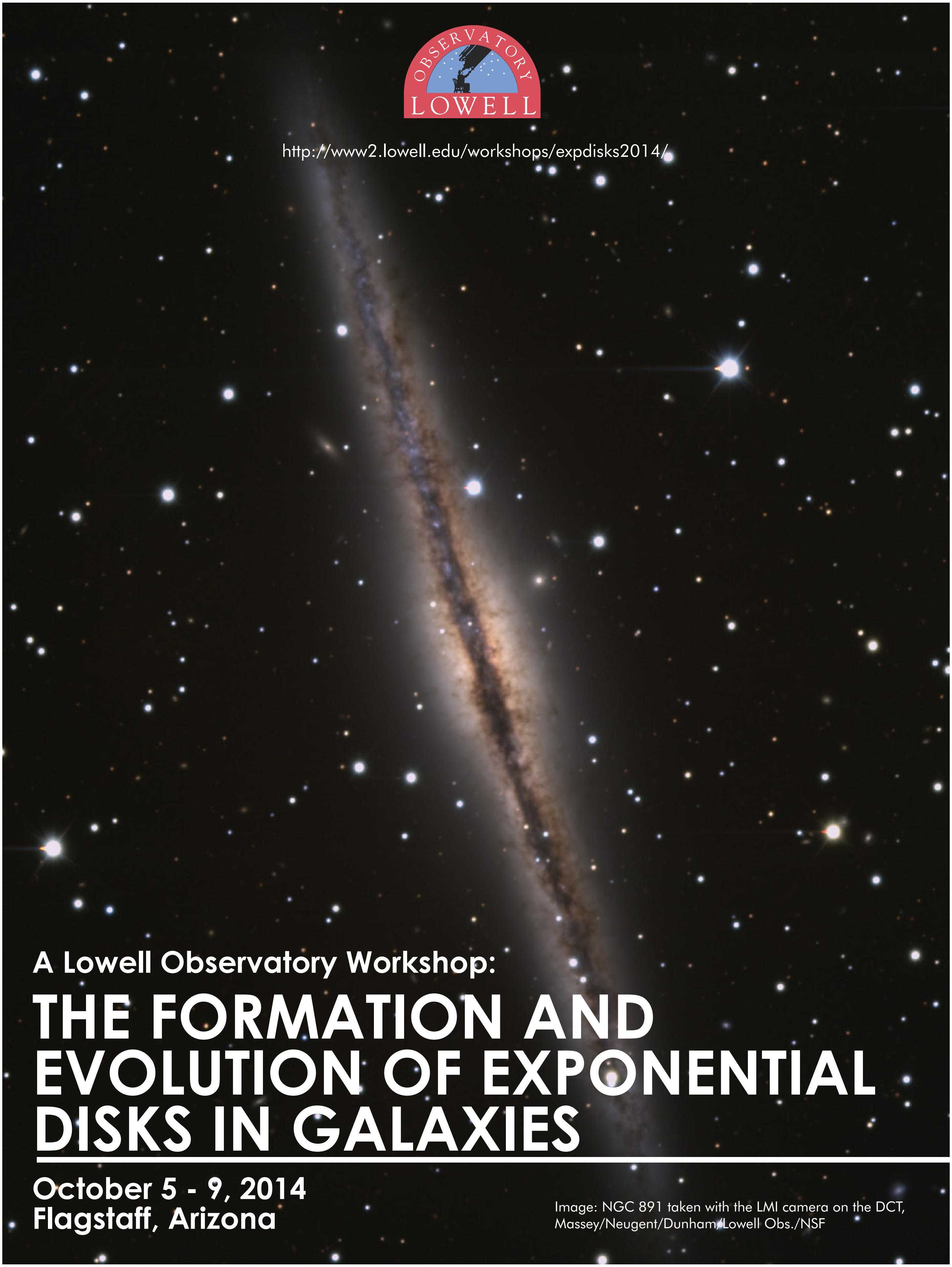

http://www2.lowell.edu/workshops/expdisks2014/

A Lowell Observatory Workshop:

THE FORMATION AND EVOLUTION OF EXPONENTIAL DISKS IN GALAXIES

October 5 - 9, 2014
Flagstaff, Arizona

Image: NGC 891 taken with the LMI camera on the DCT, Massey/Neugent/Dunham/Lowell Obs./NSF

OVERVIEW

Exponential stellar disks are ubiquitous. The stars in both spiral and dwarf galaxies are generally found to be organized in exponential disks, even to very low surface densities and in both stellar dominated and gas dominated galactic environments. But why is this? The associated gas disks do not fall off with radius in the same manner. Furthermore, star formation is highly lumpy. How does lumpy star formation produce distributions of stars that fall off smoothly. And how are these profiles maintained over many Gyr?

In addition, abrupt breaks in the stellar surface brightness or density profiles are also common: the stars follow an exponential in the inner part of the galaxy and an exponential with a different slope in the outer galaxy. In spiral galaxies there seems to be a change in the stellar populations at the break, but in dwarf galaxies the break remains in the stellar mass density profile. So what happens at the break in these galaxies?

Here we bring together theorists and observers to discuss the formation of exponential disks and their evolution.

This workshop aims to address the following fundamental questions:

- *Why are exponential disks formed?*
- *Are dwarf disks the same as spiral disks?*
- *What maintains exponential disks once formed? What role, if any, does star formation play in maintaining the exponential disk? Or are other processes continuously adjusting the profile independent of star formation? Is this the same in spirals and dwarfs?*
- *Why do spiral disks evolve inside-out and dwarf disks form outside-in?*
- *For galaxies with breaks in their stellar surface brightness or mass profiles, what happens at the break?*

PARTICIPANTS

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Owain Snaith | University of Alabama, USA
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Donna Weistrop | University of Nevada-Las Vegas, USA
Stijn Wuyts | MPE, Germany
Rosemary Wyse | John Hopkins University, USA
Peter Yoachim | University of Washington, USA
Jason Young | Pennsylvania State University, USA

PROGRAM

Sunday, October 5

5:30pm - 8:00pm	Shuttles from hotel to Lowell Observatory and back
6:00pm	HCPS library open for mounting posters
6:00pm - 7:30pm	**Reception at Steele Visitor Center, Giclas Lecture Hall**

Monday, October 6

7:45am - 8:45am	Shuttles from hotel to Lowell Observatory
	Session 0: Welcome and Introductory Remarks
8:50am - 8:55am	Welcome to Lowell Observatory (Jeff Hall)
8:55am - 9:00am	Announcements (Deidre Hunter)
	Session 1A: The Cosmological Context (Chair: Roberto Abraham)
9:00am - 9:30am	Invited Talk: *Observations of Stars in Disks at High Redshift (Stijn Wuyts)*
9:30am - 10:00am	Invited Talk: *Observations of Gas and Dust in Disks at High Redshift (Linda Tacconi)*
10:00am - 10:15am	Contributed Talk: *The Formation and Evolution of Clumpy Galaxies from z=3 to z=0.5 (Yicheng Guo)*
10:15am - 10:30am	Contributed Talk: *Near-Far Connection: The Origin of Realistic Stellar Structure and AVRs from z=0-2 in Simulated Disk Galaxies (Jonathan Bird)*
10:30am - 11:15am	**Break and Poster Viewing in HCPS Library**
	Session 1B: The Cosmological Context, continued (Chair: Roberto Abraham)
11:15am - 11:45am	Invited Talk: *Massive Quiescent Disks at High Redshift (Elizabeth McGrath)*
11:45am - 12:00pm	Contributed Talk: *Evolution of the Disk Scale-Length for Mono-Age Populations (Ivan Minchev)*
12:00pm - 12:30pm	Invited Talk: *Theory of Disk Galaxy Formation in a Cosmological Context (Chris Brook)*
12:45pm - 1:45pm	**Lunch (Tent on Mars Hill Campus)**
	Session 2A: Disk Formation and Evolution (Chair: Elizabeth McGrath)
2:00pm - 2:15pm	Contributed Talk: *Exponential Profile Formation in Simple Models of Scattering Processes (Curtis Struck)*
2:15pm - 2:45pm	Invited Talk: *Origin of Disk Angular Momentum (Adrianne Slyz)*
2:45pm - 3:00pm	Contributed Talk: *Forming Exponential Disks in Cosmological Simulations (Aura Obreja)*

3:00pm - 3:15pm	Contributed Talk: *Initial Angular Momentum and the Radial Structure of Disks (Jakob Herpich)*
3:15pm - 4:15pm	**Break and Poster Viewing in HCPS Library**
	Session 2B: Disk Formation and Evolution, continued (Chair: Elizabeth McGrath)
4:15pm - 4:45pm	Invited Talk: *Secular Evolution of Disk Mass Profiles (Jerry Sellwood)*
4:45pm - 5:15pm	Invited Talk: *Role of Gas Infall and Outflows in Formation of Galactic Disks (Dusan Keres)*
5:15pm - 5:45pm	Invited Talk: *Fountain Driven Accretion (Filippo Fraternali)*
5:45pm - 6:00pm	Contributed Talk: *Does the Milky Way Have an Accreted Disk Component? (Gregory Ruchti)*
6:15pm - 6:30pm	*Pre-dinner wine and beer*
6:30pm - 8:00pm	**Dinner (Tent on Mars Hill Campus)**
7:30pm - 8:30pm	*Shuttles to hotel*

Tuesday, October 7

7:45am - 8:45am	Shuttles from hotel to Lowell Observatory
	Session 2C: Disk Formation and Evolution, continued (Chair: Sebastien Comeron)
9:00am - 9:30am	Invited Talk: *High-Redshift Disk Galaxies: Exponential Disk Formation, Feedback Processes, and Similarity with Nearby Dwarf Galaxies (Frederic Bournaud)*
9:30am - 10:00am	Invited Talk: *Formation and Properties of Exponential Discs and the Breaks in Their Profiles: The N-Body View (Lia Athanassoula)*
10:00am - 10:15am	Contributed Talk: *Little Blue Spheroids and Disk Evolution in GAMA (Amanda Moffett)*
10:15am - 10:30am	*Poster Advertisements (1 minute per person, no visuals)*
10:30am - 11:15am	**Break and Poster Viewing in HCPS Library**
	Session 3A: Disks in the Local Universe (Chair: Sebastien Comeron)
11:15am - 11:45am	Invited Talk: *Disk and Bulge Decompositions in S4G Galaxies (Heikki Salo)*
11:45am - 12:00pm	Contributed Talk: *Progression Over Time from Clumpy to Smooth Exponential Disks (Bruce Elmegreen)*
12:00pm - 12:15pm	Contributed Talk: *Properties of Superthin Stellar Disks (Dmitry Bizyaev)*
12:15pm - 12:30pm	Contributed Talk: *Restrictions to Spiral Arms Parameters in Normal Galaxies: Ordered and Chaotic Stellar Orbital Studies (Angeles Perez Villegas)*
12:30pm - 1:30pm	**Lunch (Tent on Mars Hill Campus)**
	Session 3B: Disks in the Local Universe, continued (Chair: Joss Bland-Hawthorn)
1:45pm - 2:15pm	Invited Talk: *Disk Truncations in Spiral Galaxies (Piet Van Der Kruit)*
2:15pm - 2:45pm	Invited Talk: *Disk Breaks and Their Properties (Peter Erwin)*
2:45pm - 3:00pm	Contributed Talk: *Near Infrared View to Disk Breaks (Jarkko Laine)*
3:00pm - 3:15pm	Contributed Talk: *Stellar Surface Brightness Profile Breaks of Dwarf Galaxies (Kim Herrmann)*

3:15pm - 4:15pm	**Break and Poster Viewing in HCPS Library**
	Session 3C: Disks in the Local Universe, continued (Chair: Joss Bland-Hawthorn)
4:15pm - 4:30pm	Contributed Talk: *The Origin of Stellar Breaks at Large Radii as Probed by the Spitzer Survey of Stellar Structure in Galaxies (Juan-Carlos Munoz-Mateos)*
4:30pm - 4:45pm	Contributed Talk: *The Chemistry and Age Structure of Broken (And Not-So-Broken) Exponential Disks (Brad Gibson)*
4:45pm - 5:15pm	Invited Talk: *Observations of Thick Disks (Rosemary Wyse)*
5:15pm - 5:30pm	Contributed Talk: *The Distribution of Metals in the Thick Disk (Maider Sancho Miranda)*
5:30pm - 5:45pm	Contributed Talk: *Evidence for Concurrent Growth of Thick Discs and Central Mass Concentrations from S4G Imaging (Sebastien Comeron)*
5:45pm - 6:00pm	Contributed Talk: *Modelling Spatially Resolved Star Formation History, Metallicity Gradients and Radial Flows in CALIFA Disk Galaxies (Bruno Jungwiert)*
6:15pm - 6:30pm	*Pre-dinner wine and beer*
6:30pm - 8:00pm	**Dinner (Tent on Mars Hill Campus)**
7:30pm - 8:30pm	*Shuttles to Hotel*

Wednesday, October 8

7:45am - 8:45am	Shuttles from hotel to Lowell Observatory
	Session 3D: Disks in the Local Universe, continued (Chair: Rosemary Wyse)
9:00am - 9:30am	Invited Talk: *The Structure of the Milky Way Disk (Giovanni Carraro)*
9:30am - 10:00am	Invited Talk: *Milky Way Disk Structure from Chemical Tagging (Sofia Feltzing)*
10:00am - 10:15am	Contributed Talk: *Galactocentric Variation of the Abundance Structure in the Milky Way Stellar Disk – Results from the Gaia-ESO Survey (Thomas Bensby)*
10:15am - 10:30am	Contributed Talk: *Three Dimensional Mapping of the Stellar and Star-Formation Break of the Milky Way Galaxy (Robert Benjamin)*
10:30am - 11:15am	**Break and Poster Viewing in HCPS Library**
	Session 3E: Disks in the Local Universe, continued (Chair: Rosemary Wyse)
11:15am - 11:45am	Invited Talk: *Spectroscopic Star Formation Histories in a Variety of Exponential Disks (Peter Yoachim)*
11:45am - 12:15pm	Invited Talk: *Radial Profiles of Star Formation Histories from CALIFA (Sebastian Sanchez)*
12:15pm - 12:30pm	Contributed Talk: *Star Formation Histories in the Outer Discs of M31 and M33 (Edouard Bernard)*
12:30pm - 1:30pm	**Lunch (Tent on Mars Hill Campus)**
	Session 3F: Disks in the Local Universe, continued (Chair: Peter Erwin)
1:45pm - 2:15pm	Invited Talk: *Radial Profiles of Star Formation Histories in Local Dwarfs and MCs (Carme Gallart)*
2:15pm - 2:45pm	Invited Talk: *Radial Profiles and Color Gradients from Photometry (Judit Bakos)*
2:45pm - 3:15pm	Invited Talk: *The RAVE Survey: Structure and Kinematics of the Disk Components (Joss Bland-Hawthorn)*

3:15pm - 4:15pm	**Break and Poster Viewing in HCPS Library**
	Session 3G: Disks in the Local Universe, continued (Chair: Peter Erwin)
4:15pm - 4:45pm	Invited Talk: *Dark Matter Environment of Exponential Disks (Ortwin Gerhard)*
4:45pm - 5:15pm	Invited Talk: *Structure of the Faintest Dwarf Galaxies (Ken Freeman)*
5:15pm - 5:30pm	Contributed Talk: *Stellar Populations in Disc Galaxies from the CALIFA Survey. The Influence of Bars (Patricia Sanchez-Blazquez)*
5:30pm - 5:45pm	Contributed Talk: *Metallicity Gradients in Galaxy Discs (Patricia Tissera)*
5:45pm - 6:00pm	Contributed Talk: *Properties of Disks in Isolated Galaxies (Mirian Fernandez Lorenzo)*
6:15pm - 6:30pm	Pre-dinner wine and beer
6:30pm - 8:00pm	**Dinner (Tent on Mars Hill Campus)**
7:30pm - 8:30pm	Shuttles to hotel

Thursday, October 9

7:45am - 8:45am	Shuttles from hotel to Lowell Observatory
	Session 4A: Outer Regions of Local Disks (Chair: Patricia Tissera)
9:00am - 9:30am	Invited Talk: *Extended UV Disks (XUV-disks) and Their Inter-Relation with Optical Galaxy Structure (David Thilker)*
9:30am - 9:45am	Contributed Talk: *Stellar Populations in the Disk and Outerparts of Different Surface Brightness Profile Galaxies (Isabel Perez)*
9:45am - 10:00am	Contributed Talk: *The Extended Optical Disk of M101 (Chris Mihos)*
10:00am - 10:15am	Contributed Talk: *Studying Outer Disk Formation Using Extremely Deep Surface Photometry of Nearby Galaxies (Aaron Watkins)*
10:15am - 11:00am	**Break and Last Poster Viewing Opportunity in HCPS Library**
	Session 4B: Outer Regions of Local Disks, continued (Chair: Patricia Tissera)
11:00am - 11:30am	Invited Talk: *First Results from Project Dragonfly (Roberto Abraham)*
11:30am - 12:00pm	Invited Talk: *The Extended HI Environment of Nearby Galaxies (D.J. Pisano)*
12:00pm - 12:15pm	Contributed Talk: *Observations of Outer HI Disks in Local Spirals and Interaction Models (Sukanya Chakrabarti)*
12:15pm - 1:00pm	**Group Discussion: Outstanding Questions (Chairs: Deidre Hunter and Bruce Elmegreen)**
1:15pm - 2:15pm	**Lunch (Tent on Mars Hill Campus)**
2:00pm - 3:00pm	Shuttles to hotel

POSTERS

Three Dimensional Mapping of the Stellar and Star-Formation Break of the Milky Way Galaxy, Part 2
Robert Benjamin

The Initial Mass Function and Star Formation Law in the Outer-Disk of NGC 2915
Sarah Bruzzese

Towards Abundance Gradients in the Thin and Thick Disk of NGC300 from Full Spectral Fitting
Omar Choudhury

Tracing Evolutionary Processes in Stellar Disks in Nearby Dwarf Galaxies from X-Ray Light
Sarthak Dasadia

Evidence that Spiral Arms in Disk Galaxies are Produced by Density Waves
Benjamin Davis

The Outer Disks of Dwarf Irregular Galaxies
Deidre Hunter

The Pitch Angle Distribution Function and its Role in Understanding Galactic Disks
Daniel Kennefick

Structure of the Inner 300 Parsecs of the Milky Way Galaxy
Devaky Kunneriath

Disk Thickness Driven by the Spiral Arms in Normal Spiral Galaxies
Luis Martinez Medina

A Direct Estimate of the Radial Growth of Stellar Discs
Gabriele Pezzulli

A Portrait of Malin 2: A Case Study of a Giant Low Surface Brightness Disk Galaxy
Anna Saburova

The Chemical Evolution of Simulated Galaxies
Owain Snaith

Angular Momentum Evolution of Discs and Spheroids
Patricia Tissera

Burst and Quench? The Life Story of Low Surface Brightness Galaxies
Jason Young

ABSTRACTS

First Results from Project Dragonfly (Invited Talk)

Roberto Abraham | University of Toronto

I will describe early results from Project Dragonfly, a Toronto/Yale instrument concept whose goal is to open up the new observational regime of ultra low surface brightness astronomy at visible wavelengths. The project couples innovative observing techniques (multiple redundant unobstructed beam paths and real-time modeling of sky variations for precision control of systematics) with new technologies, such as sub-wavelength nano-fabricated optical coatings to minimize scattered light and ghosting. Its design is optimized for testing the most fundamental prediction of galaxy formation models (namely that at low surface brightness levels all galaxies are embedded within a sea of complex substructure) but its design is also useful for exploring the outer disks of nearby galaxies.

Formation and Properties of Exponential Discs and the Breaks in Their Profiles: The N-Body View (Invited Talk)

Lia Athanassoula | Laboratoire d'Astrophysique de Marseille

I follow the formation of galactic discs in Milky-Way sized halos. I use high resolution N-body + SPH simulations, including gas, star formation, feedback, cooling, accretion of gas and mergings. In all of them I witness the inside-out formation of the disc, which in a very large fraction of the cases is exponential over a number of disc scale lengths and I aim for an understanding of the conditions necessary for this. I also witness the formation of breaks and the formation of type II profiles and give a physical justification for that. In all my simulations I find that the disc has substructures, such as bars, lenses, spirals and rings.

Radial Profiles and Color Gradients from Photometry (Invited Talk)

Judit Bakos | Instituto de Astrofísica de Canarias

In my talk, I will summarize the recent results coming from the multi-wavelength observations of the structure and stellar content of spiral galaxies. For instance, using high-quality data from e.g. SDSS Stripe82, HUDF, we are now able to trace the radial surface brightness profiles down to ~30 mag/arcsec2, allowing us to study the faint outskirts of disks and explore the properties of the stellar populations well beyond the star formation threshold. At these surface brightness levels spiral galaxies reveal exciting structural components (tidal streams, satellites etc.). We are, in fact, able to reach the depth of stellar halos, which was beforehand only achieved by 'point-source photometry'. As some properties of the stellar populations, such as the age, can be interpreted in terms of colors, it is possible to confront the disk galaxy formation and evolution scenarios. The optical color profiles provide observational confirmation to the predictions of stellar migration theory. In case of some galaxies, we can also address the issue whether non-conventional IMFs play a role during galaxy assembly.

Three Dimensional Mapping of the Stellar and Star-Formation Break of the Milky Way Galaxy (Contributed Talk + Poster)

Robert Benjamin | University of Wisconsin-Whitewater

A three-dimensional map of the stellar break of the Galaxy over the longitude range l=90-270 degrees has been developed using *Spitzer*/GLIMPSE, 2MASS, and WISE data. This map is compared with a map of the density of red clump giants in order to constrain the outer scale-length of the Milky Way's disk. These maps are compared with current three dimensional maps of the HI, HII, CO and star-formation and spiral structure in the outer Galaxy and implications for models of star formation are discussed. We note that the census of both molecular gas and star formation in the outer Galaxy are incomplete and discuss the prospects for remedying this with GLIMPSE, WISE and targeted CO surveys.

Galactocentric Variation of the Abundance Structure in the Milky Way Stellar Disk — Results from the Gaia-ESO Survey (Contributed Talk)

Thomas Bensby | Lund Observatory

Being awarded 300 nights over 5 years with the FLAMES instrument on the Very Large Telescope on Paranal in Chile, the Gaia-ESO public spectroscopic survey will gather spectra for more than 100 000 stars in the Milky Way in order to map the elemental abundance structure of the main Galactic structural components. Based on data from the first 2 years of observations I will here present an investigation of how the abundance structure varies with galactocentric radius in the Galactic disk; from the bulge region to the outer disk reaching galactocentric distances of about 12-13 kpc. In particular I will focus on abundance gradients and the relative properties of the Galactic thin and thick disks with galactocentric radius, how this can help us to constrain the scale-lengths of the two disks, and whether radial migration has played a significant role in the evolution of the Galactic disk.

Star Formation Histories in the Outer Discs of M31 and M33 (Contributed Talk)

Edouard Bernard | Institute for Astronomy, University of Edinburgh

A deep colour-magnitude diagram (CMD) is the best tool to retrieve the star formation history (SFH) of a galaxy since it harbors stars born throughout its lifetime. The quantitative comparison of observed and model CMDs provides both the evolution of the star formation rate and the chemical evolution as a function of time. I will present the SFH of several fields in the far outer disks of M31 and M33 obtained from deep HST/ACS CMDs and discuss the results.

Near-Far Connection: The Origin of Realistic Stellar Structure and AVRs from z = 0~2 in Simulated Disk Galaxies (Contributed Talk)

Jonathan Bird | Vanderbilt University

We analyze the evolution of vertical disk structure and the stellar age-velocity relations in a series of high-resolution, cosmological SPH simulations. We compare current MW observations with detailed mock observations of the simulated galaxies at z=0, accounting for the latest constraints on solar position, the selection function of modern surveys, and replicating the statistical methods applied to the observational data. As observations demand more predictive power from theory, we show that the particular implementation of these mock observations becomes an increasingly crucial component of the analysis. At z=0, our fiducial simulation reproduces the three-dimensional stellar AVR measured in the solar neighborhood. Present-day simulated mono-age populations also have velocity dispersions nearly independent of height, matching the isothermal nature of mono-abundance populations in the MW. We identify two main ingredients governing the evolution of these quantities: upside-down formation and scattering processes. The galaxy forms upside-down in the sense that older populations are born with slightly larger vertical velocity dispersion than younger stars, tracing the kinematics of the collapsing gas disk. After birth, the evolution in stellar structure and kinematics is governed by scattering processes that mimic those recently found responsible for the creation of exponential disks in two-dimensional experiments. Finally, we compare our simulated galaxies with observations at high redshift and determine that "upside-down" disk formation is the natural result of the observed evolution of gas kinematics in disk galaxies and produces analogues of galaxies observed with IFU instruments at z~1-2.

Properties of Superthin Stellar Disks (Contributed Talk)

Dmitry Bizyaev | Apache Point Observatory, New Mexico State University

Edge-on Disk Galaxies In SDSS (EGIS) is a visually inspected sample of about six thousand true edge-on galaxies identified in the Sloan Digital Survey images. The large sample helps identify statistically valuable subsamples of rare objects. Some sixty galaxies in the catalog have super-thin stellar disks with the radial-to-vertical scale ratio greater than 10. We analyze conditions necessary for the creation of the super-thin disks. While a heavy dark matter halo is necessary to keep stellar disks very thin, the axis ratio range of the super-thin disks in our sample also suggests that the star formation doesn’t start below certain fixed threshold surface density.

The RAVE Survey: Structure and Kinematics of the Disk Components (Invited Talk)

Joss Bland-Hawthorn | Sydney Institute for Astronomy, University of Sydney

RAVE (RAdial Velocity Experiment) is a multi-fiber spectroscopic astronomical survey of stars in the Milky Way using the 1.2-m UK Schmidt Telescope of the Anglo-Australian Observatory (AAO). Over the period 2003-2013, the survey obtained kinematic and chemical information for almost half a million stars. The RAVE collaboration consists of researchers from over 20 institutions and is coordinated by the Leibniz-Institut für Astrophysik, Potsdam. I will briefly outline key results on the structural and kinematic properties of the Galaxy. RAVE is the largest stellar survey of its kind to date.

High-Redshift Disk Galaxies: Exponential Disk Formation, Feedback Processes, and Similarity with Nearby Dwarf Galaxies (Invited Talk)

Frederic Bournaud | CEA-Saclay

I propose to review a set of results based on hydrodynamic simulations and theory, explaining how high-redshift disk galaxies (which are irregular and "clumpy") are affected by violent disk instability and can spontaneously form exponential disks (with modest bulge fractions). I will in particular present new results on the role of feedback processes (stellar and AGN), the later stages of exponential disk formation including bar growth, and the similarity with nearby dwarves which can serve as a detailed laboratory to explore these physical mechanisms.

Theory of Disk Galaxy Formation in a Cosmological Context (Invited Talk)

Chris Brook | Universidad Autónoma de Madrid

Exponential disc formation within galaxy formation simulations is reviewed. We look for cases where the various different codes are beginning to form a consensus on how discs initially form, how discs grow over time, and what is required for forming exponential discs. The baryon-dark matter connection is explored. We also look at where the various hydrodynamics codes may differ and whether this is affecting interpretation.

The Initial Mass Function and Star Formation Law in the Outer-Disk of NGC 2915 (Poster)

Sarah Bruzzese | International Centre for Radio Astronomy Research (ICRAR), The University of Western Australia

We present the spatial distribution and photometry of the resolved stellar populations in an outer-disk region of NGC 2915, a blue compact dwarf galaxy with an extended HI disk. Hubble Space Telescope (HST) Advanced Camera for Surveys (ACS) Wide Field Channel (WFC) observations in the F475W, F606W and F814W filters reveal an elliptical distribution of red giant branch stars, and a clumpy distribution of main-sequence stars, which follows the HI distribution. We use the observed main-sequence stars and a constant star formation rate to constrain the upper-end initial mass function (IMF) and star formation law (SFL) in this field. The best fitting IMF slope ranges from α = -2.65 to -2.85, while the best fit upper-mass limit M_u ranges from 60 M⊙ to 120 M⊙, depending on which statistical test is used to determine the goodness of fit. A Kroupa IMF with M_u = 120 M⊙ cannot be ruled out using the HST photometry alone. This is due to the relative insensitivity of optical colours to stellar mass, and the difficulty of distinguishing single stars from binaries and compact clusters at the distance (4.1 Mpc) involved. Previously published Hα observations of the field, which show one faint HII region, are used to provide further constraints on the IMF. Assuming case B recombination, this implies that only one late type O stars needs to be in the field of the HST observations. A combined analysis of the HST and Hα photometry provides a best-fit IMF slope that ranges from α = -2.65 to -2.85, and an upper-mass limit M_u = 65 M⊙. Implying that the IMF is deficit in massive stars compared to a standard Kroupa IMF. Combining the HST photometry with published HI imaging we find the SFL has a power law index N = 1.53+/-0.22 and A = (4.4+/-1.1) x 10^{-5} M⊙ yr^{-1} kpc^{-2}. If these results apply to the entire outer HI disk then it contributes ~25% of the total star formation in NGC 2915. Fits to the SFL data suggest that much of the dynamical mass in the outskirts of NGC 2915 may be in the disk.

The Structure of the Milky Way Disk (Invited Talk)

Giovanni Carraro | European Southern Observatory

The spiral structure of the Milky Way is one of those topics we presuppose to know. I will go through a bit of history of this fascinating field of Galactic Astronomy, and will then discuss present day efforts to chart the Milky Way spiral structure, emphasizing their potentialities and limitations. I will also discuss the disk cut-off, warp and flare.

Observations of Outer HI Disks in Local Spirals and Interaction Models (Contributed Talk)

Sukanya Chakrabarti | Rochester Institute of Technology

Using high resolution hydrodynamical simulations I describe how interactions with dwarf galaxies can affect the structure and evolution of galactic disks in spirals. I delineate the mass regime where dwarf galaxy interactions become important in driving the evolution of disk structures in spirals. For the Milky Way, I present a detailed model that includes interactions with all the known Milky Way satellites. I compare the model to recent deep, infrared data obtained from the Vista Variables of the Via Lactea survey that allows us to map the edge of the galactic disk, which yields surprising results relative to prior observational determinations.

Towards Abundance Gradients in the Thin and Thick Disk of NGC300 from Full Spectral Fitting (Poster)

Omar Choudhury | Leibniz-Institute for Astrophysics Potsdam

We observed the face-on bulgeless galaxy NGC300 with the FORS2 spectrograph on VLT, yielding spatially resolved, optical spectral coverage with S/N above 100. The full spectra are fitted over an extended wavelength range with differential stellar population models, which allows us to obtain ages, [Fe/H] and [alpha/Fe]. We currently focus on mean gradients for the iron and alpha abundance and for the age of the disk. We will also show experiments to single out the information about the old stellar component alone from the integrated spectra, yielding abundance gradients for the thin and thick disk separately.

Evidence for Concurrent Growth of Thick Discs and Central Mass Concentrations from S4G Imaging (Contributed Talk)

Sebastien Comeron | University of Oulo

Thick discs are roughly exponential excesses of light at large heights above the mid-plane. Thick discs might have either formed already thick at high redshift or might be the consequence of secular dynamical heating of a thinner disc.

Central Mass Concentrations (CMCs) include both bulges and pseudobulges. Bulges are thought to be the product of violent formation processes at high redshift and pseudobulges are thought to be the product of secular evolution (although some simulations show that they can also form in a clumpy disc at high redshift).

We produced mid-infrared vertically integrated radial luminosity profiles of 69 edge-on galaxies from the *Spitzer* Survey of Stellar Structure in Galaxies (S4G). We decomposed the luminosity profiles into a disc and a CMC. These fits, combined with thin/thick disc decompositions from our previous studies, allow us to estimate the masses of the CMCs, the thin discs, and the thick discs (M_{CMC}, M_t and M_T, respectively). We define the CMC and the thick disc to be dynamically hot components. We find that the ratio between the mass of the hot components and that of the thin disc, $(M_{CMC}+M_T)/M_t$, does not depend on the total galaxy mass as described by circular velocities (v_c).

Our results are compatible with having CMCs and thick discs built in a short (0.5-1.0 Gyr) and early clumpy phase and that the thin disc has probably been formed afterwards at a slower pace. Simulations of clumpy discs in the literature show that the natural output are exponential discs and can even account for Type II truncations.

Tracing Evolutionary Processes in Stellar Disks in Nearby Dwarf Galaxies from X-Ray Light (Poster)

Sarthak Dasadia | University of Alabama

Shocks from massive star winds and supernovae in star-forming regions create hot gas visible at X-ray wavelengths. We use X-ray imaging spectrophotometry obtained with the Chandra X-Ray Observatory to trace this hot gas (and X-ray binaries and SNRs) in a sample of nearby dwarf galaxies from the LITTLE THINGS survey. We compare the radial distribution of X-radiation to Hα-emitting warm ionized gas and to cold HI gas morphologies as measured by the LITTLE THINGS team. We study the hot X-ray gas temperature and surface brightness profiles to search for correlations with the stellar mass surface density and radial star formation rate profiles derived by LITTLE THINGS analysis. These comparisons help to determine if shock heating is efficient in driving shells and generating large bubbles in the low-pressure outer disks compared to the dense inner-disk environments where cooling times are short and energy input from stellar winds and SNe is expected to be quickly radiated away.

Evidence that Spiral Arms in Disk Galaxies are Produced by Density Waves (Poster)

Benjamin Davis | University of Arkansas

We present results which suggest a three-variable correlation (a possible fundamental plane) between spiral arm pitch angle in disk galaxies, the gas density in the disk, and any one of several quantities related to the total mass or total central mass of the galaxy. Density wave theory demands that such a relationship exist. We examine thirty galaxies from the DiskMass Survey sample, for which a great deal of information about mass densities in the disk are known, measure their spiral arms (the sample was chosen to be face-on), and compare it with available data on the galaxy's total mass or central mass.

Progression Over Time from Clumpy to Smooth Exponential Disks (Contributed Talk)

Bruce Elmegreen | IBM T. J. Watson Research Center

The progression over time from clumpy disk galaxies at high redshift to smooth disks today occurred via a sequence of decreasing clump mass all within a continuously exponential-shaped disk. Galaxies today share some of the clumpy characteristics of the high-redshift cases, and even overlap with them in terms of clump mass and size. Generally galaxies today that resemble high-z galaxies are much lower in mass, reflecting the common notion of downsizing. A good example is the tadpole morphology, which was prominent at high-z but is very rare today. Even so, among extremely low metallicity galaxies today, the tadpole shape dominates: 75% of XMP galaxies are tadpoles, as are many BCDs and other active dwarfs. We found evidence for unusually low metallicities in the starburst heads of local tadpole galaxies, compared to the galaxy tails, suggesting active accretion of low metallicity cosmic gas onto the bright heads. We also found evidence for ultra-low metallicities in the starburst regions of other low metallicity galaxies, even if they are not tadpole-shaped. This accretion suggests a mechanism of galaxy building, and the presence of exponential disk throughout, even as underlying structures inside the tadpoles, shows the importance of this basic shape for all time.

Disk Breaks and Their Properties (Contributed Talk)

Peter Erwin | Max Planck Institute for Extraterrestrial Physics

The surface brightness profiles of galaxy disks seem to fall into three broad classes: pure exponential profiles (Type I), profiles which steepen beyond a break radius (Freeman Type II, including "truncations"); and profiles which are shallower beyond a break radius (Type III or "antitruncations"). Type II and III breaks are seen in all disk galaxies, from lenticulars through the latest-type spirals, and are found out to redshifts of at least 1; some galaxies have both types of break. I will discuss what is currently know about the frequency and nature of the different breaks, including their dependence on Hubble type and the presence and strength of bars, possible environmental variations, and whether there is more than one sub-class of each break. I will also touch on the question of whether breaks are purely a surface-brightness phenomenon: i.e., do breaks disappear when we move from surface-brightness profiles to stellar-mass-density profiles?

Milky Way Disk Structure from Chemical Tagging (Invited Talk)

Sofia Feltzing | Lund Observatory

I will discuss the promises of chemical tagging for extracting the formation history of the Milky Way. Large-scale spectroscopic surveys that are built to complement Gaia will offer a rich data-set that potentially can be used for chemical tagging. I will give a few examples of the application of this technique from the literature to current data, its successes and shortcomings and also look at the forthcoming surveys and detail what developments are needed to exploit its potential.

Properties of Disks in Isolated Galaxies (Contributed Talk)

Mirian Fernandez Lorenzo | Instituto de Astrofísica de Andalucia (IAA-CSIC)

Disentangling the processes governing the formation and evolution of galaxies requires a clear understanding of the role of environmental effects. This is only possible through comparison of samples in different environments. We present here the study of the stellar mass-size relation for the AMIGA (Analysis of the Interstellar Medium of Isolated GAlaxies; http://www.amiga.iaa.es) sample of isolated galaxies as representative of galaxies mainly affected by internal processes. Analysis of the stellar mass-size relation for our sample suggests that isolated spiral galaxies are ~1.2x larger than less isolated systems with similar mass. This difference in size is found for all spiral subtypes and becomes larger when we compare isolated galaxies with galaxies having 2 or more satellites. However, galaxies without satellites in less isolated samples are also smaller than our isolated galaxies. Then, another effect of the environment is expected to be the cause of the difference in size. Could our disks be larger because the large scale environment (group, cluster, etc) truncates the extended disks of less isolated galaxies? We will present the study of the outer profiles of disks in different environments for disentangling the mechanisms involved in the growth in size of galaxies.

Fountain Driven Accretion (Invited Talk)

Filippo Fraternali | University of Bologna

Disk galaxies must accrete gas from the intergalactic medium in order to feed their star formation. Indirect evidence of this accretion includes the reconstruction of star formation histories and chemical evolution models. However, direct detection of gas accretion taking place is difficult to achieve. Cosmology predicts that a consistent fraction of gas in the local Universe is in a low-density and high-temperature state and makes up cosmological coronae surrounding every galaxy. These coronae are large reservoirs for star formation if they can be cooled and accreted onto the disks. I discuss how the effect of galactic fountains in the cooling and accretion of the corona and the consequences of this fountain-driven accretion mode for the evolution of galaxy disks.

Structure of the Faintest Dwarf Galaxies (Invited Talk)

Ken Freeman | Australian National University

In the more massive spiral galaxies, the disks are more or less exponential and they contribute significantly to the gravitational field, at least within the inner one or two scalelengths. Although the reason for the exponential distribution of their disks is still uncertain, self-gravity is likely to play some role in determining their structure.

We are interested in the properties of the baryon distributions in the less massive galaxies. Rotation curve decompositions show that the gravitational field of the baryonic disks becomes very small for systems with DM circular velocities < 40 km/s. This is the domain of the faint dSph and dIrr galaxies, in which the rotation of the baryons is insignificant and the gravitational field of the baryons is much weaker than the field of their dark matter. These galaxies are in pressure equilibrium. With some simple and probably realistic assumptions, we would expect the density distributions of baryons in dSph and dIrr galaxies to be similar. Comparison of star counts in dSph galaxies and HI distributions in dIrr galaxies shows that they are indeed similar.

We use the dynamics and distribution of the baryons to measure the central density of their dark matter (DM) halos. We can then use the scaling laws for DM halos to estimate (1) the fraction of baryonic mass lost by the dwarfs relative to that lost by the brighter spirals, and (2) the relation between the kinematics and scale lengths of the baryons and the corresponding properties of their dark halos.

Radial Profiles of Star Formation Histories in Local Dwarfs and Magellanic Clouds (Invited Talk)

Carme Gallart | Instituto de Astrofísica de Canarias

Color-magnitude diagrams reaching the oldest main sequence turnoffs, and covering a wide range of galactocentric distances, are allowing us, for the first time, to derive spatially resolved star formation histories (SFHs) of nearby galaxies. This kind of data can be obtained with wide-field ground-based images for the nearest galaxies, namely, the Milky Way satellites,and with ACS+WFC3 on HST for more distant Local Group galaxies. These full-time, detailed SFHs are revealing the true nature of the stellar population gradients that have been described in these galaxies since the early observations of Baade. In general, star forming galaxies such as the Magellanic Clouds and dwarf irregular galaxies show a smooth variation of the SFH from an inner part with high current star formation rate, to an outer part dominated by intermediate-age and old stars. Dwarf spheroidal galaxies also show stellar population gradients, with more extended SFHs in their central parts. I will present detailed results on the Magellanic Clouds and a number of dwarf galaxies, with some emphasis on the Local Cosmology from Isolates dwarfs (LCID) sample of six isolated Local Group dwarfs.

Dark Matter Environment of Exponential Disks (Invited Talk)

Ortwin Gerhard | Max Planck Institute for Extraterrestrial Physics

In this talk my goal is to discuss the dynamical masses of exponential disks from different approaches, including the Milky Way disk and peanut bulge, and then turn to the inferred properties and effects of the dark matter halos surrounding them.

The Chemistry and Age Structure of Broken (And Not-So-Broken) Exponential Disks (Contributed Talk)

Brad Gibson | Jeremiah Horrocks Institute, University of Central Lancashire

The origin of the apparent correlation between surface brightness "breaks" and "U-shaped" age gradients in galaxies possessing Type II profiles has received much attention, with scenarios postulated ranging from radial migration to star formation density thresholds (e.g. Sanchez-Blazquez et al 2009, and references therein). Having said that, a fully holistic approach spanning the spectrum of surface brightness profiles (Types I, II, and III), making use of unbiased suites of cosmological disk simulations, has not been undertaken. I will present a detailed deconstruction of the photometric, chemical, and density profiles of 20 simulations drawn from RaDES (Few et al 2012), spanning a range of Type I, II, and III profiles. The degree of kinematic heating (driven by secular and accretion events) will be shown to leave tell-tale signatures in the age gradient, age-metallicy relation gradient, and age-velocity dispersion gradient, consistent with (primarily) a satellite accretion origin.

The Formation and Evolution of Clumpy Galaxies from z=3 to z=0.5 (Contributed Talk)

Yicheng Guo | University of California - Santa Cruz

A common feature of star-forming galaxies at $z>1$ is the existence of giant star-forming clumps, which are fundamental to our understanding of the accretion history of galaxies, formation of bulges, and evolution of gas-rich disks. In this talk, I will present our work on linking high-redshift clumpy galaxies and low-redshift settled (rotation dominated) disks in three aspects: (1) the physical properties of high-redshift clumps; (2) the evolution of the fraction of clumpy galaxies from $z=3$ to $z=0.5$; and (3) the connection between the clumpy appearance and the kinematics of settled and unsettled disks at $z\sim0.5$. The three aspects provide important clues of tracing the physical mechanisms that are responsible for transferring distant clumpy galaxies into disk galaxies seen in the local universe.

Stellar Surface Brightness Profile Breaks of Dwarf Galaxies (Contributed Talk)

Kim Herrmann | Pennsylvania State University - Mont Alto

Radial stellar surface brightness profiles of spiral galaxies can be classified into three types: (I) single exponential, or the light falls off with one exponential out to a break radius and then falls off (II) more steeply ("truncated"), or (III) less steeply ("anti-truncated"). Why there are three different radial profile types is still a mystery, including why light falls off as an exponential at all. Profile breaks are also found in dwarf disks, but some dwarf Type IIs are flat or increasing (FI) out to a break before falling off. I have been re-examining the multi-wavelength stellar disk profiles of 141 dwarf galaxies, primarily from Hunter & Elmegreen (2004, 2006). Each dwarf has data in up to 11 wavelength bands: FUV and NUV from *GALEX*, *UBVJHK* and Hα from ground-based observations, and 3.6 and 4.5 μm from *Spitzer*. I will highlight some results from a semi-automatic fitting of this data set including: (1) statistics of break locations and other properties as a function of wavelength and profile type, (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 the 40 dwarfs of the LITTLE THINGS subsample.

Initial Angular Momentum and the Radial Structure of Disks (Contributed Talk)

Jakob Herpich | Max-Planck-Institut für Astronomie Heidelberg

Analytic models of exponential disk formation assume that the specific angular momentum of a galaxy is conserved. I will report the results of a study on the formation of exponential disks based on hydrodynamical simulations of Milky Way sized galaxies. I test the dependence of disk size on the initial angular momentum distribution of baryons which is motivated by cosmological simulations and also used in analytic models (e.g. Dutton 2008). The results are compared to the findings of these analytic models. In particular I will show evidence that specific angular momentum is not conserved unlike analytic models assume.

The Outer Disks of Dwarf Irregular Galaxies (Poster)

Deidre Hunter | Lowell Observatory

In order to explore the properties of extreme outer stellar disks, we obtained ultra-deep *V* and *GALEX* ultraviolet (UV) images of four dwarf irregular galaxies and one blue compact dwarf galaxy, and ultra-deep *B* images of three of these. Our *V*-band surface photometry extends to 29.5 mag/arcsec^2. We convert the FUV and *V*-band photometry, along with Hα photometry obtained in a larger survey, into radial star formation rate profiles that are sensitive to timescales from 10 Myr to the lifetime of the galaxy. We also obtained H I-line emission data and compare the stellar distributions, surface brightness profiles, and star formation rate profiles to H I-line emission maps, gas surface density profiles, and gas kinematics. Our data lead us to two general observations. First, the exponential disks in these irregular galaxies are extraordinarily regular. We observe that the stellar disks continue to decline exponentially as far as our measurements extend. In spite of lumpiness in the distribution of young stars and H I distributions and kinematics that have significant unordered motions, sporadic processes that have built the disks--star formation, radial movement of stars, and perhaps even perturbations from the outside-— have, nevertheless, conspired to produce standard disk profiles. Second, there is a remarkable continuity of star formation throughout these disks over time. In four out of five of our galaxies the star formation rate in the outer disk measured from the FUV tracks that determined from the *V*-band, to within factors of five, requiring star formation at a fairly steady rate over the galaxy's lifetime. Yet, the H I surface density profiles generally decline with radius more shallowly than the stellar light, and the gas is marginally gravitationally stable against collapse into clouds. Outer stellar disks are challenging our concepts of star formation and disk growth and provide a critical environment in which to understand processes that mold galaxy disks.

Modelling Spatially Resolved Star Formation History, Metallicity Gradients and Radial Flows in CALIFA Disk Galaxies (Contributed Talk)

Bruno Jungwiert | Astronomical Institute ASCR

Spatially resolved spectroscopy of galaxies coupled to detailed stellar population synthesis modeling allows to put important constraints on star formation and metallicity buildup histories. However, various radial mixing phenomena related to the presence of spiral arms and bars intervene to influence the mass and metallicity radial profiles. We use the spatially resolved star formation history as deduced from disk galaxies of the CALIFA survey and interpret it by means of N-body gas dynamical simulations, trying to quantify the role of migration processes in redistributing mass and metallicity across galactic disks.

The Pitch Angle Distribution Function and its Role in Understanding Galactic Disks (Poster)

Daniel Kennefick | University of Arkansas

We present a sample of galaxies in the southern hemisphere (drawn from the Carnegie-Irvine Near Galaxy Survey) for which we have measured pitch angles for nearly all visible galaxies closer than 25.4 Mpc. From this we can produce a pitch angle distribution function, which may be useful in two different ways. First of all it may help us to better understand the structure of galaxies in the neighboring Universe, based on evidence that pitch angle correlates well with other features of disk galaxies (such as central mass and disk density). Secondly it will be a useful baseline by which more distant galaxies can be compared to see if they differ from spiral galaxies in the current epoch. In this way the evolution of spiral galaxies may be better understood.

Role of Gas Infall and Outflows in Formation of Galactic Disks (Invited Talk)

Dusan Keres | University of California, San Diego

Formation of observed population of galaxies requires galactic gas infall and galactic outflows. Recently, we have implemented physically motivated star-formation-driven feedback model on scales of giant molecular clouds and used it to model galaxies within cosmological environments. Results from our FIRE project simulation suite demonstrate that such feedback can drive large scale galactic outflows that help produce realistic galaxies. These simulations enable us to follow galaxy evolution, gas infall and outflow and their mutual interaction in greater details than previously possible. I will briefly discuss early stages of galaxy evolution with rapid gas infall, bursty star formation and efficient outflows and focus on the late time evolution when inefficient outflows and continuous gas infall enable continuous star formation and buildup of extended galactic disks.

Structure of the Inner 300 Parsecs of the Milky Way Galaxy (Poster)

Devaky Kunneriath | Astronomical Institute - Prague

The central region of the Milky Way galaxy contains the Nuclear Bulge (NB), composed of the Nuclear Stellar Cluster (NSC) and the Nuclear Stellar Disk (NSD). Extinction due to gas and dust towards the Galactic centre along our line of sight is strong and highly variable, making it difficult to infer the intrinsic properties of the NB, such as structure and size. We present results from our analysis of the central 300 pc x 200 pc region of the Milky Way galaxy, using *Spitzer* images from 3-8 microns, where extinction is at a minimum. Our results include 2-d surface brightness profile fits to the NSC and NSD. We also discuss other properties of the NB such as scale lengths, mass and luminosity.

Near Infrared View to Disk Breaks (Contributed Talk)

Jarkko Laine | University of Oulu

I will present the results of a study of disk breaks in radial surface brightness profiles that uses the near infrared data of the *Spitzer* Survey of Stellar Structure in Galaxies (S4G) and the Near Infrared S0-Sa galaxy Survey (NIRS0S). We have used two samples that have been studied with the same methods. The first sample focuses on massive disk galaxies ($\sim 10^{10}$-10^{11} $M_\odot$, $-3<T<7$), while the second one is a complementary sample of smaller mass galaxies ($\sim 10^{8}$-10^{10} $M_\odot$, $-3<T<9$). We have also connected the breaks to the morphological features in galaxies. We found that the downbending double exponential profiles (type II) in massive galaxies can be divided into to two distinct classes, as also proposed in earlier studies. In early type ($T<3$) massive disk galaxies type II profiles are related to the resonance features of the bar (e.g. outer rings, lenses), with the radius of the feature matching the break radius. The nature of type II breaks in late type ($T>3$) massive galaxies is different, so that the break radius is found to be connected with the star formation regions in the spirals or with the apparent outer edges of the spiral structure. For the less massive galaxy sample our preliminary results show that single exponential profiles are more common than in massive galaxies, but also some of the disks seem to follow a Sersic profile more closely than an exponential. In addition, we have also done an environmental analysis for the massive galaxy sample in order to examine the effect of the local environment to the disk features. We found a weak, but statistically significant correlation, between the environmental parameter estimating the tidal interaction strength and the disk scalelengths of type III profiles in massive galaxies.

Disk Thickness Driven by the Spiral Arms in Normal Spiral Galaxies (Poster)

Luis Alberto Martinez Medina | Departamento de Física, Cinvestav

The fact that galactic disks heat with time has now been known for over 60 years. Recent studies actually show that many, if not all, edge-on spiral galaxies appear to host dual disk systems. An important question of modern galactic astronomy is how thick discs came into existence. Among the many mechanisms proposed to explain the disk heating, we attempt to isolate and quantified the contribution of the spiral arms to the formation of a thick disk. We perform numerical simulations of test particles in a 3D galactic potential that models normal spiral galaxies (Sa, Sb and Sc) and includes the axisymmetric component plus the spiral arms based on a self-gravitating potential, PERLAS model (Pichardo et al. 2003). By varying the parameters of the spiral arms we found that the vertical heating of the stellar disk is very important in some cases and strongly depends on the galaxy morphology, pitch angle, arm mass and pattern speed.

Massive Quiescent Disks in the Early Universe (Invited Talk)

Elizabeth McGrath | Colby College

Observations in the local Universe suggest that the mechanism responsible for quenching star formation in galaxies may be intimately linked to their structural transformation from disks to spheroids. In order to test quenching scenarios, however, it is vital to look beyond the local Universe and identify the first generation of quiescent galaxies at high redshift. Using CANDELS, we have examined the rest-frame visible morphologies for a sample of massive, quiescent galaxies at $z>1$. Interestingly, a significant fraction (~30%) have morphologies dominated by massive exponential disks. The persistence of massive disks, long after star formation has ceased, implies that in at least some cases quenching precedes morphological transformation. I'll examine what constraints these observations place on the mechanisms responsible for quenching the first generation of passive galaxies at $z\sim2$ and discuss them in context with an emerging picture of massive galaxy formation and evolution.

The Extended Optical Disk of M101 (Contributed Talk)

Chris Mihos | Case Western Reserve University

We use deep ($\mu_{B,lim} = 29.5$) optical imaging of the nearby spiral galaxy M101 to study the structure of its outer disk to a radial extent of nearly 50 kpc (~10 scale lengths, or 3 R_{25}). At these radii, the well-known asymmetry of the inner disk slews 180 degrees, resulting in an asymmetric plume of light to the NE which follows the galaxy's very extended HI disk. This NE plume has very blue colors, suggesting that it is the somewhat more evolved counterpart of the young FUV-emitting population traced by *GALEX*. We also detect another, redder spur of extended light to the east of the disk, and both structures are reminiscent of features produced during fly-by galaxy interactions. Because of the strong disk asymmetry, the disk scale length and presence/absence of a profile break depends strongly on the range of radii and azimuth used to do the fit, but in the end the overall profile of the disk is reasonably (and surprisingly) well fit by a single exponential, arguing that the ongoing buildup of extended exponential galaxy disks continues even today in the local universe.

Evolution of the Disk Scale-Length for Mono-Age Populations (Contributed Talk)

Ivan Minchev | Leibniz-Institute for Astrophysics Potsdam

I will use numerical simulations of galactic disk formation in the cosmological context to show how stellar radial profiles evolve with time for populations of different ages. It will be shown that while old stars tend to increase their radial scale-length with time, the opposite effect is seen for the youngest stellar populations. I will relate this to the SFH and evolution of stellar birth velocity dispersion with redshift. The agents responsible for the redistribution of disk angular momentum, as a function of redshift, will be identified.

The Distribution of Metals in the Thick Disc (Contributed Talk)

Maider Sancho Miranda | University of Central Lancashire

We examine how both the radial and vertical metallicity gradients change as a function of distance from the galactic plane and radius, along with an analysis of the stellar rotational velocities. We use a suite of chemo-dynamical simulations, realised as part of the MAking Galaxies In a Cosmological Context (MaGICC) project, the McMaster Unbiased Galaxy Survey (MUGS) and one galaxy using the new Ramses-CH code. The galaxies span a range of masses, feedback prescriptions and initial conditions/assembly history. Our work reveals the radial metallicity gradients of the kinematically-defined disk stars to be negative in the mid-plane of the simulated discs but when we reach $\sim$1 kpc above the plane the radial gradients become inverted (i.e. more metal-rich in the outskirts, relative to the inner parts of their respective discs). Such behaviour is consistent with that inferred from SEGUE data (e.g. Cheng et al 2012; Carrell et al 2012). Our measurements of the vertical metallicity gradients show no clear correlation between them and distance from the galactic centre, but do find values of vertical gradients to be in good agreement with the observations from Carrell et al 2012. Each of the simulations shows a decline in rotational velocity with increasing height from the plane of the galaxy. However, only one simulation shows a decline of similar amount to observations of the Milky Way (e.g. Moni Bidin et al 2012). We conclude our simulated galaxies that use the higher feedback prescriptions (MaGICC and 109-CH) show results more in line with observations. This extra feedback is needed to drive both the radial and vertical metallicity and kinematic gradients to values that better match the most recent observations in this field.

Little Blue Spheroids and Disk Evolution in GAMA (Contributed Talk)

Amanda Moffett | ICRAR, University of Western Australia

A population of blue, morphologically early-type galaxies, dubbed the "Little Blue Spheroids" (LBSs), has been identified as a significant contributor to the low z galaxy demographics of the Galaxy And Mass Assembly (GAMA) Survey. These typically low stellar mass galaxies may represent a transitional class between traditional early-type and late-type populations, with colors implying the recent star formation expected of late types combined with the morphologies of early types and certain structural characteristics in common with both classes. Using deep, high-resolution optical imaging from the Kilo Degree Survey (KiDS) data release 1, we examine the detailed bulge and disk properties of LBSs identified in GAMA, finding evidence for distinct disk components often not well detected in prior SDSS imaging. We further examine the typical environments, star formation properties, and gas content of LBSs to better understand the conditions of their formation and the current status of their structural evolution.

The Origin of Stellar Breaks at Large Radii as Probed by the *Spitzer* Survey of Stellar Structure in Galaxies (Contributed Talk)

Juan-Carlos Munoz-Mateos | European Southern Observatory

Is the current distribution of old stars in disks mostly determined by in-situ star formation or by radial stellar migration? Breaks in the radial profiles of disks may hold the answer to this question: they can result from changes in the local star formation activity, but they may also form at the resonances of bars and spirals via stellar migration. I will present our recent results on this subject using data from the *Spitzer* Survey of Stellar Structure in Galaxies (S4G), a deep and homogeneous survey of more than 2300 nearby galaxies imaged at 3.6 and 4.5 microns, which allows us to peer through dust at the old stellar backbone of galaxies. In the case of barred galaxies, apart from the well-known breaks at roughly twice the bar radius (the bar OLR), we also found a second family of breaks at larger radii, in quantitative agreement with a dynamical coupling between the bar and the spirals. Numerical simulations have shown that such a coupling can be indeed a very efficient driver of stellar migration out to large radii. I will also discuss our current efforts to map the distribution of molecular gas in galaxies with potential signs of migration, in order to quantify how in-situ star formation and radial migration compete to build and mold the stellar structure of disks.

Forming Exponential Disks in Cosmological Simulations (Contributed Talk)

Aura Obreja | Universidad Autónoma de Madrid

Forming exponential disks similar to observed spiral galaxies is now possible in cosmological simulations of galaxy formation using supernovae and pre-SN stellar feedback schemes. Analytic models find that exponential disks are the result of angular momentum conservation. In cosmological simulations, however, it is not yet clear whether the collapsing gas conserves its angular momentum. We use the fiducial run from the MaGICC project (Stinson et al 2013) to study the evolution of the stellar surface density profiles in correlation with the angular momentum evolution of the progenitor gas. The radial density profile of this disk galaxy at any epoch can be described as an exponential or a broken exponential (Kormendy 1977). The transition between the two profile types may be linked to merger events. We select mono-age stellar populations of the disk and track the evolution of the angular momentum, temperature and time of disk accretion particle by particle to study the exact mechanism that brings about the exponential surface density profile in these cosmological simulations.

A Direct Estimate of the Radial Growth of Stellar Discs (Poster)

Gabriele Pezzulli | Department of Physics and Astronomy - University of Bologna

We present a new and simple way to measure the instantaneous growth rate of a stellar disc, based on its star formation rate density (SFRD) profile. Under the hypothesis that the stellar mass surface density of a disc is well described by an exponential with a scalelength that grows with time, we derive a theoretical profile for the SFRD, which depends on two parameters: the mass and size growth rates of the disc. We test the predictions of this theory on a sample of 35 nearby spiral galaxies, for which we derived profiles of stellar mass and SFRD from published profiles at 3.6 micron and extinction-corrected FUV, based on data from the SINGS and *GALEX* surveys (Munoz-Mateos et al. 2009). For most galaxies, we find good agreement with expectations and we are able to measure the specific growth rates for the disc stellar mass and scalelength. We briefly discuss our findings in the light of scaling relations and their evolution with cosmic time.

Stellar Populations In The Outer Regions from the CALIFA Survey (Contributed Talk)

Isabel Perez Martin | Universidad de Granada

Far from the simple exponential profile proposed some decades ago to explain the light distribution of disc galaxies, it has been shown that they can also present a variety of profiles in their outer parts. Despite the great observational and theoretical effort on this topic, the origin of these features is still unknown. Different mechanisms have been proposed to explain these profiles. Until now very few observational constrains have been obtained to help discern among the different mechanisms. The distribution of stellar parameters can help to constrain these different scenarios. In this study, we present the radial stellar population distribution, ages, metallicities and SFHs, of a large and well defined sample of small galaxies within the CALIFA survey. We have analysed the CALIFA 2-D spectra using full spectral fitting techniques. We find statistical trends for the stellar population radial gradients and SFHs of galaxies presenting different light profiles in the outer parts. We compare the results from the spectral fitting with the SDSS radial colour distributions.

Restrictions to Spiral Arms Parameters in Normal Galaxies: Ordered and Chaotic Stellar Orbital Studies (Contributed Talk)

Angeles Perez Villegas | Universidad Nacional Autónoma de México

We built a family of non-axisymmetric potential models for normal non-barred spiral galaxies. For this purpose a three-dimensional self-gravitating model for spiral arms (PERLAS) is superimposed to the galactic axisymmetric potentials. We analyze the stellar dynamics varying structural and dynamical parameters such as pitch angle, strength of spiral arms (spiral arm mass) and angular speed. For the pitch angle, we found two limits, one of their steady or transient nature and one on their maximum pitch angle. The first limit, based on ordered behavior, periodic orbits studies show that for pitch angles up to approximately 15 deg, 18 deg, and 20 deg for Sa, Sb and Sc galaxies, respectively, the density response supports the spiral arms potential, a requisite for the existence of a long-lasting large-scale spiral structure. Beyond those limits, the density response tends to "avoid" the potential imposed by maintaining lower pitch angles in the density response; in that case the spiral arms may be explained as transient features rather than long-lasting large-scale structures. In a second limit, from a phase space orbital study based on chaotic behavior, we found that for pitch angles larger than ~30 deg, ~40 deg and 50 deg for Sa, Sb, and Sc galaxies, respectively, chaotic orbits dominate all phase space prograde region that surrounds the periodic orbits sculpting the spiral arms and even destroying them. Finally, we studied orbital dynamics now varying other parameters as pattern speed and spiral arms mass; also we were looking for restriction for these parameters in different morphological types. In these studies we noticed that the spiral arms effect produces to the disk dynamics when we vary the pattern speed and mass is strongly linked to the pitch angle.

The Extended HI Environment of Nearby Galaxies (Invited Talk)

D.J. Pisano | West Virginia University

Compared to stars, the neutral hydrogen (HI) in galaxies generally extends to larger distances. As such, HI serves as an excellent tracer of how big galaxy disks are and the environmental influences on the outer parts of galaxies. In this talk, I will review what we know about the extended HI disks of galaxies and what lies beyond their edges. In addition, I will present new results from an ongoing Green Bank Telescope survey of HI around galaxies probing down to extremely low column densities and the resulting implications for the evolution of galaxy disks.

Does the Milky Way Have an Accreted Disk Component? (Contributed Talk)

Gregory Ruchti | Lund Observatory

Recent simulations have shown that massive satellite galaxies can experience a phenomenon known as dynamical friction plane dragging when they interact with the disk of the Milky Way during mergers. Thus, after several passes through the Galactic disk, remaining stars in the satellite galaxy will be dragged down to the disk plane and deposited into the disk of the Milky Way. We have developed a new chemo-dynamical template based on the dynamics of galactic mergers combined with the characteristic element ratios of stars present in surviving satellite galaxies to find these accreted disk stars. We have applied our analysis to several high-resolution spectroscopic samples, as well as to data from the Gaia-ESO Survey, which is an extraordinary resource for this study. I will discuss our results from this work.

A Portrait of Malin 2: A Case Study of a Giant Low Surface Brightness Disk Galaxy (Poster)

Anna Saburova | Sternberg Institute of M.V. Lomonosov Moscow State University

The low surface brightness (LSB) disk galaxy Malin 2 challenges the standard theory of galaxy evolution because of its enormous total mass 2×10^{12} Msun, which must have been formed without recent major merger events. The aim of our work is to create a coherent picture of this exotic object by using new optical multicolour photometric and spectroscopic observations at the Apache Point Observatory as well as archival data sets from Gemini and wide-field surveys. We have performed Malin 2 mass modelling, we have estimated the contribution of the host dark halo and we have found that it acquired its low central density $\rho_0 = 0.003$ Msun pc^3 and huge isothermal sphere core radius rc = 27.3 kpc before the disk subsystem was formed. Our spectroscopic data analysis reveals complex kinematics of stars and gas in the very inner region (r = 5-7 kpc). We have measured the oxygen abundance in several clumps and we have concluded that the gas metallicity decreases from the solar value in the centre to a half of that at 20-30 kpc. Our modelling of the ultraviolet-to-optical spectral energy distribution favours the exponentially declined star formation history over a single-burst scenario. We argue that the massive and rarefied dark halo which formed before the disk component describes all the observed properties of Malin 2 well and we find that there is no need to assume additional catastrophic scenarios (such as major merging) proposed previously in order to explain the origin of giant LSB disks.

Disk and Bulge Decompositions in S4G Galaxies (Invited Talk)

Heikki Salo | University of Oulo

The *Spitzer* Survey of Stellar Structure in Galaxies (http://www.cv.nrao.edu/~ksheth/S4G/Site/S4G_Home.html) is a volume, size and magnitude limited survey which provides deep homogeneous 3.6 and 4.5 micron data for over 2300 nearby (D < 40 Mpc) galaxies, giving an (almost) unbiased view of the local galaxy properties over a wide range of stellar masses, morphological types and environments. I review the results from the S4G structural decomposition analysis, for example concerning the disk mass-size and mass-surface density scaling relations. Our results complement in an interesting manner the results from larger (eg. SDSS-based) surveys which however are typically limited to intrinsically brighter galaxies.

Radial Profiles of Star Formation Histories from CALIFA (Invited Talk)

Sebastian Francisco Sanchez | Universidad Nacional Autónoma de México

We present here the last results we obtained on the spatial resolved analysis of the stellar populations and ionized gas of disk-dominated galaxies based on CALIFA data. CALIFA is an on-going IFS survey of galaxies in the Local Universe ($0.005<z<0.03$), aimed to obtain spectroscopic information up to ~2.5 R_{eff} with a spatial resolution better than 1 kpc for a total number of 600 galaxies of any morphological type, covering the CM-diagram up to $M_r<-18$ mag. With nearly 2000 spectra obtained for each galaxy, CALIFA offer one of the best

IFU data to study the star-formation histories and chemical enrichment of galaxies. In the case of disk-dominated galaxies, we analysed the stellar populations using different inversion methods and line analysis, and the ionized gas identifying the main properties of the HII-regions within the FoV. Both analyses produce coherent analysis indicating that disk-galaxies growth is inside out, with a chemical enrichment dominated by local processes, and limited effects of radial mixing or global outflows.

Stellar Populations in Disc Galaxies from the CALIFA Survey. The Influence of Bars (Contributed Talk)

Patricia Sanchez-Blazquez | Universidad Autónoma de Madrid

We present a study devoted to test observationally the theoretical prediction that non-linear coupling between the bar and the spiral arms is an extremely efficient mechanism at producing radial migrations across significant distances in the galactic discs. The process of radial migration should flatten the stellar metallicity gradient with time. While studies of gas-phase metallicity gradients in disc galaxies are common, very few works have obtained stellar metallicity gradients in the disc region of spiral galaxies. We present here a comparative study of the stellar metallicity and age distribution in a sample of 62 face-on, spiral galaxies with and without bars using data from the CALIFA survey. We analyse the metallicity gradient for stellar populations of different ages and the relation between the slope of the stellar population gradients and other properties of the galaxies. Our main result is that we do not find any difference in the metallicity or age gradients in galaxies with and without bars. Furthermore, when normalized to the effective radius of the disc, the slope of the stellar population gradients do not correlate with the mass or with the morphological type of the galaxies. We discuss possible scenarios that can lead to this absence of difference.

Secular Evolution of Disk Mass Profiles (Invited Talk)

Jerry Sellwood | Rutgers University

The secular evolution of galaxy disks is largely driven by spiral instabilities. In particular, they transport angular momentum, scatter stars, cause extensive radial mixing, help drive galactic dynamos, and smooth out irregularities in the mass profile and rotation curves. Here I will focus on this last topic, giving examples and explaining the smoothing mechanism.

Origin of Disk Angular Momentum (Invited Talk)

Adrianne Slyz | University of Oxford

I will describe theoretical ideas about how disk galaxies acquire angular momentum, focusing on the role of the cosmic web. I will show a case study of a high resolution resimulation of a galaxy indicating the dominant role played by gas filaments in angular momentum transport, discuss how this transport for gas differs from that of dark matter, and present ideas about how the dynamics of the cosmic web explains the angular momentum content of filaments and the direction of the spin of disk galaxies forming within them.

The Chemical Evolution of Simulated Galaxies (Poster)

Owain Snaith | University of Alabama

The chemical properties of stars encode the star formation history of galaxies. We examine the chemical history of stars using a sample of simulated galaxies from the McMaster Unbiased Galaxy Simulations. By contrasting these simulated galaxies with a further galaxy modelled by using early feedback (Stinson et al), we consider the expected signatures of galaxy assembly in the abundances of stars. We see that at any given age there is a one dex scatter in the metallicity of stars in the disc component alone. We identify the origin of considerable amounts of substructure and the cause of non-monotonic behavior in the metallicity of our galaxies and their satellites. By framing our results in terms of observations of stars in the Milky Way and beyond, we discuss the consequences of using metallicities and alpha abundances as a proxy for age and the observational precisions required to see similar results in observed galaxies.

Exponential Profile Formation in Simple Models of Scattering Processes (Contributed Talk)

Curtis Struck | Iowa State University

We have carried out simple models of the effects of scattering of stars by massive density disturbances in disks, especially large clumps in young disks. Regardless of initial density profile, halo potential structure, and the details of the scattering structures, we find a strong tendency to form exponential surface density profiles. On the other hand, there are important differences in how the density profiles evolve and the stellar orbital kinematics, which do depend on halo potential structures and details of the scattering process. These simple few-body (e.g., halo potential plus softened point-mass clumps) models, with test particle stars, provide an important bridge between comprehensive disk evolution simulations and fundamental theory.

Observations of Gas and Dust in Disks at High Redshift (Invited Talk)

Linda Tacconi | Max Planck Institute for Extraterrestrial Physics

Comprehensive and systematic studies of the gas content and dynamics of galaxies during the epochs that are associated with the peak ($z\sim1$-2), and subsequent winding down ($z<1$) of star formation in the Universe are enabling us to illustrate the important roles that gas accretion, star formation and feedback have played in the assembly of galaxies across cosmic time. In this talk I will discuss progress made in studies of the kinematics, star formation and gas properties of hundreds of $z\sim0.5$-3 massive star forming galaxies (SFGs) with spatially resolved NIR and millimeter spectroscopy. These SFGs are very gas rich and likely develop from continuous, rapid accretion of gas from their dark matter halos. Their evolution is strongly influenced by internal, secular evolution. I will discuss the first scaling relations for massive SFGS, and the impact of all of these new observations on our understanding of galaxy evolution in the early Universe.

Extended UV Disks (XUV-disks) and Their Inter-Relation with Optical Galaxy Structure (Invited Talk)

David Thilker | John Hopkins University

The discovery of extended ultraviolet disk (XUV-disk) galaxies early in the *GALEX* mission invigorated the study of star formation in the low surface density regime characteristic of outermost exponential disks. However, initial results concerning the XUV-disk population were based on a rather small set of objects with potential bias. The situation has improved greatly with *GALEX* UV observations now available for many thousand nearby galaxies – forming a comprehensive, statistically significant sample in which to probe this mode of star formation / disk growth. Highlights from this new, broader view include the existence of early type galaxies with XUV-disks and giant, low surface brightness disk galaxies apparently caught in formation. We will review the findings of an updated census of XUV-disks based on the latest *GALEX* release, and will attempt to reconcile such UV-traced star formation with new, deep Pan-STARRS1 (PS1) optical imaging which shows a characteristic radial minimum and outer disk rise in the mean stellar age profiles of disk galaxies.

Metallicity Gradients in Galaxy Discs (Contributed Talk)

Patricia Tissera | Universidad Andrés Bello

We analyse the distributions of stars of different ages and chemical abundances in the disc components of galaxies formed in ΛCDM cosmology. We explore how their metallicity gradients and compared them with current observations. Similarly we analyse the chemical abundances of the gas components. Since we have a variety of galaxy morphologies, we aim at understanding how the chemical properties of the discs are modified along their evolutionary history. In this regard, we follow the stars on the disc in time to determine the evolution of the metallicity profiles and their place of formation.

Angular Momentum Evolution of Discs and Spheroids (Poster)

Patricia Tissera | Universidad Andrés Bello

In the current cosmological paradigm, galaxy formation is a very complex process and the key factors that determine the final morphology of galaxies are still a matter of debate. We analyze comparatively the correlation between the specific angular momentum and the stellar mass of the discs and bulges. For this purpose, we use intermediate resolution hydrodynamical cosmological simulations that are part of the Fenix Project.

Disk Truncations in Spiral Galaxies (Invited Talk)

Piet van der Kruit | Kapteyn Astronomical Institute

It has been recognized around 1980 that stellar disks of edge-on spirals do not fade out radially but show a often rather sharp truncation. The majority of edge-ons show this behaviour. When the HI layer is more extensive than the stellar disk, a warp usually starts just beyond the truncation. The origin of these truncations is not clear, but the association with warps indicated that it probably is the extent of the disk after initial disk formation corresponding to the maximum specific angular mementum present and that the HI of the warp is matter that fell in later. Truncations have been elusive in face-on or moderately inclined disks, due to the expected very faint surface brightness at which they are expected to occur. In a sample of galaxies from the IAC Stripe82 Legacy Project we have been able to detect truncations in three cases (out of 23) at about 29 mag arcsec in r′. In most other cases a faint halo around the galaxy prevents the detection of truncations. The galaxies used are only a few arcmin in diameter and these faint structures are to a large extent probably scattered light from the central regions.

Studying Outer Disk Formation Using Extremely Deep Surface Photometry of Nearby Galaxies (Contributed Talk)

Aaron Watkins | Case Western Reserve University

Under current models of galaxy formation, disk galaxies form "inside out", implying that the most recent signatures of their formation should be evident in their outermost regions. To search for such signatures, we have conducted deep ($\mu_{B,lim} \sim 30$, with accurate *B-V* colors down to $\mu_B \sim 27$) observations of 7 nearby disk galaxies, including three members of the Leo I Group, as well as more isolated galaxies such as M94. We present preliminary results on the morphologies, surface brightnesses, and colors of these galaxies out to large radius. We quantify the varying structural properties of these galaxies, including, for example, the presence of a sharp anti-truncation in the exponential profile of M64's outer disk. In general, we find few signs of strong perturbations or extensive ongoing star formation in the outer disks of our galaxies, save for those in the most strongly interacting systems. This argues that outer disk building has either slowed in recent times, or that it is driven by more modest secular processes inside the galaxies.

Observations of Stars in Disks at High Redshift (Invited Talk)

Stijn Wuyts | Max Planck Institute for Extraterrestrial Physics

The *Hubble Space Telescope* and integral-field spectrographs on the ground offer us an unprecedented view of the internal physics within high-redshift galaxies. Exploiting the powerful synergy between multi-band high-resolution imaging from CANDELS and spectroscopy from 3D-HST, SINS, and KMOS^{3D}, I will present new insights on resolved stellar populations, bulge growth and quenching since $z \sim 2.5$, as well as dynamical constraints on the mass budget in early disks. I will emphasize the importance of using both stellar and gaseous tracers to reconstruct the characteristic life cycle of galaxies, and obtain a comprehensive picture of galaxy growth.

Observations of Thick Disks (Invited Talks)

Rosemary Wyse | John Hopkins University

The vertical structure of stellar disks in spiral galaxies is determined by the relative importances of diverse physical processes, including gaseous dissipation prior to star formation, subsequent gas accretion into the disk, heating mechanisms such as interactions with transient spirals, and the mass ratios and gas content of merging systems. I will discuss observational constraints on disk evolution from the properties of thick disks, in resolved stars at low redshift and in spatially resolved galaxies at higher redshift.

Spectroscopic Star Formation Histories in a Variety of Exponential Disks (Invited Talk)

Peter Yoachim | University of Washington

With large (4.3 arcsecond) fibers, the VIRUS-P spectrograph is an amazing instrument for gathering optical spectra at extremely low surface brightness levels. I will summarize three projects related to exponential disks we have undertaken with this instrument. (1) The outskirts of spirals with down-bending surface brightness profiles where we find signs of stellar radial migration, (2) The star formation history of “red spirals”, and (3) Uncovering the formation of giant low surface brightness galaxies.

Burst and Quench? The Life Story of Low Surface Brightness Galaxies (Poster)

Jason Young | The Pennsylvania State University

We present a first look at spatially resolved optical/infrared spectral energy distributions (SEDs) of low surface brightness disk galaxies. We have observed a sample of low surface brightness galaxies with the VIRUS-P integral field spectrograph and have combined those observations with archival *Spitzer* IRAC images to create SEDS. We present these SEDs in the context of different candidate star-formation histories.

This easily overlooked class of galaxy comprises up to half of the galaxy population with masses spanning that of the Milky Way, making them cosmologically significant baryon repositories. They are also very different from the more familiar archetypal galaxies in that they have unusually high gas fractions, up to 95%. Yet, they do not represent a distinct class of galaxy, but are simply on the low surface brightness end of a continuum.

Our spatially resolved spectra give our analyses a significant advantage over those based on broad-band photometry, which have significant model degeneracies, and those based on whole-galaxy measurements, which average out distinct stellar populations. Additionally, because we analyze our optical spectra, which are sensitive to age indicators such as Lick Indicies and the 4000 angstrom break, in tandem with *Spitzer* IRAC photometry, which is a direct measurement of the integrated star-formation history, we are able to discriminate between candidate histories with greater confidence than earlier works.

We aim to use our analyses to characterize the star-formation histories of galaxies over a range of surface brightnesses near the low end of the observed continuum so that these galaxies can be appropriately placed in the larger context of galaxy formation over cosmic time.