundances are consistent with the luminosity-metallicity relation of the dSphs, and its age-metallicity relation is similar to the luminous dSph Fornax and the SMC. This suggests that environmental processing may more strongly affect the kinematics and structure of low mass systems than their chemical evolution, which is still dictated largely by halo mass. However comparison of the spatial distribution of [Fe/H] in WLM, the Magellanic Clouds, and a sample of Local Group dSphs shows an apparent dichotomy, in the sense that the dIrrs have statistically flatter radial [Fe/H] gradients than the low angular momentum dSphs. We discuss this, and a comparison of intrinsic metallicity spreads within dwarf galaxies and star clusters, in the context of recent simulations on SF in low mass systems.

Vianney Lebouteiller (Talk) -- *The ISM structure in low-metallicity environments probed by the far-infrared cooling lines*

The bright far-infrared (FIR) cooling lines are unobscured star-formation tracers potentially detectable at any redshift. Among these lines, the [CII] 157 μm is often used as a star- formation rate (SFR) tracer since its emission folds into the photoelectric effect paradigm that is tightly linked to the energy input from massive stars. However, correlations between [CII] and other SFR tracers such as H-alpha, 24 μm warm dust emission, or the FIR luminosity show a wide spread that is not yet fully understood. The origin of the spread must be at least partly due to different timescales of star-

formation probed by the various tracers.

Nearby star-forming dwarf galaxies, with their elusive star-forming reservoir, are prime targets to (1) constrain the origin of [CII] and the other FIR lines in a low dust-to-gas ratio environment, and (2) calibrate [CII] as a SFR tracer in such conditions. In order to understand how the UV photons from young stars deposit their energy into the ISM and how the gas cools down, the spatial information is invaluable. I will present preliminary results from several Herschel key programs (SHINING, HERITAGE, Dwarf Galaxy Survey) targeting several HII regions in the Magellanic Clouds - including 30 Doradus - and also the closest starburst galaxy known, IC10, with a metallicity between the SMC and the LMC. For the first time we are able to spatially resolve the emission of [CII] 157μm, [OI] 63 μm, 145 μm, [NII] 122 μm, and [OIII] 88 μm in these sources.

The most unexpected result comes from the prevalence of the ionized gas in all the regions, showing that UV photons are able to escape the star-forming regions to deposit a significant fraction of energy on relatively large scales. We predict that the [OIII] 88 μm line will be the brightest FIR line in the metal-poor sources that will be observed with ALMA at highredshift. We also demonstrate a triple origin of [CII], from the photodissociation regions, from the photoionized gas, and from the diffuse neutral gas. I will discuss how these results will help us to understand and constrain [CII] as a star-formation tracer in unresolved galaxies.

Janice Lee (Invited Talk) – *Understanding Star Formation in Dwarf Galaxies: Step One*

What are the principle mechanisms that globally drive, regulate and extinguish star formation in dwarf galaxies? From an observational perspective, the first step required to answer this question involves the quantitative measurement of star formation. In this opening talk, I will review progress in the empirical characterization of activity and the calculation of star formation rates in low-mass systems, highlighting the challenges inherent in studying this particular galaxy population.

Federico Lelli (Talk) -- *Blue Compact Dwarfs: is internal dynamics the key?*

Blue Compact Dwarfs (BCDs) are characterized by two striking properties: i) strong concentrations of HI towards the central starburst region; and ii) steep central velocity gradients. Both properties are not observed in more quiescent dwarf irregulars (dIrrs). We are studying a sample of BCDs using both new and archival HI data and in several cases we are finding that the steep velocity gradient is due to a steeply-rising rotation curve that flattens in the outer parts. This points to a strong concentration of mass in the central regions. We decompose the rotation curves into mass components using a novel approach: we estimate the stellar mass-to-light ratios using HST observations, which resolve these BCDs into single stars and thus provide star-formation histories and stellar masses. Remarkably, it appears that baryons (gas and old stars) constitute an important fraction of the total dynamical mass. These are striking differences with respect to typical dIrrs, which usually have slowly-rising rotation curves and are thought to be entirely dominated by dark matter. We discuss the implications of these results on the evolution of dwarf galaxies and in particular on the properties of the progenitors and descendants of BCDs. We also find that radial motions, either inflows or outflows, are common in BCDs. Finally, we discuss interactions/mergers or cold gas accretion as likely explanations for the triggering of the starburst.

Adam Leroy (Invited Talk) – *Observations of Dust in Dwarfs*

I will review observations of dust in dwarf galaxies, focusing on what we have learned from observing infrared and sub-millimeter continuum emission. I will focus on the dust-to-gas ratio and its dependence on environment, in particular metallicity, and the use of dust as an independent ISM tracer. I will also mention depressed PAH emission and long-wavelength "excesses", two ways in which the dust SEDs of dwarf galaxies differ from those of large spiral galaxies. Finally, I will show observations of the dust-to-gas ratio that suggest that it plays a major role regulating the formation of star-forming gas in galaxies.

Ute Lisenfeld (Talk) -- *The dust SED in the dwarf galaxies: The case of NGC 4214*

The dust emission from many dwarf galaxies shows an excess emission in the submillimeter range compared to spiral galaxies. Different explanations have been proposed to account for this, ranging from different dust properties, large abundances of cold dust, or spinning grains. In order to investigate this issue in detail, we have carried out a detailed modeling of the dust heating and emission of the nearby, starbursting dwarf galaxy NGC 4214. Due to its proximity and the great wealth of data available from the UV to the mm-range (from Galex, Hubble, Spitzer, Herschel, Planck and IRAM) a detailed modeling of the dust heating and emission is possible. A key point of our modeling is that we distinguish the emission from HII region and their associated PDRs and the emission from diffuse dust. For both components we apply templates from the literature (Groves et al. 2005 for the emission of HII+PDR region, and the library of Popescu et al. 2011 describing the diffuse emission in galaxy disks) derived with a detailed modeling based on a realistic geometry and including radiation transfer. Due to the wealth of data available for NGC 4214, very few free parameters are present in the problem. We find that we can fit the dust emission of NGC 4214 to a large extent (but not perfectly) with these models. I will present the results, identify the agreements and discrepancies between data and model and discuss the conclusions.

Angel R. Lopez-Sanchez (Talk) -- *Neutral and ionized gas in Blue Compact Dwarf Galaxies*

We are obtaining deep multiwavelength data of a sample of nearby blue compact dwarf galaxies (BCDGs). Here we present some results combining the 21-cm HI maps obtained with the Australia Telescope Compact Array and the 3D optical spectroscopy data obtained using WiFeS instrument at the 2.3m ANU telescope at the Siding Spring Observatory. We analyze their chemical abudances and the intriguing kinematical features found in both the neutral and the ionized gas of these objects. The results reinforce the hypothesis that interactions with or between low-luminosity dwarf galaxies or HI clouds are the main trigger mechanism of the star-forming bursts in BCDGs (Lopez-Sanchez 2010). In particular, I'll present the results of the multi-wavelength analysis of NGC 5253 (Lopez-Sanchez et al. 2012).

Mordecai Mac Low (Invited Talk) – *What are the links between turbulence, kinematics and galaxy structure in star formation in dwarfs?*

Galactic structure and interactions determine the global distribution of mass in the form of stars and gas. Gravitational instability acts to gather mass together, first in clumps and spirals, depending on the rotation and structure of the galaxy; and then in collapsing clouds that quickly become molecular

as they reach high densities. Turbulence, along with magnetic fields, shear, and thermal pressure, resists collapse, determining the effectiveness of gravitational instability in driving star formation. In this review I will consider how these general principles lead to different outcomes in dwarf galaxies than in classical disk galaxies, because of the dwarfs lower metallicities, differential rotation, and surface densities.

Suzanne Madden (Talk) -- *Herschel Dwarf Galaxy Surveys: effects of metallicity on gas and dust properties*

Local Universe dwarf galaxies provide a rich variety of conditions to study star formation and feedback on the interstellar medium in conditions that may be representative of early universe environments. Their low metallicity has a striking impact on the physical processes that take place to shape the structure of the interstellar medium (ISM). The Herschel Dwarf Galaxy Survey has targeted 50 low metallicity galaxies in photometry and spectroscopy and highlights the enigmatic dust and gas properties in low metallicity ISM. The dust reservoirs of dwarf galaxies are certainly not negligible, as originally perceived, given their relatively low metal abundance. Modelling of the mid-infrared (MIR) to submillimetre (submm) dust Spectral Energy Distribution (SED) of low metallicity galaxies also shows notable differences compared to their more metal-rich counterparts. For example an excess in the expected SED beyond ~ 450 microns is seen to date, only in low metallicity environments. Often the excess is only seen at wavelengths longer than Herschel, and then LABOCA on APEX is necessary to uncover the excess. The nature of this submm excess, whether it is cold dust or spinning dust or dust of completely different optical properties, in not yet clear. The nature of the molecular clouds, photodissociation regions and ionized phases of dwarf galaxies is very different from those of their more metal rich counterparts. While molecular gas is considered to be an essential ingredient for star formation, detecting CO, the standard tool to probe the molecular hydrogen reservoir in galaxies, has always been a challenge in low metallicity dwarf galaxies. Surveys of CO show that it is an unreliable tracer of molecular gas in dwarf galaxies. The FIR fine structure line survey reveals remarkably high [CII]/CO(1-0) ratio compared to their dustier starburst counterparts, suggesting a very clumpy environment and the presence of a substantial reservoir of CO-dark molecular gas which is not traced by CO, but which may be residing in the

Dmitry Makarov (Talk) -- *Groups of dwarf galaxies in Local Universe*

We present a study of groups composed of dwarf galaxies only. These groups evolve outside massive concentrations of matter. Extremely metal-deficient galaxies like I Zw 18 could be found among them. As usual the groups of dwarfs consist of gas-rich blue galaxies with ongoing star formation. These groups constitute about 5% of all groups in Local Supercluster, but taking into account selection effects this number can be increased in 5-6 times. The groups of dwarfs contain significant amount of dark matter. We present the results of spectroscopic survey of these systems with Russian 6-meter telescope.

Lidia Makarova (Poster) -- *A unique isolated dwarf spheroidal galaxy at D=1.9 Mpc*

We present a photometric and spectoscopic study of the unique isolated nearby dSph galaxy KKR25. The galaxy was resolved into stars with HST/ACS including old red giant branch and red clump. We have constructed a model of the resolved stellar populations and measured the star formation rate

and metallicity as function of time. The main star formation activity period occurred about 8 – 14 Gyr ago. These stars are mostly metal-poor, with a mean metallicity [Fe/H] ~ -1 -- -1.6 dex. About 62 per cent of the total stellar mass was formed during this event. There are indications of intermediate age star formation in KKR25 between 1 and 4 Gyr with no significant signs of metal enrichment for these stars. A long-slit spectroscopy was made with the Russian 6-m telescope. We have discovered a planetary nebula in KKR25. This is the first PNe in a dwarf spheroidal galaxy outside the Local Group. We have measured a metallicity of the object to be -1.4 dex and a radial velocity Vh = -79 km/s. We have analysed stellar density distribution in the galaxy body. The galaxy has an exponential disk and a central light depression. We discuss an evolutional status of KKR25, which belongs to a rare class of very isolated dwarf galaxies with spheroidal morphology.

Kristen McQuinn (Talk) -- *The Starburst Mode of Star Formation in Dwarf Galaxies*

A significant number of dwarf galaxies in the local extragalactic environment show signs of a starburst mode of star formation. Understanding the starburst phenomenon is a key component to understanding the evolution of dwarf galaxies. Using HST optical observations of resolved stellar populations in 20 nearby starburst dwarf galaxies, the defining temporal and spatial characteristics of the burst events can be measured by reconstructing the star formation histories (SFHs) of the sample. Contrary to the short 5-10 Myr timescales often assumed for starbursts, the SFHs show elevated rates of SF sustained over a few hundred Myr. Further, the spatial distribution of young (<250 Myr) blue helium burning stars show that the spatial distribution of the starbursts lie on a continuum from highly centrally concentrated to more distributed. These longer lasting starbursts that are not solely co-located with the central regions of highest gas density create a new paradigm for the starburst mode of star formation in low mass galaxies. These results suggest that starbursts have a global triggering mechanism, are self-regulating, and have a larger impact on the evolutionary state of the host galaxy than previously thought.

Desika Narayanan (Talk) -- *Fueling Star Formation: How to Determine the Gas Content in a Dwarf Galaxy*

The molecular gas content is one of the most fundamental physical quantities one can measure in a galaxy. Despite the obvious importance of this quantity, however, measuring the H_2 mass is an incredibly difficult task. Typically, one observes CO as a proxy for the observationally elusive H_2, and converts to an H_2 mass via a CO-H_2 conversion factor (X_{co}). Unfortunately, our understanding of X_{co} is rudimentary at best. While X_{co} clearly depends on the physical conditions in the ISM of a galaxy (i.e. the H_2 formation/destruction pathways which depend on UV radiation fields, and hence SFRs, CO formation/destruction pathways which depend primarily on metallicity, and radiative transfer), the community traditionally uses a constant value for X_{co}. In this talk, I will present a general model for the CO-H_2 conversion factor. I will describe how X_{co} is dependent on the physical conditions in the ISM of galaxies (including metallicity), and show how it may be derived from observational quantities alone. I will then apply this model to recent observations in order to derive the H_2 gas content of nearby dwarf galaxies.

Se-Heon Oh (Talk) -- *High-resolution rotation curves and mass models of LITTLE THINGS*

We present high resolution rotation curves and mass models of a sub-sample of nearby dwarf galaxies culled from LITTLE THINGS. The high-resolution HI observations (~6" angular; < 2.6 km/s velocity resolution) of LITTLE THINGS enable us to derive reliable rotation curves of the galaxies in a homogeneous and consistent manner. The rotation curves are combined with Spitzer archival 3.6 micron and ancillary optical BV images to construct mass models. The high quality multi-wavelength dataset significantly reduces observational uncertainties and thus allows us to examine in detail the dark matter distribution in the galaxies. We compare the derived dark matter distributions of the sample galaxies with those of dwarf galaxies from The HI Nearby Galaxy Survey (THINGS) and new LambdaCDM simulations in which the effect of baryonic feedback processes is included. From this, we find that they are mostly consistent with each other in terms of (1) the rotation curve shape, showing a linear increase in the inner regions, and (2) a shallow slope of the mass density in the inner parts, resulting in dark matter halos characterised by a core. In addition, we report three LITTLE THINGS dwarf galaxies of which steep inner- density slopes (~1.0) and rotation curve shapes show a good agreement with those of dark matter halos with central cusps predicted from dark-matter-only LambdaCDM simulations. The cusp-like dark matter distributions of the galaxies are more likely to be consistent with those found in recent hydrodynamic N-body SPH simulations that central cusps still remain in low mass dwarf galaxies where SN feedback is inefficient.

Juergen Ott (Poster) -- *VLA-ANGST: Data Release*

VLA-ANGST ("Very Large Array -- ACS Nearby Galaxy Survey Treasury") is an NRAO Large Program to observe 35 nearby (distance <4Mpc) galaxies in the 21cm line of neutral atomic hydrogen (HI). All VLA-ANGST galaxies were observed at high spatial (~6", corresponding to ~100pc) and high spectral (0.65-2.6 km/s) resolution in the VLA B, C, and D array configurations. The galaxies are selected to map all gas-rich and actively star forming objects that are included in the "ACS Nearby Galaxy Survey Treasury" (ANGST). ANGST is a systematic survey to establish a legacy of uniform multi-color photometry of resolved stars for a volume-limited sample of nearby galaxies (D < 4 Mpc). The ANGST observations allow derivation of spatially resolved star formation histories (SFHs). The high spatial resolution of the VLA-ANGST observations allow meaningful comparisons to these ANGST SFH maps, as well as to surveys at other wavelengths such as LVL, KINGFISH, and 11HUGS. In addition, THINGS, LITTLE THINGS, SHIELD, and VLA-ANGST all follow similar observation strategies and data reduction procedures for a combined sample of >100 galaxies. The VLA-ANGST data products (data cubes, HI spectra, moment maps) are now publicly available at http://www.nrao.edu/~jott/VLA-ANGST.

Juergen Ott (Poster) -- *Giant Molecular Clouds in the Large Magellanic Cloud*

With the Magellanic Mopra Assessment (MAGMA), we have recently completed a CO imaging survey of ~450 giant molecular clouds (GMCs) in the Large Magellanic Cloud (LMC). In this poster, I describe some results and ongoing work that deepen our understanding of GMC formation and evolution in the LMC. GMCs in the LMC appear to have lower mass surface densities than GMCs in nearby spirals (assuming that CO is a reliable tracer of molecular hydrogen) and, unlike the situation in the Galaxy, low-mass clouds contribute the bulk of the LMC's total molecular mass. The velocity gradients across GMCs are similar to those found in the surrounding atomic gas and do not appear indicative of rotation, contrary to a simple top-down model for GMC formation. We have examined the

location of GMCs relative to young stellar objects (YSOs), finding some evidence that high-mass YSOs are better associated with CO emission. Sightlines with high HI column density and HI peak brightness have a higher probability of association with CO, although the detection fraction remains below 30% across the LMC. We find a weak anti-correlation between the detectability of CO and the HI velocity dispersion, which we interpret as a time delay between cloud compression and CO molecule formation.

Anahi Caldu Primo (Poster) -- *Velocity Dispersion Differences of the Atomic and Molecular Gas in Nearby Galaxies*

We investigate the relation between the velocity dispersion of the atomic and molecular gas phases in a sample of 28 nearby galaxies, including dwarf galaxies that are detected in CO emission. The HI data is drawn from the THINGS Survey (Walter et al. 2008) and the CO data is from the IRAM HERACLES Survey (Leroy et al. 2009). We are investigating possible changes in the ratio of the atomic to molecular dispersion as a function of different parameters (e.g. radius, star formation rate density, total gas surface density) by employing stacking techniques to improve the signal-to-noise ratio of the data. We conclude that the ratio of atomic-to-molecular gas dispersion is greater than unity but that it is surprisingly constant at our working resolution on scales of ~500 parsec.

Aurelie Remy (Talk) -- *The Far Infrared view of the interstellar medium of dwarf galaxies: unusual dust properties of dwarfs galaxies as uncovered by the Herschel Dwarf Galaxies Survey*

The FIR continuum is a powerful tracer of the chemical and physical conditions of the interstellar medium (ISM) of galaxies. The ISM of dwarfs galaxies poses a number of interesting puzzles in terms of the abundance of dust grains, the dust composition and even the FIR emission processes. New 70 to 500 μm observations of dwarf galaxies with our Herschel Key Program, The Dwarf Galaxy Survey, are designed to adress these questions in a systematic way. We are uncovering unusual properties in low metallicity sources: for example an excess submillimeter (submm) emission is often apparent near or beyond 400/500 μm rendering large uncertainties in the dust properties, even for something as fundamental as dust masses. To date, this submm excess seems to be uniquely prominent in low metallicity environments and its origin is still quite uncertain. Moreover large masses of cold dust have been uncovered, inconsistent with the lower metallicities, even when a submm excess is not present. We will present the first results of the analysis of the Herschel photometric data for our Dwarf Galaxies Survey. We present Herschel color-color diagrams and interpret these with the aid of our SED model. Star Formation Rates and Gas-to-Dust ratios as a function of metallicity will be discussed. A comparison with the more metal-rich galaxies from the Herschel-KINGFISH sample will be performed.

Soo-Chang Rey (Poster) -- *Ultraviolet Color-Magnitude Relations of Early-type Dwarf Galaxies in the Virgo Cluster*

We present ultraviolet (UV) color–magnitude relations (CMRs) of early-type dwarf galaxies in the Virgo cluster, based on Galaxy Evolution Explorer (GALEX) UV data and the Extended Virgo Cluster Catalog (EVCC). We find that dwarf lenticular galaxies (dS0s) show a surprisingly distinct and tight locus separated from that of ordinary dEs, which is not clearly seen in previous CMRs. The dS0s in UV CMRs follow a steeper sequence than dEs and show bluer UV–optical color at a given magnitude. We explore the observed CMRs with population models of a luminosity-dependent delayed

exponential star formation history. The observed CMR of dS0s is well matched by models with relatively long delayed star formation. dS0s are most likely transitional objects at the stage of subsequent transformation of late-type progenitors to ordinary red dEs in the cluster environment. Most early type dwarf galaxies with blue UV colors (FUV-r < 6 and NUV–r < 4) are identified as those showing spectroscopic hints of recent or ongoing star formation activities. In any case, UV photometry provides a powerful tool to disentangle the diverse subpopulations of early-type dwarf galaxies and uncover their evolutionary histories.

Andrew Rigby (Poster) -- *Triggering and Regulation of Extragalactic Star Formation - J1023+1952 as a unique laboratory*

We present a study of the role of environment in triggering extragalactic star formation, using high-resolution imaging from the HST WFC3 in the F547M filter and ground-based multi-band imaging of the interacting galaxy system Arp 94 (NGC 3227/6). The system includes a tidal dwarf galaxy candidate named J1023+1952 at the intersection of two tidal streams wrapped around the two galaxies, which contains an unusual star formation dynamic. Despite having similar column density in H_2 and HI right across the dwarf, ongoing SF occurs only the southern half. We compare color-magnitude diagrams and mass functions for stellar clusters in different regions in each galaxy in the system - in particular, the bar and spiral arms of NGC3227 and the active southern half of J1023+1952 - with the goal of determining the origin of the triggering mechanism in these locally different environments.

Lucia Rodriguez-Munoz (Poster) -- *Physical properties from deep spectroscopy of star-forming dwarf galaxies at intermediate redshift*

Dwarf galaxies remain as one of the most important and missing pieces of the great puzzle of formation and evolution of galaxies. Due to their low luminosities, their study has been mainly biased to the local universe or clusters, which implies a certain limitation in our knowledge of their formation redshift and properties along the cosmological time, strong observational tests to recent models of formation and evolution of low-mass galaxies. Using the multiwavelength database RAINBOW, that provides photometric redshifts and masses estimations, we selected a representative sample of dwarf galaxies in the EGS and GOODS-S cosmological fields. We considered two different criteria: objects with stellar mass (Mstellar < 10^8 Msun in the 0.3<z<1 range, and the classic definition of Blue Compact Dwarf galaxies (MB,0 > -18.5 , (B-V)0 < 0.6, Seff,B,0 < 23 mag/arcsec²). We present the results of the spectroscopic study of our sample, carried out using own spectra obtained with VLT/VIMOS and complemented with previous data from DEEP and VVDS surveys. These observational data provide spectroscopic redshifts and measurements of emission lines such as [OII], Hbeta, [OIII] and Halpha that allow the estimation of the physical properties. We also use some spectral indexes to estimate the epoch of formation of their stellar populations.

Teresa Ross (Poster) – *Metallicity Distribution Functions for Three Local Group Dwarf Galaxies*

We present metallicity distribution function's (MDF's) for Leo I, Phoenix and IC 1613, derived from photometry with the Wide Field Camera 3 (WFC3) aboard the Hubble Space Telescope (HST).

We obtained relatively high S/N photometry in V (F555W), I (F814W) and Ca H & K (F390M) for

giants. Using the medium band filter that covers the Ca H & K lines - the strongest metal absorption lines in the visible spectrum - in conjunction with the V and I band photometry, we calculate the stellar metallicities of individual stars with an expected accuracy of approximately 0.2 dex.

From the photometric metallicities we construct a MDF for Leo I containing almost 8000 stars, 10 times more stellar metallicities than have been obtained from the ground. For Phoenix and IC 1613 we have of order 3000 stars. While the metallicity accuracy in our study is lower than spectroscopic measurements, the larger number of data points provides some advantages in looking for rarer components of the population and possible substructure.

Future work: Our long term goals are to use the MDF's of these galaxies to constrain the formation and evolution of the system through an understanding of their chemical evolution.

Monica Rubio (Talk) -- *Dark gas in the Magellanic Clouds*

The Magellanic Clouds provide unique laboratories to study gas, dust, and star formation in low metallicity environments, resembling the early phases of galaxy formation in the universe.

The SMC and LMC have been extensively observed in CO line emission, but due to their low metallicities and dust content most of the molecular gas is likely to be in moderate extinction regions where CO is faint and mostly photo-dissociated. Dust emission is potentially a better molecular tracer, because of its independence from the photo-chemistry and density structure. Large envelopes of molecular dark gas not emitting in CO, are an important component of the molecular mass in low metallicty systems. We will present results of our LABOCA imaging program yielding images of giant molecular clouds at 10 pc resolution and probing dust properties in a range of environments. In combination with Spitzer (SAGE) and Herschel (HERITAGE) observations these data are used to determine dust temperature and surface density. Their spectral energy distributions (SED) confirm an important submillimeter excess from the dust emission.

Ruben Sanchez-Janssen (Talk) -- *AVOCADO: A Virtual Observatory Census to Address Dwarfs Origins*

AVOCADO aims at establishing firm conclusions on the formation and evolution of dwarf galaxies by constructing a homogeneous, multiwavelength dataset for a statistically significant sample of several thousand nearby dwarfs ($-18 < M_i < -14$). Using data from public surveys and Virtual Observatory tools, we have built UV-to-NIR spectral energy distributions that are fitted by a library of stellar population models. Physical properties derived both from SEDs and low-resolution spectra are further complemented with structural parameters that can be used to classify them morphologically. This unique dataset, coupled with a detailed characterization of each dwarf's environment, allows for a fully comprehensive investigation of their origins and to track the (potential) evolutionary paths between the different dwarf types. Here we will present an overview of the project and an investigation of the transition between the blue cloud and the red sequence at low galaxy masses by means of the UV-optical colour-magnitude diagram.

David Sand (Talk) -- *The Structure and Star Formation History of the New Milky Way Satellites*

The recent discovery of faint Milky Way (MW) satellites, along with faint companions to M31, has led to a confrontation between the expected number of satellite galaxies seen in Cold Dark Matter (CDM) simulations with those observed in recent very wide-field surveys. However, connecting simulations with observations is not trivial and only once we have a deep observational understanding of these new objects (e.g. their star formation history, structure, mass, internal dynamical state and gravitational interaction with the MW) can we robustly answer the question: Do the observed satellites fit into the standard CDM picture of structure formation? Thus motivated, we have undertaken a large, wide-field imaging program to study the new MW satellites with 6-8 meter class telescopes in order to measure their structural properties and star formation history via color-magnitude diagram fitting techniques, and will present our sample results here.

Joeri Schroyen (Talk) -- *The influence of internal dynamics and star-formation prescriptions on the star-formation modes and radial profiles in simulated dwarf galaxies*

We present Nbody-SPH simulations of the formation and evolution of isolated dwarf galaxies, using our adapted version of the Gadget2 code (Springel 2005). These adaptations include star formation prescriptions, stellar feedback, gas enrichment (Valcke et al. 2008), and most recently new radiative gas cooling curves (De Rijcke, in preparation). The isolation of our dwarf galaxy models permits us to unambiguously analyze the influence of the different parameters in our models/codes. After total mass as the first parameter, angular momentum plays the role of second parameter in determining dwarf galaxy behaviour (Schroyen et al. 2011). Rotation profoundly influences the mode of star formation, differentiating between a centralized/bursty star-formation mode in low angular momentum systems and an extended/continuous mode in high angular momentum galaxies. The latter behaviour is caused by the centrifugal barrier which prevents gas from rapidly sinking towards the galaxy center. All this is reminiscent of the dIrr/BCD dichotomy. Moreover, this has consequences for the radial stellar metallicity profiles, causing slowly rotating simulated dwarf galaxies to build up strong, negative metallicity gradients while fast rotating dwarfs appear to have flat metallicity profiles. Such behaviour has also been observed in real dwarfs (Koleva et al. 2009). We have also investigated the long-term survival of metallicity gradients. In giant late-type galaxies, resonant scattering of stars off transient spiral arms near corotation leads to widespread stellar migration (Roskar et al. 2008). Dwarf late-types lack such spiral patterns, although compact star-forming clouds and short-lived gaseous arms, curved by differential rotation, could also act as scatterers. Although the star formation prescriptions influence the strength of this scattering through the density threshold (0.1 - 100 amu/cm^3), our simulations, however, show radial migration of stars in dwarf late-type galaxies to be limited, allowing radial metallicity profiles to survive for up to a Hubble time.

Andreas Schruba (Talk) -- *The dust-to-gas ratio in dwarf galaxies*

We study the relationship between dust and gas abundance in a large set (50+) of nearby dwarf galaxies by combining sensitive HI data from the three large VLA surveys THINGS, LITTLE THINGS, and VLA-ANGST with archival Spitzer IR data. To improve our sensitivity to the typically faint IR emission, we average the Spitzer IR data in regions of common gas surface density or star formation rate surface density. We find that the dust-to-gas ratio within and between individual dwarf galaxies is a sensitive function of metallicity, gas surface density, and star formation rate. After constraining the dust-to-gas ratio, we invert the problem to place constrains on the amount of molecular gas near star

forming peaks. By applying the averaging technique also to the HERACLES CO data, we can constrain the H_2-to-CO ratio in low metallicity environments. In summary, this localized study of the dust-to-gas ratio provides important benchmarks on the metal and dust enrichment of dwarf galaxies both by internal processes as star formation as well as by accretion of intergalactic gas.

Caroline Simpson (Poster) -- *Star Formation in IC 1613*

Using the high resolution data from the LITTLE THINGS survey, we examine the star formation history in IC 1613, and test various models for cloud formation in small galaxies.

Christine Simpson (Talk) -- *The effect of feedback and reionization on star formation in low-mass dwarf galaxy halos*

We simulate a 10^9 Msun halo in a cosmological setting with an adaptive-mesh refinement code as an analogue to local low luminosity dIrrs and dSphs. We include a wide range of physical effects, including metal cooling, molecular hydrogen formation and cooling, photoionization and photodissociation from a metagalactic background, a simple prescription for self-shielding, star formation, and a simple model for supernova driven energetic feedback. To better understand the impact of each physical effect, we carry out simulations excluding each effect in turn, finding that reionization is primarily responsible for ejecting most of the gas in our simulations, but that supernova feedback is required to disperse the dense, cold gas in the core of the halo. For our full physics run with reionization at z=9, we find a stellar mass of about 10^5 Msun, and a mass-to-light ratio within the half-light radius of nearly 70, consistent with observed low-luminosity dwarfs. However, the resulting median stellar metallicity is 0.06 Zsun, considerably larger than observed systems. In addition, we find star formation is truncated between redshifts 4 and 7, probably at odds with the observed late time star formation in isolated dwarf systems. We investigate the efficacy of energetic feedback in our simple thermal-energy driven feedback scheme, and suggest that it may still suffer from excessive radiative losses, despite reaching stellar particle masses of about 100 Msun, and a comoving spatial resolution of 11 pc.

Evan Skillman (Talk) -- *How studying SF at z=0 helps us understand SF at higher z*

We are learning a tremendous amount about star formation in nearby dwarfs galaxies. I will discuss what I consider to be the most relevant observations of nearby dwarfs for understanding star formation in dwarf galaxies at the earliest epochs.

Else Starkenburg (Talk) -- *Investigating the earliest phases of star formation in dwarf galaxies: The extremely metal-poor tails of the classical dwarf spheroidal galaxies*

The lowest metallicity stars that still exist today probably carry the imprint of very few generations of supernovae. A comparison of these stars in the Milky Way and surrounding dwarf galaxies can teach us about the earliest phases of star formation and its dependence on environment and the mass of the galaxy. I will show that the Ca II triplet lines can be used as an efficient tool to search for these stars. A re-analysis of existing Ca II triplet surveys show that the (extremely) metal-poor tails of the spheroidal dwarf galaxies are well in agreement with the results found in the Milky Way halo. I will subsequently discuss results from follow-up high-resolution studies, among which a new study of the

extremely metal-poor tail of the Sculptor dwarf galaxy. In these studies we can investigate the detailed chemical evolution within these dwarf galaxies and the connection between the present-day dwarf galaxies and the building blocks of the Milky Way. The main question to answer would be: “Are the earliest stages of star formation more universal in their chemistry than later star formation epochs and less dependent on the mass of the galaxy?”

Tjitske Starkenburg (Poster) -- *Interactions of Dwarf Galaxies and Dark Satellites*

Within the LCDM cosmogony small dark matter halos are predicted to be very abundant. A large majority of these small haloes however, will never get massive enough to form stars and lighten up and will therefore remain ‘dark’, but may leave dynamical imprints in luminous galaxies. This motivates our poster on a suite of controlled simulations of dwarf galaxies and dark satellites. We simulate mergers between a dark satellite and a disky dwarf galaxy both with and without gas. The collisionless mergers show that dark satellites do perturb the disky dwarf, leading to significant thickening and important morphological changes. This thickening depends strongly on the mass ratios of the satellite to the host disk, which leads us to conclude that such encounters are likely to be important in the evolution of dwarf galaxies. Our simulations with gas show that the accretion of a dark satellite can induce a starburst. The increase in the star formation rate ranges from a few to factors greater than ten, depending on the orbital characteristics of the encounter. Interestingly, in such cases the dominant starburst is located in the center of the (eventually) accreted dark satellite, thereby lightening it for a brief period of time after which it finally merges with the dwarf.

Eon-Chang Sung (Poster) -- *The Environments of Star-burst Activities of Blue Compact Dwarf Galaxies*

We present a study of the local and global environments of star- burst activities for a sample of ~6,000 blue compact dwarf galaxies (BCDs) from SDSS DR7. We classified the sample by a plausible classification scheme based on the local environments of BCDs which was introduced by Sung et al. (2002). We found that more than 60% of nearby BCDs ($z < 0.02$) have regular shaped outer envelopes. BCDs spend most their life time on the regular shaped BCD stage. At least ~70% of our sample within the detection limits are classified interacting or merging in progress. There are not great differences in the local environments from both of regular shaped (N type) and disturbed (D type) BCDs except mergers. At the redshifts of $0.1 < z < 0.2$, the Merging type is higher fraction than nearby sample. This result is due to luminosity effects, that is the brighter objects are likely higher merging rate. On the contrary, less luminous objects are more common in detached interacting type. For the detached Interacting type, the ratios between dwarf-dwarf interacting and interacting as satellites of larger galaxies are different as morphology and redshifts. These results imply that tidal forces under the local environments should be important role of BCD activities and its evolution, and galaxy mass or luminosity are also important factors on the evolution of BCDs.

Angela Van Sistine (Poster) -- *Star Formation Properties of Dwarf Galaxies in the ALFALFA H-alpha Survey*

The ALFALFA H-alpha survey uses a volume-limited sample of HI-selected galaxies from the ALFALFA survey to study star formation in the local universe. When complete, this project will provide narrow-band H-alpha images of ~1400 HI-selected galaxies. ALFLAFA detects galaxies in our survey

volume with HI masses smaller than 10^8 M_sol, probing well into the flat portion of the HI mass function. Our primary science goal is to produce the best possible measurement of the local star-formation rate density. We also use our data set to study star formation as a function of galaxy environment, compare UV and H-alpha star-formation rates (using GALEX), and explore the star-formation properties of a sub-sample of HI-selected dwarf galaxies within our volume. With our unique data set, we are able to study star formation in a sample of galaxies selected based on their capability of making stars while remaining unbiased to the optical properties of the galaxies.

Ignacio Vega-Acevedo (Poster) -- *Are the A parameter and the SFR relation for gas-rich galaxies?*

The asymmetry parameter (A) is linear related to the Clumpiness (S) parameter when a close-box model is considered for the galaxy. Moreover, the S parameter is related with the FR. Therefore, for a close-box galaxies the asymmetry might be related with the SFR. We will present such relationship for a sample of late-type galaxies and will discuss if the could be close-box or not.

Steven Warren (Talk) -- *The Cold H I in Nearby, Low-Mass Galaxies*

We inspect line-of-sight atomic hydrogen (H I) emission line spectra in 31 nearby, low-mass galaxies to trace regions containing cold (T < 1400 K) H I at a common linear scale of 200 pc/beam. The galaxies in our sample were selected from the Very Large Array - ACS Nearby Galaxy Survey Treasury (VLA-ANGST) and The H I Nearby Galaxy Survey (THINGS). We successively fit single and double Gaussian functions to each spectrum. The majority of the spectra are best fit by a single Gaussian with a velocity dispersion of 7-12 km/s; however, some lines-of-sight also contain a second, colder component defined by a low (< 6 km/s) velocity dispersion. Cold H I is found in 23 of 27 galaxies after quality control cuts are applied. For the lines- of-sight that contain both cold and warm H I, the cold H I contributes ~20% of the flux density. Spatially, the cold H I is generally not coincident with the peaks in the total H I surface density. We find that only a few percent of each galaxy's total H I mass is in the cold phase. Preliminary work indicates that the cold H I is found in locations devoid of recent star formation.

Dan Weisz (Invited Talk) -- *Modes of Star-Formation in Dwarf Galaxies from Color-Magnitude Diagram Analysis*

Over 100 dwarf galaxies in the Local Group and nearby universe have well-characterized star formation histories (SFHs) based on color-magnitude diagram analysis. In this talk, I will review results from SFH analyses for a diverse range of dwarfs from Local Group 'ultra-faints' to SMC analogs outside the Local Group. I will also discuss our understanding of the modes of star formation in dwarfs across cosmic time in relation to fundamental quantities such as environment, baryonic content, and present day morphological type.

Hong-Xin Zhang (Poster) -- *HI Power Spectra Analysis of Dwarf Irregular Galaxies*

We studied HI spatial power spectrum variations with channel width for a sample of 24 nearby dwarf irregular galaxies selected from the LITTLE THINGS (Local Irregulars That Trace Luminosity Extremes - The HI Nearby Galaxy Survey) sample. The two-dimensional power spectral indices

asymptotically become a constant for each galaxy when a significant part of the line profile is integrated. For narrow channel maps, the PS become shallower as the channel width decreases, and this shallowing trend continues to our single channel maps. This implies that even the highest velocity resolution of 1.8 km/s is not smaller than the thermal dispersion of the coolest, widespread HI component. The one-dimensional power spectra of azimuthal profiles at different radii suggest that the shallower power spectra for narrower channel width is mainly contributed by the inner disks, which indicates that the inner disks have proportionally more cooler HI than the outer disks. Galaxies with lower luminosity ($M_B > -14.5$ mag) and star formation rate (SFR, $\log(\mathrm{SFR}\ (M_O/\mathrm{yr})) < -2.1$) tend to have steeper power spectra, which implies that the HI line-of-sight depths can be comparable with the radial length scales in low mass galaxies. A lack of a correlation between the inertial-range spectral indices and SFR surface density implies that either non-stellar power sources are playing a fundamental role in driving the interstellar medium turbulent structure, or the nonlinear development of turbulent structures has little to do with the driving sources.