Evolutionary Paths in Galaxy Morphology

Schedule and Scientific Program

Version 2.0 17 September 2013

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Evolutionary Paths in Galaxy Morphology: a Galaxy Zoo Conference

Powerhouse Museum, Sydney Australia, 23 to 26 September 2013

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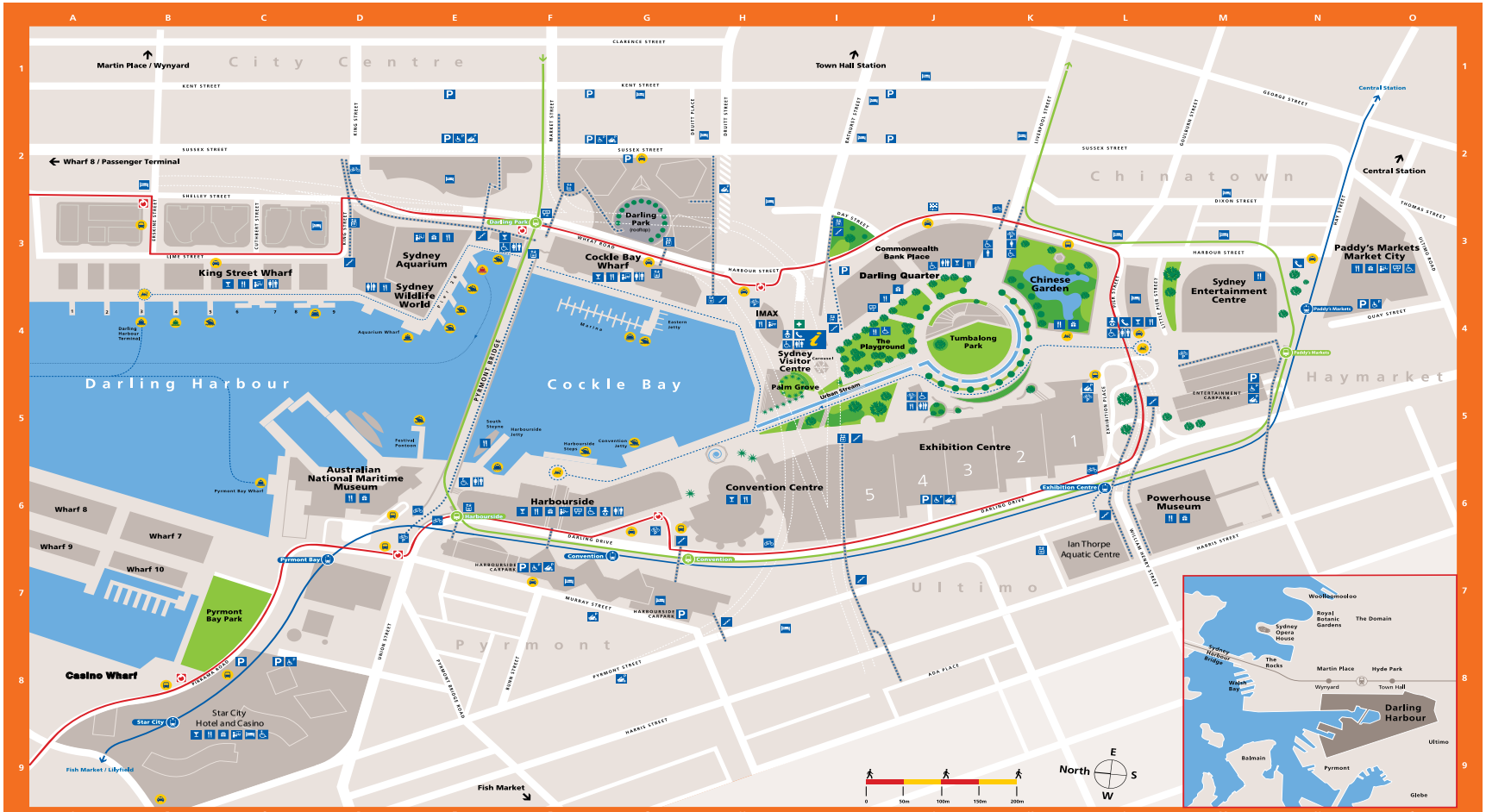
DARLING HARBOUR MAP



Attractions and museums

Australian National Maritime Museum	D6
Captain Cook Cruises	E3
Carousel	I4
Chinese Garden of Friendship	K3
Cockle Bay Amphitheatre	H4
Cockle Bay Wharf	F3 – H3
Darling Harbour Marina	F4 – G4
Harbourside Amphitheatre	F5
Kingpin Bowling Lounge	G6
King Street Wharf	A3 – D3
LG IMAX Theatre Sydney	H4
Powerhouse Museum	L6 – M6
Pyrmont Bridge	F3 – F6
Sailing Sydney	D4
Star City Hotel and Casino	B9 – C8
Sydney Aquarium	E3
Sydney Convention and Exhibition Centre	H6 – L6
Sydney Entertainment Centre	M4
Sydney Wildlife World	E4
Sydney Visitor Centre	I4
Tall Ship James Craig	B6
The Playground	I4

Shopping, restaurants and bars

Criniti's Ristorante	F6
Darling Quarter	I3
Harbourside	E6 – H6
Hard Rock Cafe Sydney and Rock Shop	G6
Jordons Seafood Restaurant	G6
Market City	N3 – O3
Mövenpick Ice Cream	E6
Paddy's Markets	N3 – O3
South Steyne Restaurant	E5

Parks and gardens

Chinese Garden of Friendship	K3
Palm Grove	I5
Pyrmont Bay Park	C7
The Garden at Darling Park	G3
The Playground	I4
Tumbalong Park	J4

Services

Sydney Visitor Centre	I4
First Aid	I4
Public Toilets	
Baby Change	
Accessible Toilets	
Telephone	
ATMs	
Money Exchange	
Accommodation/Hotels	
Police	

Access

- Lifts
- Stairs
- Accessible Way
- Cycleway

Sydney Monorail stations

Convention	G6
Darling Park	F3
Harbourside	E6
Paddy's Markets	N4

Light Rail stations

Convention Centre	G6
Exhibition Centre	L6
Paddy's Market	N4
Pyrmont Bay	D7
Star City	B8

Leisure

- Cafe/Restaurants
- Bars
- Shopping

Transport

- Sydney Ferries
- Express Ferry to Circular Quay
- Harbour Cruises
- Chartered Vessels
- Water Taxis
- Bus Stop
- Sydney Sightseeing Bus Stops
- Taxis
- People Mover Stops
- Parking Stations
- Accessible Parking
- Cycle Parking
- Motorcycle Parking

Accommodation

Crowne Plaza Darling Harbour	H3
Four Points by Sheraton Sydney	E2
Fraser Suites Sydney	J1
Grand Mercure Apartments Darling Harbour	F6
Holiday Inn Darling Harbour	M3
Hotel Ibis Darling Harbour	F7
Ibis Sydney King Street Wharf	B2
Mantra on Kent	G1
Medina Grand Harbourside	C3
Mercure Grand Sydney	I1
Novotel Rockford Darling Harbour	L4
Novotel Sydney on Darling Harbour	G7
Oaks Goldsbrough Apartments	I7
Oaks Maestri Towers	I2
Quest on Dixon	L2
Radisson Hotels and Suites	K2
Seasons Darling Harbour Sydney	L3
Somerset Darling Harbour	H2
Star City Hotel and Casino	B9 – C8

Conference Program

Monday, September 23

09:00 - 09:10	Welcome Address by Powerhouse Museum Director	*Rose Hiscock*
Session I - Chair: Bob Nichol		
09:10 - 09:40	**Invited: The Importance of morphology for galaxy evolution**	*Roger Davies*
09:40 - 10:10	**Invited: Fundamental problems in galaxy evolution**	*Karl Glazebrook*
10:10 - 10:30	Are major mergers important?	*Sugata Kaviraj*
10:30 - 11:00	Morning tea	
Session II - Chair: Bob Nichol		
11:00 - 11:30	**Invited: Scientific impact of Galaxy Zoo**	*Chris Lintott*
11:30 - 11:50	Galaxy Zoo 2: quantifying detailed morphologies for 300,000 galaxies	*Kyle Willett*
11:50 - 12:10	From mergers to post-mergers: a complete view of the galaxy interaction sequence	*Sara Ellison*
12:10 - 12:30	On the evolution of observable properties of 1:1 merger remnants	*Inchan Ji*
12:30 - 13:30	Lunch	
Session III - Chair: Roger Davies		
13:30 - 14:00	**Invited: Environmentally-driven evolution**	*Aeree Chung*
14:00 - 14:20	The role of stellar mass and environment for cluster blue fraction, AGN and star formation	*Kevin Pimbblet*
14:20 - 14:40	Kinematic morphology and its relationship to local and global environment	*Nicholas Scott*
14:40 - 15:00	UV bright red sequence cluster galaxies: their environment and morphology	*Jake Crossett*
15:00 - 15:30	Afternoon tea	
Session IV - Chair: Roger Davies		
15:30 - 16:00	**Invited: New simulations in galaxy evolution**	*Darren Croton*
16:00 - 16:20	Major mergers on massive early-type galaxies in clusters	*Sukyoung Yi*
16:20 - 16:40	A signature of merger driven star formation in spiral galaxies	*Tim Dolley*
16:40 - 17:00	On the origin of tidal features in cluster galaxies	*Hoseung Choi*

Tuesday, September 24

09:00 - 09:05	Announcements	*Ivy Wong*
Session V - Chair: Darren Croton		
09:05 - 09:35	**Invited: Secular process and galaxy evolution**	*Karen Masters*
09:35 - 09:55	Secular evolution in the green valley	*Thiago Goncalves*
09:55 - 10:15	Galaxy and mass assembly (GAMA): the connection between metals, specific SFR and HI gas in galaxies: the Z-SSFR relation	*Maritza Lara-Lopez*
10:15 - 10:35	Ordered vs. random motions, the morphology dependence of Tully-Fisher relation and the Fundamental Manifold of spiral galaxies	*Chiara Tonini*
10:35 - 11:00	Morning tea	
Session VI - Chair: Darren Croton		
11:00 - 11:30	**Invited: The role of AGN feedback**	*Kevin Schawinski*
11:30 - 11:50	Secular growth of galaxies and supermassive black holes	*Brooke Simmons*
11:50 - 12:10	Connecting black hole activity and star formation with Galaxy Zoo	*Stas Shabala*
12:10 - 12:30	The environmental impact on the powerful radio galaxy NGC 612 (PKS 0131-36)	*Julie Banfield*
12:30 - 13:30	Lunch	
Session VII - Chair: Karen Masters		
13:30 - 13:50	Stochastic nature of feedback processes in galaxies	*Joss Bland-Hawthorn*
13:50 - 14:10	The role of galactic bars on central star formation and AGN	*Seulhee Oh*
14:10 - 14:30	Galaxy Zoo: evolution of the bar fraction over the last 8 billion years	*Thomas Melvin*
14:30 - 14:50	Clues to galaxy evolution from galaxy structure, and the M_BH - M_BULGE relation	*Alister Graham*
14:50 - 15:20	Afternoon tea	
15:20	**Bus departs from Powerhouse Museum**	
15:50 - 17:20	**Tour of Sydney Observatory**	
17:30	**Walk down Observatory Hill**	
17:45 - 22:00	**Conference dinner cruise around Sydney Harbour**	

Wednesday, September 25

Session VIII - Chair: Karl Glazebrook

09:50 - 10:20	**Invited: The impact of citizen science outreach & education**	*Carol Christian*
10:20 - 10:40	A BOINC based project for Spectral Energy Distribution fitting	*Kevin Vinsen*
10:40 - 11:10	Morning tea	

Session IX - Chair: Karl Glazebrook

11:10 - 11:40	**Invited: Quantifying galaxy morphology**	*Jen Lotz*
11:40 - 12:00	Relating the formation and evolution of disk galaxies from their morphology	*Ivan Minchev*
12:00 - 12:20	What is a Pseudobulge and why should I care?	*David Fisher*
12:20 - 12:40	Bar morphology as a function of wavelength: a local baseline for high-redshift studies	*Karin Menendez-Delmestre*
12:40 - 13:40	Lunch	

Session X - Chair: Kevin Schawinski

13:40 - 14:10	**Invited: What the Zooniverse can do for you**	*Chris Snyder*
14:10 - 14:30	Web developer	*Ed Paget*
14:30 - 14:50	Morphological classification of galaxies in CANDELS	*Jeyhan Kartaltepe*
14:50 - 15:10	Early-type galaxies in a cluster at z=2	*Veronica Strazzullo*
15:10 - 15:40	Afternoon tea	

Session XI - Chair: Kevin Schawinski

15:40 - 16:00	Fading AGN and backlit galaxies - finding the rare and unexpected with Galaxy Zoo	*William Keel*
16:00 - 17:00	**Discussion session - "Is galaxy morphology important?"**	*moderated by K. Schawinski*

18:30 - 20:30 Zooniverse community workshop for educators & school teachers chaired by Rob Hollow and Kelly Borden

Thursday, September 26

Session XII - Chair: Ray Norris

09:00 - 09:30	**Invited: Multiwavelength morphology and galaxy evolution studies**	*Andrew Hopkins*
09:30 - 09:50	Low-mass galaxies are bursting for attention	*Amanda Bauer*
09:50 - 10:10	The parameter space of local dwarf galaxies in GAMA	*Smriti Mahajan*
10:10 - 10:30	Neutral gas in blue compact dwarf galaxies	*Angel Lopez-Sanchez*
10:30 - 11:00	Morning tea	

Session XIII - Chair: Ray Norris

11:00 - 11:20	The morphological transformation of galaxies in compact groups	*Iraklis Konstantopoulos*
11:20 - 11:40	Tracing outer edges of galaxy disks	*Baerbel Koribalski*
11:40 - 12:10	**Invited: Zooniverse case study: Radio Galaxy Zoo**	*Ivy Wong*
12:10 - 12:30	Constraining the evolutionary path of the youngest radio galaxies using radio morphology	*Jordan Collier*
12:30 - 13:30	BBQ Lunch	

Session XIV - Chair: Andrew Hopkins

13:30 - 14:00	**Invited: Integral Field Unit Surveys**	*Scott Croom*
14:00 - 14:20	HI discs in early-type galaxies	*Paolo Serra*
14:20 - 14:40	Finding galaxies with unusual HI content	*Helga Denes*
14:40 - 15:00	The HST GOALS Survey: probing the morphology and evolution of (U)LIRGs	*Sebastian Haan*
15:00 - 15:20	Star formation in red spiral galaxies	*Michael Brown*
15:20 - 15:50	Afternoon tea	

Session XV - Chair: Andrew Hopkins

15:50 - 16:20	**Invited: Conference summary**	*Matthew Colless*

The end. We hope that you have enjoyed this meeting.

POSTER PRESENTATIONS

Title	Presenter
Detecting the cold neutral gas in young radio galaxies	*James Allison*
Search for fly-by encounters of galaxis in cosmological simulations	*Sung-Ho An*
Dynamical study of the vast thin plane of corotating dwarf galaxies orbiting the Andromeda galaxy	*Veronica Arias*
Gas inflow and cosmic star formation efficiency beyond z=3	*Fuyan Bian*
The outer halo of Centaurus A	*Sarah Bird*
What shapes the local galaxy luminosity function?	*Nicolas Bonne*
Morphological transformation of red sequence galaxies in high-z galaxy clusters	*Pierluigi Cerulo*
Nature or nurture? The relationship between star formation and AGN activity in NGC 7130	*Rebecca Davies*
A new morphological catalogue of ~12,000 IRAS galaxies: setting the z=0 baseline for star-forming galaxies	*Ashley Hyde*
The extended Virgo Cluster catalog	*Suk Kim*
StarBugs: a new technology for galaxy survey instruments	*Kyler Kuehn*
The chemistry and kinematics of molecular clouds near Sagittarius A*	*John Lopez*
Elemental Abundances on Galaxies hosting type Ia SN	*Manuel Emilio Moreno Raya*
Construction of global magnetic field structure model in disk galaxies with three dimensional magnetohydrodynamic simulations: effects of steady spiral arms	*Sho Nakamura*
The rise and fall of the star formation histories of blue galaxies at redshifts $0.2 < z < 1.4$	*Camilla Pacifici*
Extragalactic globular clusters: the fossil record of galaxy formation	*Vincenzo Pota*
Ubiquitous early-type dwarf galaxies with blue centers in the Ursa Major Cluster	*Soo-Chang Rey*
Connections between galaxy morphology and star cluster populations in nearby spirals	*Jenna Ryon*
The supermassive black hole mass-sersic index (and other) relation(s) for bulges and elliptical galaxies	*Giulia Savorgnan*
Census of blue compact dwarf galaxies from SDSS DR7	*Eon-Chang Sung*
The sizes of globular clusters in NGC 4278	*Christopher Usher*
The Skymapper view of red spirals	*Christian Wolf*
Multiwavelength properties of dwarf galaxies in the Local Volume I: deep near-infrared surface photometry and properties	*Tye Young*

Contributed abstracts

Detecting the cold neutral gas in young radio galaxies.

James Allison

HI absorption provides direct evidence of the presence of cold neutral gas in/out-flows, indicating that interaction between the Active Galactic Nucleus (AGN) with the interstellar medium is common. I will present an overview of results from our search for cold HI gas around compact radio sources using the Australia Telescope Compact Array (ATCA). Selected from the AT20GHz survey, these compact sources are thought to represent some of the most recently triggered radio-loud AGNs in the nearby Universe. Application of our novel detection technique to these ATCA data has proved robust in finding and modelling low S/N 21cm lines, and has revealed the presence of an unusually weak, broad absorption-line in an early-type galaxy. I will also discuss a recent search for HI absorption in nearby radio galaxies using data from the HI Parkes All-sky Survey (HIPASS). Given the low optical depth sensitivity of HIPASS, the number of detected associated HI absorbers is very promising for early science with the Square Kilometer Array pathfinders, with which we will be able to study the HI content of the Universe to much higher redshifts.

Searching for Fly-by Encounters of Galaxies in Cosmological Simulations

Sung-Ho An

Fly-by encounters of galaxies are believed to be far more frequent than direct mergers, playing an important role in galaxy evolution. Using cosmological N-body simulations, we have investigated the statistical properties of the fly-by interactions as functions of halo masses and ambient environments. We use a tree-particle-mesh code GOTPM, and discern impulsive fly-by pairs from eventual merger candidates based on the total energy of the two halos of interest. The results are summarized as follows: (1) Halos in the cluster environment experience more frequent mergers and fly-by encounters than those in the field region; (2) Both merger and fly-by fractions for the massive halos evolve more dramatically with time than those for dwarfs; and (3) The fly-by fraction decreases as approaching to $z = 0$, while the merger fraction increases.

A dynamical study of the vast thin plane of corotating dwarf galaxies orbiting the Andromeda galaxy.

Veronica Arias

The origin of the recently discovered ˝vast thin plane of corotating dwarf galaxies˝ orbiting the Andromeda galaxy remains a puzzle. Such a structure, which is around 400 kiloparsecs (kpc) in diameter and has a perpendicular scatter of less than 14.1kpc, cannot be explained by current galaxy formation models. Some alternative attempts have been made to explain this planar structure, but a validation or rejection of any possible formation scenario requires a rigorous dynamical understanding of the system. In this work, we carry out a numerical study of this plane of dwarf galaxies, to better understand the dynamics and the long term stability of such a structure.

The environmental impact on the powerful radio galaxy NGC 612
Julie Banfield

There are many various types of morphological properties of radio galaxies and it remains unclear as to what causes these differences. Do the intrinsic properties of the central engine ('nature') mold and shape the radio source? Do the properties of the surrounding medium of the central engine and host galaxy ('nurture') cause these differences? Settling this 'nature vs nurture' debate for nearby radio galaxies will provide clues to the properties and evolution of radio galaxies throughout the Universe. In this talk I will present NGC 612 and provide evidence for interaction between the radio-lobe hot-spot and the HI bridge connecting NGC 612 to NGC 619. I will discuss the importance of lobe-HI interactions for the morphology and dynamics of radio galaxy lobes and the host galaxy.

Low-Mass Galaxies are Bursting for Attention
Amanda Bauer

I will present evidence for stochastic star formation histories in low-mass ($M^* < 10^{10}$ Msun) galaxies from observations within the spectroscopic Galaxy And Mass Assembly (GAMA) survey. By evolving simple parametrizations of exponentially declining star formation histories previously fit to galaxies observed at $z=1$, we cannot recover the distributions of specific star formation rates (SSFR) and stellar masses observed in the GAMA sample at low redshift ($0.05<z<0.32$). In particular, a large number of low-mass galaxies are observed to have much higher SSFRs than can be explained by these simple models, even when invoking mass-dependent staged evolution. For such a large number of galaxies to maintain low stellar masses, yet harbour such high SSFRs, requires the late onset of a weak underlying exponentially declining SFH with stochastic bursts of star formation superimposed.

Gas inflow and Cosmic Star formation Efficiency Beyond z=3
Fuyan Bian

We present a large sample of z~3 Lyman break galaxies (LBGs) selected in the NOAO deep and wide field surveys. We estimate the average host halo mass for two samples of bright LBGs by studying their spatial correlation function. Combining it with other measurements at higher redshifts and lower luminosities, we find a tight relation between the host halo mass and the galaxy star formation rate, which follows the trend predicted by the baryonic accretion rate onto the halo, suggesting that the star formation in LBGs is fueled by baryonic accretion through the cosmic web. By comparing the SFRs with the total baryonic accretion rates, we find that cosmic star formation efficiency is about 5%-20% and it does not evolve significantly with redshift, halo mass, or galaxy luminosity.

The Outer Halo of Centaurus A
Sarah Bird

The very earliest stars in giant galaxies – the most metal-poor halo stars and globular clusters – may have formed before the onset of hierarchical merging, within small pregalactic dwarfs that populated the large-scale dark-matter potential well. Today, these relic stars should be found in a sparse and extremely extended "outermost-halo" component. Finding clear traces of this component in other giant galaxies, and deconvolving it from the more obvious and metal-rich spheroid component generated later by mergers, has been extraordinarily difficult. Now, striking new evidence discovered in M 31 and NGC 3379 suggests that the metal-poor outermost halo can be isolated at very large radii, R > 12Reff. We now have a new deep imaging study with ESO VLT of the nearest giant elliptical and merger remnant, Centaurus A, to search for this extended remnant of the galaxy's earliest history.

Stochastic nature of feedback processes in galaxies
Joss Bland-Hawthorn

The Galactic Centre provides us with a front-row seat on powerful AGN activity over the last 100 Myr. Recent observations provide new insights, in particular, that the circumnuclear gas is unstable and leads to stochastic accretion onto the accretion disk. More remarkably, the duration time of an Eddington accretion event can be as short as 1 Myr having declined by ten orders of magnitude within that time frame. Much of this activity would be invisible in galaxies beyond the Local Group. Feedback and recycling of gas may be energetically important but largely invisible with current technologies. We review this evidence and discuss its importance in the context of galaxy evolution.

What Shapes the Local Galaxy Luminosity Function?
Nicolas Bonne

We have determined near infrared K-band luminosity functions for 13,321 galaxies in the local Universe, as functions of both morphology and colour. All galaxies have known morphologies and redshifts, and K_{tot} $\leq$ 10.75. Photometry is taken from the 2MASS XSC catalogue, redshifts and magnitudes are taken from a number of catalogues. In addition, redshift independent distances are compiled from a number of publications and redshifts are corrected for local bulk flows. By combining redshift independent distances and redshift derived distances with bulk flow corrections, we expect to produce an improved estimate of the faint end of the luminosity function. Red/blue and early/late-type selected luminosity functions have different shapes, and we investigate the causes for this by measuring the optical red and blue luminosity functions of early and late-type galaxies using photometry from SDSS. We find that the bright end of our spiral galaxy luminosity function is dominated by a population of massive, red spiral galaxies. If red spirals are formed through the truncation of star formation, these objects must be relics of a much earlier age. Alternatively, these red spirals may not be passive, continuing to form stars and grow.

Star Formation in Red Spiral Galaxies
Michael Brown

It is often assumed that red spiral galaxies are produced when star formation is truncated in blue spiral galaxies. However, this picture must be flawed, as the largest red spiral galaxies are more massive than present-day blue spiral galaxies. We have used SDSS, 2MASS, NVSS, WISE, Spitzer, GALEX and HIPASS to identify and characterise nearby spiral galaxies with very low star formation rates. The vast majority of red spiral galaxies are detected in archival 21-cm data, and thus have reservoirs of hydrogen gas to fuel star formation. We find that all red spiral galaxies have mid-infrared PAH and dust emission, consistent with continued star formation.

Morphological Transformation of Red Sequence Galaxies in High Redshift Galaxy Clusters
Pierluigi Cerulo

I present the results of a detailed analysis of the morphological properties of red sequence galaxies in a X-ray detected cluster at redshift z=0.98. Overall, the red sequence is dominated by elliptical and S0 galaxies. The fraction of S0s decreases at faint luminosities, where disc-dominated systems tend to become more frequent. From the comparison with a sample of local galaxy clusters, I discuss possible scenarios for the evolution of galaxies of different morphologies. I finally show the ongoing application of the analysis developed for this cluster to a sample of galaxy clusters at $0.8 < z < 1.5$ and its implications for the investigation of the environmental drivers of galaxy evolution.

On the origin of tidal features in cluster galaxies
Hoseung Choi

Although galaxy mergers are thought to play an important role in forming elliptical galaxies, mergers in galaxy clusters have drawn less attention compared to mergers in field environments due to high peculiar velocities of cluster galaxies. However, comparable fractions of merger features in cluster galaxies have been reported from deep imaging of Abell clusters, suggesting the relevance of mergers in the transformation of cluster early-type galaxies (Sheen et al. 2012). As a more direct approach to understanding the origin of tidal features in clusters, we perform zoomed hydrodynamics simulations on a cluster of galaxies. By utilizing mock observation images of the simulated cluster galaxies, we construct and analyze the cluster early-type galaxy sample in a consistent manner with Sheen et al. 2012. We find ~20% of tidal feature fraction from the simulated cluster, which is comparable to the observational study. Individual evolution history of the galaxies with merger features shows that most of the mergers responsible for the merger features in the present originates from outside the cluster 2Gyrs or further ago. We also find that most of the galaxies with tidal features show correlations with subgroups in the cluster. All these results suggest that merger features in the cluster originates from preprocessing before accretion into the cluster.

Constraining the Evolutionary Path of the Youngest Radio Galaxies Using Radio Morphology

Jordan Collier

We have observed the largest faint population of Gigahertz Peaked Spectrum (GPS) and Compact Steep Spectrum (CSS) sources to date, using the Australia Telescope Compact Array, in order to: (1) test the hypothesis that GPS/CSS sources are the youngest radio galaxies; (2) place GPS/CSS sources into an evolutionary sequence along with a number of other young AGN candidates; and (3) search for evidence of the evolving accretion mode and its relationship to star formation (SF). GPS/CSS sources have very small radio jets, which grow in linear size as they evolve. In the radio, GPS sources are generally < 1 kpc in size, while CSS sources are one to several tens of kpc in size. The linear size of the jets is therefore an excellent indicator for dating the evolutionary stage of the AGN. To achieve our goals, we combine high-resolution radio observations with redshifts to determine the linear size of GPS/CSS sources, resolve their jets and observe their small-scale morphology. We combine this with other multi-wavelength age indicators, including the separation of nuclei, the colours and Spectral Energy Distribution of the host galaxy, the optical spectra, the electron age of the jet and luminosity functions, to see if they can be assembled into a self-consistent model. Future Very Large Baseline Interferometry (VLBI) observations will separate AGN from distributed SF, to help pinpoint the transition between SF and AGN activity caused by the merger, and perhaps even measure their timescales.

UV Bright Red Sequence Cluster Galaxies: Their Environment and Morphology

Jake Crossett

While it is commonly accepted that most spheroidal galaxies on the red sequence contain largely older stellar populations, it has been suggested that a small amount of recent star formation may have occurred within the last billion years (Yi et al. 2005; Kaviraj et al. 2007; Schawinski et al. 2007). This residual star formation is observationally detected by high NUV flux, and is found to be present in over 10% of early-type galaxies down of a magnitude of R=-18 in clusters at z~0.1. I will present results using Galaxy Zoo, to determine the morphological and environmental properties of these galaxies with residual star formation in the NUV. I will show that despite optical colours corresponding to the red sequence, these galaxies are not found to resemble early-type galaxies, but reside in low density (~100 Gal/Mpc2) at predominantly high (>2Mpc) radii from their host cluster centre. In addition to this, their morphology displays very spiral like signatures compared to quiescent red sequence galaxies. This suggests evidence of "quenching" of star formation in spiral galaxies, as opposed to a residual burst of star formation.

Nature or nurture? The relationship between star formation and AGN activity in NGC7130

Rebecca Davies

We use the Wide-Field Spectrograph (WiFeS) on the ANU 2.3m telescope to investigate the power sources of the composite activity in the luminous infrared galaxy NGC7130. We show that NGC7130 is a spectacularly clean case of starburst + AGN activity. We observe clear and distinct rings of gas ionised by increasing fractions of AGN activity towards the nucleus. We use our data to robustly estimate the relative contribution of star-formation and AGN activity to the EUV radiation field in NGC7130, and our integral field data allows us to estimate the radius of the narrow line region. The next step in this line of research is to determine whether the observed mixing properties are the result of nature or of nurture – in particular, whether or not star formation properties change considerably as a function of AGN properties or whether they simply reflect the conditions in the ISM. This analysis paves the way for large scale investigation of the starburst-AGN connection using current and future IFU surveys.

Finding galaxies with unusual HI content

Helga Denes

There is more and more evidence that some galaxies in groups show similar trends to galaxies in clusters, such as redder colours and gas deficiency, highlighting that gas stripping mechanisms are not only important on galaxy cluster scales but also in galaxy groups. The question is though, which mechanisms are important in low density environments? To answer this, we need to identify galaxies with recent or ongoing gas stripping in these environments. A good tool for this are optical-HI scaling relations which make it possible to find galaxies with significantly less HI than an average galaxy of the same type. I derived new, multi wavelength scaling relations by comparing the HI content of galaxies in the HI Parkes All Sky Survey (HIPASS) with optical and near infrared datasets available for southern galaxies. I will present these scaling relations and their application of identifying HI deficient galaxies in low density environments. I will also use these relations for predicting the HI content of galaxies for upcoming large scale surveys such as WALLABY, the ASKAP HI All Sky Survey.

A Signature of Merger Driven Star Formation in Spiral Galaxies

Tim Dolley

Local galaxy star formation is thought to be dominated by secular evolution, but star formation triggered by mergers must also contribute. We have measured the clustering of spiral galaxies as a function of specific star formation rate (SSFR), for a morphology selected sample. We find that large scale clustering of spiral galaxies is independent of SSFR, indicating spiral galaxies with high and low SSFRs typically reside within the same mass dark matter halos. On intermediate scales (~500kpc), spiral galaxies with high SSFRs have a deficiency in satellite companions, but an excess of satellite companions at smaller scales (~50kpc). This appears to be the signature of recent or ongoing mergers, where the suppressed correlation function at ~500kpc scales is due to the infall of a satellite companion.

From mergers to post-mergers: a complete view of the galaxy interaction sequence
Sara Ellison

Galaxy-galaxy interactions are responsible for potentially dramatic changes in morphology, star formation rate, metallicity and black hole accretion rate. However, the magnitude of these changes is expected to vary during an interaction, with theoretical predictions that the biggest changes may occur after final coalescence. By combining a large sample of spectroscopically selected galaxy pairs from SDSS with a Galaxy Zoo post-merger sample, I will present the first observational study of the changes experienced by galaxies throughout the interaction sequence. I will also present a comparison with high resolution simulated galaxy mergers in order to provide an interpretive framework for the observations.

What Is a Pseudobulge, and Why Should I Care?
David Fisher

Observations show that bulges come in at least two different types: pseudobulges, which have properties similar to disks, and classical bulges, which have properties similar to elliptical galaxies. I will show that these pseudobulges are gas rich, star forming, dynamically cold, and do not participate in the fundamental plane. These properties are more consistent with a formation scenario in which pseudobulges are the result of secular processes, such as bar driven evolution. Indeed, I will show connections between pseudobulge properties and bars, which are consistent with a picture in which bars preferentially build pseudobulges. The data is consistent with a scenario in which the two types of bulges are indicative of different channels of galaxy evolution. Pseudobulges imply a merger-quiet history, and the consistency between classical bulges and elliptical galaxies suggest that classical bulges may have experienced more merging at low redshift. Finally, I will show that in the local Universe 75% of bulge-disk galaxies contain pseudobulges. This implies first that theories aimed at describing the evolution of galaxies must account for the properties of galaxies, and secondly that large surveys, such as the Galaxy Zoo, are filled with galaxies containing pseudobulges.

Clues to Galaxy Evolution from Galaxy Structure, and the M_bh-M_bulge relation
Alister Graham

One way to study galaxy evolution is through a direct comparison of the physical structure of galaxies at low and high-redshifts. My recent 50-page review article about "elliptical and disc galaxy structure, and modern scaling laws" (arXiv:1108.0997) presents and explains numerous local (z=0) benchmark relations. In particular, it revealed that the Sersic bulges of local, massive, disc galaxies have the same physical properties as the massive, compact galaxies seen at z~1.5-2.5, suggesting that early-type disc galaxies have evolved by growing discs around preexisting, massive compact bulges. This talk will then discuss how supermassive black hole mass scales *quadratically*, rather than simply linearly, with the mass of disc galaxy bulges in general (Graham 2012, ApJ, 746, 113; Graham & Scott 2013, ApJ, 764, 151).

Secular Evolution in the Green Valley
Thiago Goncalves

The bimodality in galaxy properties has been observed at low and high redshift, with a clear distinction between star-forming galaxies in the blue cloud and passively evolving objects in the red sequence. The absence of galaxies with intermediate properties indicates that the quenching of star formation and subsequent transition between populations must happen rapidly. By using very deep spectroscopy with the DEIMOS instrument at the Keck telescope we are able to infer the star formation histories of so-called "green valley" galaxies at intermediate redshifts (z~0.8), when the universe was half its current age. We measure the stellar mass flux density of green valley galaxies transiting from the blue cloud to the red sequence and find that this transition happens more rapidly in the past and that at z~0.8 this process happens more rapidly for more massive galaxies. This suggests a top-down scenario in which the massive end of the red sequence forms first, representing another aspect of downsizing, with the mass flux density moving towards smaller galaxies in recent times. It remains an open question, however, which physical mechanisms are responsible for quenching star formation and how they may be more efficient at z~0.8 than at lower redshifts. To tackle this we have recently initiated a project to detect the presence of bars at low and high redshift, and correlate their strength with the quenching timescales. This will allow us to infer the influence of secular evolution in galaxies at different epochs.

The HST GOALS Survey: Probing the Morphology and Evolution of (U)LIRGs
Sebastian Haan

Luminous and Ultraluminous Infrared Galaxies (U/LIRGs) represent a key stage in galaxy evolution and provide a perfect laboratory to test the environment of extreme starbursts and the impact of major mergers on galaxy formation. The Great Observatories All-sky LIRG Survey (GOALS) combines high-resolution multiwavelength Hubble Space Telescope observations with mid-IR and far-IR diagnostics (Spitzer, Herschel) for a complete sample of (U)LIRGs in the local Universe. Our study of the nuclear stellar structure in the 85 most luminous U/LIRGs of the GOALS sample revealed that most U/LIRGs exhibit nuclear stellar cusps which are measured as a resolved central excess light component in the stellar light profiles. Here we compare for the first time the cusp and core properties in the few remaining gas-rich major mergers still present in the local Universe to those of present-day core and cusp-dominated ellipticals as tracer of their evolutionary linkage. Moreover, we find that the nuclear stellar structure becomes significant more compact with far-IR luminosity and merger stage, which can be associated with the build-up of nuclear stellar cusps and might explain the dramatic increase of nuclear compactness as observed in high-redshift galaxies (e.g. CANDELS survey).

A new morphological catalogue of ~12,000 IRAS galaxies: setting the z=0 baseline for star-forming galaxies

Ashley Hyde

A large, statistically-significant morphological study of infrared (IR)-selected star-forming galaxies in the local Universe has so far been lacking. We present a morphological catalogue of ~12,000 galaxies, selected from the Imperial IRAS-FSC Redshift Catalogue (IIFSCz) and crossmatched with the SDSS DR7 spectroscopic sample. We determine morphologies via visual inspection of SDSS images (much in the spirit of Galaxy Zoo!) and use UV (GALEX), optical (SDSS) and IR (IRAS) photometry to model galaxy SEDs and derive a range of physical properties. The unprecedented sample size allows us to set, for the first time, the z=0 baseline for IR-selected star-forming galaxies in terms of trends between properties such as morphology, IR luminosity, stellar mass, velocity dispersion, specific SFR, environment and AGN activity. We highlight our key science results (to be published in a suite of forthcoming papers), including the distribution of local ($z<0.1$) IR luminosity as a function of galaxy morphology, the enhancement in specific SFR triggered by minor mergers and the impact of bars on star formation and stellar/gas velocity dispersion in the host galaxy.

On the evolution of observable properties of 1:1 merger remnants

Inchan Ji

The evolution of star formation rates and observable properties of equal-mass disk mergers were investigated using numerical simulations. We perform N-body/hydrodynamic simulations and all of which include cooling of gas, star formation, and supernova feedback. We study twelve different merger simulations considering various initial orbital configurations and morphological properties of progenitor galaxy. We have calculated the observable properties of merger remnants i.e., colors and magnitudes convolved with dust attenuation. Then we compare our results with observational data from the Sloan Digital Sky Survey (SDSS). We show that u – r colors of merger remnants coevolve with star formation rates. u – r colors of merger remnants evolve differently between the merger simulations without considering dust attenuation. However, dust attenuation hinders the clear differences especially during starburst. We estimate the post-merger time, the moment when post-merger features of merger remnants disappear. We compare the post-merger times between the simulations after synthesizing mock images using the SDSS r band. The post-merger time is useful to understand morphological transformation of galaxy merger. We found that the post-merger features involve a small fraction of stars and the post-merger time depends on how galaxies interact. The post-merger time is, on average, ~ 2 times the final coalescence time for a shallow surface bright limit, i.e. μ ~ 25 mag per square arcsec. For a deeper surface brightness limit, i.e. μ ~ 28 mag per square arcsec, however, the post-merger time is by a factor of ~ 2.3 longer than in the shallow one, which is the reason why detecting merger features by using shallow surveys were difficult in the past.

Morphological Classification of Galaxies in CANDELS

Jeyhan Kartaltepe

The CANDELS collaboration has undertaken an ambitious program to visually classify galaxies in all of the CANDELS fields down to a magnitude limit of H<24.5. Here, we present our classification scheme and the initial results of these classifications. We study the classifier to classifier variation as well as the differences between two different depths (2 and 4-orbit HST depths). Additionally, we compare these classifications to several automated classification techniques to quantify how well they work as a function of redshift and study the affects of morphological K-corrections. Finally, CANDELS galaxies are now a part of Galaxy Zoo and we compare the results of our scheme to the Galaxy Zoo classifications.

Are major mergers important?

Sugata Kaviraj

Major mergers have been classically thought to inducing strong star formation episodes, black hole growth and morphological transformations. We present observational evidence that argues against major mergers having a prominent role in driving cosmic star formation and creating spheroids in the early Universe. Employing visually-classified morphologies from HST (via the WFC3 Early-Release Science programme), we show that only ~15% of the cosmic star formation budget can be attributed to the major-merger process at z~2. Furthermore, at least 50% of blue spheroids at 1<z<3 - i.e. those that are vigorously forming stars - do not show tidal features that are expected, based on hydro simulations, from major mergers at these epochs. This suggests that the formation of a significant fraction of primordial spheroids may be unrelated to the major-merger process. Taken together, our empirical results point to processes other than major mergers (e.g. minor mergers and cold streams), as the primary drivers of star formation and spheroid growth in the early Universe.

The Morphological Transformation of Galaxies in Compact Groups

Iraklis Konstantopoulos

The majority of galaxies out there live in families of five or more members. As they slum it in the highest volume densities, compact galaxy groups (CGs) often strong-arm their members into living fast and spending their most precious currency, their gaseous reservoirs, on shiny new stars. We have initiated a detailed study of the behaviour of these abusive families, CGs, through the GAMA Survey and will be exploring two of the traits that fit neatly within the context of this conference. First, nurture wins over nature in CGs as they often show elevated SFRs, regardless of morphological type. This effect cultivates a sense of rebellion and brazen disregard of norms, landing spirals in the red sequence and forcing rapid morphological transformation. Second, the fast expenditure of gas in CGs build up their lenticular galaxy populations. Since roughly half of CGs are embedded in larger structures -- including clusters -- they should also be considered as the sites of industrial-scale lenticular production.

Fading AGN and backlit galaxies - finding the rare and unexpected with Galaxy Zoo

William Keel

I describe experience in working with Galaxy Zoo participants to identify rare classes of galaxy, and in following up the discovery of the giant nebula known as Hanny's Voorwerp to define a new class of ionized clouds ionized by fading active nuclei. Finding backlit-galaxy pairs was one of the first subprograms going beyond the original statistical aims of classic Galaxy Zoo, and was carried out on the project forum. This project has increased the sample of such pairs for dust studies nearly a hundredfold, and already led to UV studies as well as detailed mapping of extinction in many disks. Hanny's Voorwerp, found by Hanny van Arkel only weeks into Galaxy Zoo, was also reported on the project forum. Our discussions on its nature and results from followup observations were reported on the forum and blog. Spectroscopy revealed that this galaxy-sized cloud was ionized by a QSO-luminosty AG leading to the definition of dramatic fading to account for the faint nucleus observed directly. As it became clear that participants could find similar, fainter objects, a systematic hunt involving ~200 volunteers allowed search of 18,000 AGN, giving a prioritized list of candidates for spectroscopy. As a result, we generated an additional sample of 19 analogous (fainter) objects with spectroscopic confirmation, of which 8 show an energy deficit from the nucleus sufficient to suggest fading over times ~100,000 years. These objects provide hints to the duration of AGN episodes unavailable in other ways. These disparate programs illustrate the sophistication and flexibility shown by many Zoo participants, and yield lessons for further programs.

The Extended Virgo Cluster Catalog

Suk Kim

We present a new catalog of galaxies in the wider region of the Virgo cluster, based on the Sloan Digital Sky Survey (SDSS) Data Release 7. This Extended Virgo Cluster Catalog (EVCC) covers an area of 750 deg^2 or 62.2 Mpc^2, is 5.4 times larger than the footprint of the classical Virgo Cluster Catalog (VCC) and reaches two times the virial radius of the Virgo cluster. We selected 1328 spectroscopically targeted galaxies with heliocentric radial velocities less than 3,000 km/s. In addition, 271 galaxies that have been missed in the SDSS spectroscopic survey are also added from the NED. Our selection process secured a total of 1,599 galaxies of which 862 galaxies are not included in the VCC. The certain and possible cluster members are defined by morphology and by means of redshift comparison with a cluster infall model. We employed two independent and complementary galaxy classification schemes: the traditional morphological classification based on the visual inspection of optical images (i.e., primary morphology) and a characterisation of galaxies from their spectroscopic features (i.e., secondary morphology). SDSS u, g, r, i, z passband photometry of all EVCC galaxies was performed using Source Extractor. We compare the EVCC with the VCC in terms of the morphology, spatial distribution, and magnitude distribution. The EVCC defines a comprehensive galaxy sample covering a wider range in galaxy density that is significantly different from the inner region of the Virgo cluster. It will be the foundation for forthcoming galaxy evolution studies in the extended Virgo cluster region, complementing ongoing and planned Virgo cluster surveys at various wavelengths.

Tracing the outer edges of galaxy disks
Baerbel Koribalski

What determines the size and shape of galaxy disks ? I will present a detailed look at the gas distribution and kinematics of individual nearby galaxies in a range of environments. The outskirts of galaxy disks are best traced in the HI 21-cm line and display the impact of physical processes such as accretion and ram pressure stripping. Dwarf galaxies are particularly susceptible to their environment and are often seen in the act of transformation.

StarBugs: a New Technology for Galaxy Survey Instruments
Kyler Kuehn

We describe the development of StarBugs, the massively parallel robotic fibre-positioner technology that facilitates much more rapid field configuration compared to currently-implemented fibre positioner technologies (e.g., pick-and-place robots and plug plates). The first-generation instrument to make use of StarBugs will be TAIPAN, to be installed on the UK Schmidt Telescope in 2015. We highlight the galaxy survey that will be undertaken by TAIPAN and the science that can be acquired from it, and we will conclude with a look forward to MANIFEST, an even larger-scale implementation of the StarBugs fibre positioners, to be installed on the Giant Magellan Telescope in the next decade.

Galaxy And Mass Assembly (GAMA): The connection between metals, specific SFR and H I gas in galaxies: the Z-SSFR relation
Maritza Lara-Lopez

We study the interplay between gas phase metallicity (Z), specific star formation rate (SSFR) and neutral hydrogen gas (HI) for galaxies of different stellar masses. Our study uses spectroscopic data from Galaxy and Mass Assembly (GAMA) and Sloan Digital Sky Survey (SDSS) star-forming galaxies, as well as HI detection from the Arecibo Legacy Fast Arecibo L-band Feed Array (ALFALFA) and Galex Arecibo SDSS Survey (GASS) public catalogues. We present a model based on the Z-SSFR relation that shows that at a given stellar mass, depending on the amount of gas, galaxies will follow opposite behaviours. Low-mass galaxies with a large amount of gas will show high SSFR and low metallicities, while low-mass galaxies with small amounts of gas will show lower SSFR and high metallicities. In contrast, massive galaxies with a large amount of gas will show moderate SSFR and high metallicities, while massive galaxies with small amounts of gas will show low SSFR and low metallicities. Using ALFALFA and GASS counterparts, we find that the amount of gas is related to those drastic differences in Z and SSFR for galaxies of a similar stellar mass. The results of this study were publish recently in a "letter to the editor" (Lara-Lopez, M. A. et al. 2013, MNRAS, 433, L35)

The Chemistry and Kinematics of Molecular Clouds near Sagittarius A*
John Lopez

There is strong scientific evidence to show that Sagittarius A* (Sgr A*, in short hand form) is a supermassive black hole which is located at the center of our Milky Way galaxy. We have conducted a chemical and kinematical analysis of molecular clouds near this black hole. We selected an area of l = 0.47° (galactic longitude) x b = 0.2° (galactic latitude) within the Central Molecular Zone (CMZ), which encompasses the Galactic Center (GC). A statistical analysis has been carried out on 21 regions, within our selected area, associated with the locations of molecular clouds close to the black hole. Concordantly, line abundance ratios were calculated for those regions. The results show that the molecular abundances are fairly consistent across all 21 regions, indicating that the gas is well mixed. Furthermore, position velocity diagrams have been extracted from the radio data to analyse two molecular clouds close to Sgr A*, known as the 20 km/s and the 50 km/s clouds, as well as a connecting stream of molecular gas known as the Molecular Ridge. Our results show evidence that the 20 km/s cloud and the Molecular Ridge are part of one large elongated clumpy cloud with an extended velocity gradient across it (from 0 to 50 km/s) that spatially stretches as far as the 50 km/s cloud. This result is different to currently accepted models. Based on these results, we apply simple modelling to calculate appropriate timescales.

Neutral gas in Blue Compact Dwarf Galaxies
Angel Lopez-Sanchez

We are obtaining deep multiwavelength data of a sample of nearby blue compact dwarf galaxies (BCDG). We are combining deep optical/NIR photometric and 1D/2D spectroscopic observations with HI and 20-cm radio-continuum data obtained using the Australian Telescope Compact Array (ATCA), plus UV (GALEX) and IR (Spitzer) data when available. We analyze the chemical and physical properties of young star-forming regions within these BCDG 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 BCDG (Lopez-Sanchez 2010). In particular, I'll present the interesting HI results obtained in NGC 5253 (Lopez-Sanchez et al. 2012) and Tol 30 (Lopez-Sanchez et al. 2013). These analyses are providing important clues to understand the star-formation processes and feedback, the fate of the neutral gas, the importance of galaxy interactions and the evolution of dwarf galaxies.

The parameter space of local dwarf galaxies in GAMA
Smriti Mahajan

We use the deep, multi-wavelength spectroscopic and photometric data from the Galaxy and Mass assembly (GAMA) survey to test how many different classes are required to dissect the population of dwarf galaxies in the local (D<~87 Mpc) Universe. To accomplish this, we use brodband colours, spectroscopic properties, mass, structural parameters such as size and surface brightness, and properties derived by modelling the spectral energy distribution of galaxies as probes. I will use the distribution of visually classified dwarf and luminous galaxies in multi-dimensional parameter space and statistical clustering analysis, to show the evidence for (or against) evolutionary links between different populations.

Galaxy Zoo: Evolution of the bar fraction over the last eight billion years from HST COSMOS

Thomas Melvin

We measure the redshift evolution of the bar fraction in a sample of 2,380 visually selected disk galaxies found in Cosmic Evolution Survey (COSMOS) Hubble Space Telescope (HST) images. The visual classifications used to identify both the disk sample, and the presence of stellar bars were provided by citizen scientists via the Galaxy Zoo: Hubble (GZH) project. We find that the overall bar fraction increases by a factor of 2, from 11±2% at z=1.0 to 22±5% at z=0.4. Splitting our volume limited sample of massive disk galaxies into three bins of stellar mass, we find that the increase in bar fraction is most prominent in the highest mass bin, while the lower mass discs in our sample show a more modest evolution. Our results are consistent with a picture in which massive disc galaxy evolution begins to be affected by slow (secular) internal process at z=1.

Bar Morphology As A Function Of Wavelength: A Local Baseline for High-Redshift Studies

Karin Menendez-Delmestre

Stellar bars are present in roughly 2/3 of all nearby galaxies and may play a critical role in the evolution of their hosts. With the advent of large high-resolution imaging surveys, bar studies are currently being extended to distant galaxies. However, photometric studies of the distant universe are invariably subject to the effects of band-shifting, the progressive shifting of the photometric band to bluer rest-frame wavebands. In order to reliably characterize the intrinsic evolution of bars with redshift safe from band-shifting effects, it is necessary to establish a local anchor of how bar properties vary with wavelength. To achieve this, we investigate bar properties in 16 large nearby – clearly barred – galaxies taken from the Spitzer Survey of Stellar Structure in Galaxies (S4G) at ultraviolet (GALEX FUV/NUV), optical (B, R) and mid-infrared (Spitzer/IRAC 3.6/4.5μm) wavebands. Based on the ellipticity and position angle profiles resulting from fitting elliptical isophotes to the full 2D light distribution, we determine the bar length and strength – characterized by ellipticity – for each galaxy, in each band. We find that at bluer wavebands both the bar length and the bar ellipticity increase. We attribute the increase in bar length to the frequent presence of prominent star forming knots at the end of bars: these regions are significantly brighter in bluer bands, resulting in the “artificial” lengthening of the bar. On the other hand, we interpret the increase in bar ellipticity as a result of the fact that the bulge, composed primarily of old and red stars, is less prominent at bluer bands, allowing for thinner ellipses to be fit within the bar region. The resulting effect is that bars appear longer and thinner when traced at bluer wavebands. Although we find that ~40% of the bars disappear in the UV, the results on bar ellipticity and length extend to those cases in which the bar is still visible in the UV. Therefore, these results may be used as a reference to implement band-shifting corrections to high-redshift studies of bar properties beyond z~0.8, when optical filters start tracing rest-frame UV bands. This opens the door for detailed morphological studies of bars to reliably gauge any intrinsic redshift evolution of bar properties out to the distant universe.

Relating the formation and evolution of disk galaxies from their morphology

Ivan Minchev

Galactic disks are shaped by the perturbative effect of mergers at high redshift and the bar and/or spiral arms at later times. Using numerical simulations, I will relate these agents to the formation of thick disks, extended disks, and the evolution of chemical gradients. I will show that interference among multiple spiral arms can cause the same galaxy to appear with different morphology, e.g., 2-armed, 3-armed, or 4-armed, changing within a dynamical time. Possible tests with the Galaxy Zoo database will be outlined, that would allow us to relate disk morphology to galactic formation and evolution.

Elemental Abundances on Galaxies hosting type Ia SN

Manuel Emilio Moreno Raya

The metallicity of the progenitor system producing a Supernova type Ia could play an important role in the estimate of the maximum luminosity of the explosion. This dependance should change the usual calibration between the light curve parameters of SN Ia and its absolute magnitude. To test this idea, we analyse the spectra from SLOAN/SDSS galaxies hosting SN Ia, determine the emission line intensities and estimate the oxygen abundances by using well known empirical calibrations. The final aim is to study if these abundances might have a role in the determination of the absolute magnitude of the SN Ia and in the Hubble diagram, helping to reduce the dispersion and the systematic errors, by using the metallicity dependent theoretical calibration by Bravo (2010).

Construction of Global Magnetic Field Structure Model in Disk Galaxies with three dimensional magnetohydrodynamic Simulations: Effects of Steady Spiral Arms

Sho Nakamura

We study numerically the large-scale gas and magnetic field evolution of spiral galaxies in the gravitational potential of a disk, bulge, halo, and spiral arms. We adopt a steady axisymmetric gravitational potential given by Miyamoto et al. and rigid rotating spiral potential. In order to understand the physical processes that the galactic magnetic fields are amplified and maintained, we assume initial condition is a magneto-hydro dynamically equilibrium thin disk gas component (T~10^4K) centered at r=10kpc threaded by weak azimuthal magnetic fields. We carried out three-dimensional magneto-hydrodynamic simulation taken into account radiative cooling energy loss. Our models demonstrate that the magnetic fields strength are dramatically amplified by disturbance due to gravitational potential of spiral arms in early phase. Numerical results indicate that the isothermal shocks generated by gravitational potential of spiral arms. Magnetic fields are dramatically amplified due to galactic shocks and the magnetic arms are generated. Magnetic fields around the spiral arms are amplified up to a few μG at 150Myr. The azimuthal direction of mean magnetic fields in the disk changes with radius due to magneto-rotational instabilities. The resultant structure of azimuthal magnetic fields distribution is also qualitatively consistent with the observed distribution of the Faraday rotation measure.

The role of galactic bars on central star formation and AGN

Seulhee Oh

Galactic bars efficiently drive outer gas to the nuclear region of galaxies, and so they are often suspected to trigger central star formation and AGN. However, the current status on this issue based on empirical studies is unsettling, especially regarding AGNs. We investigate this question based on the nearby ($0.01 < z < 0.05$) bright ($Mr < -19$) late-type galaxies on the Sloan Digital Sky Survey Data Release 7. Barred galaxies are visually selected, and galaxy activities are classified via emission line diagnostics. Multiple factors (bar frequency, stellar mass, black-hole mass, gas contents, etc.) seem to contribute to bar effects on star formation or AGN in intricate manners. In the hope of breaking these degeneracies, we inspect bar effects for fixed galaxy properties. Bar effects on central star formation seem higher in redder galaxies. Bar effects on AGNs on the other hand are higher in bluer and less massive galaxies. These effects seem more pronounced with increasing bar length. Our results imply that a large-scale bar can be a channel of gas inflow as expected, and the infalling gas activates both central star formation and AGN under certain condition. We discuss possible implications in terms of gas contents, bar strength, bar evolution, fueling timescale, and the dynamical role of supermassive black hole.

The Rise and Fall of the Star Formation Histories of Blue Galaxies at Redshifts $0.2 < z < 1.4$

Camilla Pacifici

Popular cosmological scenarios predict that galaxies form hierarchically from the merger of many progenitors, each with their own unique star formation history (SFH). We use a sophisticated approach to constrain the SFHs of 4517 blue (presumably star-forming) galaxies with spectroscopic redshifts in the range $0.2 < z < 1.4$ from the All-Wavelength Extended Groth Strip International Survey. This consists in the Bayesian analysis of the observed galaxy spectral energy distributions with a comprehensive library of synthetic spectra assembled using realistic, hierarchical star formation, and chemical enrichment histories from cosmological simulations. We constrain the SFH of each galaxy in our sample by comparing the observed fluxes in the B, R, I, and Ks bands and rest-frame optical emission-line luminosities with those of one million model spectral energy distributions. We explore the dependence of the resulting SFHs on galaxy stellar mass and redshift. We find that the average SFHs of high-mass galaxies rise and fall in a roughly symmetric bell-shaped manner, while those of low-mass galaxies rise progressively in time, consistent with the typically stronger activity of star formation in low-mass compared to high-mass galaxies. For galaxies of all masses, the star formation activity rises more rapidly at high than at low redshift. These findings can help us constraining the physical processes that shape galaxies, e.g. feedback, star-formation efficiency, in-situ star formation, and gas accretion.

Web Developer
Ed Paget

After it's launch in 2007 a deeply engaged community of Galaxy Zoo volunteers began to emerge in the forums and it became evident that many of them were interested in participating to a greater level than offered by the standard classification interface. In the past volunteers sought SkyServer for more data, allowing them to delve more deeply into the galaxy objects they were classifying, but the barrier to entry was high and only the most dedicated of volunteers had the time and ability to participate. To enable volunteers to more easily conduct independent research, the Zooniverse is developing a collection of tools to facilitate data exploration. This collection of tools began with Talk, a discussion tool that allows volunteers to engage in conversations about specific objects or collections of objects. More recently ZooTools, a platform containing a collection of tools, has been developed (http://tools.zooniverse.org/). Within the platform, volunteers may import their curated collections from Talk, and more easily access metadata from SkyServer. ZooTools provides a suite of plotting tools, as well as tools tailored for Galaxy Zoo, Snapshot Serengeti, and Space Warps. Utilizing much of the same technology, the Zooniverse has also released The Navigator, an interactive classroom tool. Students can classify galaxies as a classroom activity and explore galaxy characteristics together. It also demonstrates to students the basics of Zooniverse's crowdsourcing model, by allowing them to compare their classifications to the community as a whole. While The Navigator was designed with a high school audience in mind, it's functionality is applicable for basic astronomy teaching at a university level, with the ZooTools making an ideal follow up for more advanced projects. This workshop will demonstrate the tools themselves as well as discussing opportunities for using them for education and outreach purposes. Participants are invited to bring their laptops and actively take part.

Extragalactic globular clusters: the fossil record of galaxy formation
Vincenzo Pota

The advent of HST and of 10-meter class telescopes has opened a new window into the study of extragalactic globular clusters. We now know that globular clusters formed at high redshift and that they survived violent merging events and galaxy metamorphoses with time, preserving the chemo-dynamical record of their parent galaxies. The fact that we still observe thousands of globular clusters in the local Universe around galaxies of all types and of all masses, makes these objects the 'fossil record' of galaxy formation. During this talk I will discuss what we can learn about galaxy evolution by studying extragalactic globular clusters in the local Universe. I will present results from an extended spectro-photometric survey of a dozen never-before studied globular cluster systems, with particular emphasis to their dynamics. These data were obtained from the synergy between the Subaru/Suprime-Cam wide-field imager and the Keck/DEIMOS multi-object spectrograph. The kinematics for each globular cluster system and for their metal-rich and metal-poor subpopulations will be discussed in terms of: (1) origin and evolution of globular cluster systems and their host galaxies themselves, (2) connection with supermassive black holes and (3) galaxy dark matter modelling as key test for the LambdaCMD cosmology.

Ubiquitous Early-type Dwarf Galaxies with Blue Centers in the Ursa Major Cluster
Soo-Chang Rey

We construct a new catalog of galaxies in the Ursa Major cluster, a well-known nearby galaxy group, using the SDSS DR7 and NED data. The 167 spectroscopically confirmed member galaxies with Mr < -13.5 mag are selected. While the Ursa Major cluster is dominated by late-type galaxies, a large fraction (about 15%) of early-type dwarf galaxies are classified by careful visual inspection of the SDSS images. The fraction of early-type galaxy in subgroups appears to be correlated with their velocity dispersion which infers that the Ursa Major cluster consist of subgroups in different dynamical states. A significant fraction of early-type dwarf galaxies are identified to have central blue centers whose color is bluer than that of the outer part of the galaxy. These galaxies show higher star formation activity in ultraviolet flux and Ha emission line with respect to the counterparts in the Virgo cluster. We discuss the possible mechanisms for the formation of early-type dwarf galaxies with blue centers in the group environment in the context of the pre-processing of galaxies.

Connections between Galaxy Morphology and Star Cluster Populations in nearby spirals
Jenna Ryon

All star-forming galaxies host populations of young and intermediate-age star clusters. The properties of these star cluster populations (that is, their ages and masses) reflect the star formation history and morphological peculiarities of their host galaxies. The Snapshot Hubble U-Band Cluster Survey (SHUCS) is intended to characterize the star cluster populations of a sample of nearby (< 25 Mpc) spiral galaxies by obtaining luminosities, ages, masses, extinctions, and sizes of hundreds of star clusters in each galaxy. We can therefore 'map' each galaxy spatially and temporally using star clusters, which allows us to probe the events that resulted in the current morphology. We present three SHUCS galaxies of dissimilar morphology for which we have found connections between the host galaxy structure and the star cluster population.

Kinematic morphology and it's relationship to local and global environment
Nicolas Scott

Nature vs. nurture is one of the most hotly debated topics in galaxy evolution and recent and upcoming 3D integral field spectroscopy of galaxies is providing a new and fruitful avenue to address this issue. The SAURON and ATLAS3D integral field surveys proposed a new classification scheme for galaxies, based on the morphology of their stellar kinematics - their velocity fields - rather than simply their light profiles. They showed that a galaxy's kinematic morphology is closely related to its assembly history. Drawing on data from four separate integral field surveys of galaxies in the local Universe (covering the local field and the Fornax, Virgo, Coma and Abell1689 clusters), I will show how kinematic morphology depends on both a galaxy's global and local environments, and how this can be used to constrain the dominant formation mechanisms operating in these environments.

The supermassive black hole mass-Sersic index (and other) relation(s) for bulges and elliptical galaxies

Giulia Savorgnan & Alister Graham

Scaling relations between supermassive black hole (SMBH) mass, MBH, and various host spheroid properties are a powerful tool for studying galaxy-(black hole) coevolution. Furthermore, these relations enable us to predict the masses of SMBHs in other galaxies, and to measure the SMBH mass function and quantify the SMBH space density in our local universe. Graham & Driver (2007) presented evidence for a strong correlation between MBH and the central light concentration of the host bulge, quantified by the Sérsic index n. The MBH - n relation might be one of the simplest and strongest black hole mass scaling relations, requiring only uncalibrated galaxy images. However, the recent literature has failed to recover a strong MBH - n relation. Working with the authors of those works, we have successfully recovered the useful MBH - n relation. Moreover, we have explored for potential substructure in the MBH - n diagram based on galaxy morphology (elliptical or disc) and the nature of the central light profile (Sérsic or coreSérsic). Future work will focus on accurately modelling the bulge/disc structure of ~80 local galaxies with direct MBH values and a re-investigation of all the black hole mass scaling relations.

HI discs in early-type galaxies

Paolo Serra

Recent work as part of the Atlas3D project demonstrates that HI is relatively common in early-type galaxies (ETGs). Both HI mass and morphology are strongly dependent on the environment of the host. In particular, 1/4 of all ETGs outside clusters host a disc (or ring) of low-column-density HI with size from a few to tens of kpc and mass form ~1e+7 to a few times 1e+9 solar masses. In this talk I will show that these gas discs are often misaligned relative to the stellar kinematics of the host based on an analysis of HI and stellar velocity fields, and I will compare for the first time these results to predictions of LCDM hydrodynamical simulations of galaxy formation.

Connecting black hole activity and star formation with Galaxy Zoo

Stas Shabala

AGN feedback is a complicated process. Feedback can be imparted in many different ways, and the triggers of AGN activity play an important role in determining the efficiency of the feedback process. I will show how Galaxy Zoo can provide a unique window on the AGN - star formation connection. Armed with a morphologically-selected sample of early-type galaxies with dust lanes, I will argue that gas-rich galaxy interactions are responsible for triggering radiatively efficient AGN in the local Universe. Using such a clean, morphologically-selected sample allows us to reconstruct the timeline linking star formation and AGN activity. [Shabala et al. 2012, MNRAS, 423, 59; Kaviraj et al. 2012, MNRAS, 423, 49].

Secular Growth of Galaxies and Supermassive Black Holes
Brooke Simmons

We have recently identified and analyzed a population of galaxies which have grown to large sizes (M* ~ 10^10 Msun) despite calm formation histories free of both significant mergers and violent non-merger processes, evidenced by their lack of classical bulges and extremely small (or non-existent) pseudobulges. Yet each galaxy in the sample also has a growing supermassive black hole, and our analysis strongly suggests the black holes have grown substantially, to typical black hole masses for bulge-dominated and elliptical galaxies of these stellar masses. Interestingly, the galaxies and black holes appear to obey the same black hole-galaxy mass relation as that empirically determined based on galaxies with histories including major mergers. This implies that the co-evolution of black holes and galaxies may proceed independently of the details of the dynamical evolution of the host galaxy. This talk will discuss these results in the context of a more general study indicating bulgeless galaxies are not as rare as previously thought, indicating that secular growth plays a significant role in the evolution of most galaxies.

Early-type galaxies in a cluster at z=2
Veronica Strazzullo

Cl J1449+0856 at z=2 is the most distant galaxy cluster for which an extended X-ray emission has been detected. A likely representative progenitor of today's typical massive clusters, it allows the study of galaxy populations in most dense environments 10 billion years ago, a crucial time bridging proto-clusters to the first established clusters, and marking the main formation epoch of massive cluster early-type galaxies. In the core of this system, a remarkably diverse galaxy population clearly shows how galaxy evolution is in a much more active phase as compared to cluster cores at z<1-1.5. Nonetheless, together with still actively forming galaxies, we identify a population of massive sources already showing quiescent stellar populations and early-type morphologies. These galaxies are mostly segregated within ~200kpc from the cluster center, in the most dense region of this structure. As observed also in the field up to similar epochs, we find a strong correlation between stellar populations and galaxy structure, with most passive galaxies showing an early-type morphology (and viceversa). Although these passive cluster early-types appear smaller than similarly massive early-types in the nearby Universe, as routinely found in high-redshift studies, they seem to be generally larger than their z~2 field counterparts. These results, albeit still hampered by poor statistics, would support recent claims of an accelerated structural evolution in high-redshift dense environments.

Census of Blue Compact Dwarf Galaxies from SDSS DR7
Eon-Chang Sung

We present a study of the local and global environments of star-burst activities for a sample of ~10,000 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% galaxies of our sample are classified interacting or merging in progress within the detection limit. 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.

Ordered versus random motions, the morphology dependence of the Tully-Fisher relation and the Fundamental Manifold of spiral galaxies
Chiara Tonini

We investigate the morphology dependence of the Tully-Fisher (TF) relation, and the expansion of the relation into a higher-dimensional manifold akin to the ellipticals Fundamental Plane, to account for such a feature. In this work, we take advantage of a full semi-analytic hierarchical model (based from Croton et al. 2006), built on cosmological simulations of structure formation, to model galaxy evolution and build the theoretical TF relation. With this tool, we analyse a unique dataset of galaxies (Catinella et al. 2010) for which luminosity and both the total circular velocity and the central velocity dispersion are provided. We provide a theoretical framework to calculate such measurable quantities from hierarchical semi-analytic models. We establish the morphology dependence of the TF relation in both model and data. We analyse the dynamical properties of the model galaxies and determine that the parameter σ_A/V_C, i.e. the ratio between random and total motions characterised by velocity dispersion and circular velocity profiles, is an accurate proxy for galaxy morphology. We apply such dynamical cuts to the observed galaxies and find indeed that such selection produces a differential slope of the TF relation. We conclude that the σ_A/V_C is a valid parameter to expand the TF relation into a three-dimensional manifold, and that it successfully characterises the hierarchical assembly history that determines the disk-to-bulge ratio and therefore the galaxy morphology.

The Sizes of Globular Clusters in NGC 4278
Christopher Usher

We have used ACS imaging to study the sizes of globular clusters around the early type galaxy NGC 4278. We find that the size of globular clusters increases with distance from the centre of NGC 4278. This relationship is expected as the size of a globular cluster is strongly effected by the tidal field it experiences. We also see that redder globular clusters are smaller than bluer ones. Since the mean colour of globular clusters become bluer with increasing distance it is unclear it whether the size difference between blue and red globular clusters is due to a combination of the colour-distance and distance-size relationships or is due to an intrinsic size dependence on colour. When we compare the ratio of the mean sizes of blue globular clusters to the mean sizes of red ones in bins of distance from NGC 4278, we find that the ratio is independent of distance showing that the size of globular clusters does depend on their colour and not just on their location with in their host galaxy

A BOINC based project for Spectral Energy Distribution fitting
Kevin Vinsen

In this work we present the SkyNet Pan-STARRS1 Optical Galaxy Survey (POGS) project. This research project uses the Berkeley Open Infrastructure for Network Computing (BOINC) middleware and Internet-connected computers to measure the galactic structural properties of ~200,000 Galaxies. We are combining the spectral coverage of GALEX, Pan-STARRS1, SDSS, and WISE to generate a multi-wavelength UV-optical-NIR galaxy atlas for the nearby Universe. We are measuring physical parameters (such as stellar mass surface density, star formation rate, surface density, attenuation, and first-order star formation history) on a resolved pixel-by-pixel basis using spectral energy distribution (SED) fitting techniques in a distributed computing mode.

Galaxy Zoo 2: quantifying detailed morphologies for 300,000 galaxies in the SDSS
Kyle Willett

Galaxy Zoo 2 (GZ2) is a citizen science project that provides morphological classifications of more than 300,000 galaxies drawn from the Sloan Digital Sky Survey. The GZ2 data release compiles results from more than 16~million individual classifications and is more than an order of magnitude larger than the largest visually-classified sample from professional astronomers. Features classified in GZ2 include bars, bulge shapes, edge-on disks, and mergers, as well as galactic bulge strength, spiral arm multiplicity and pitch angle. GZ2 agrees well with visual classifications from several sets of professional astronomers, especially for early/late-type separation, barred galaxies, and mergers. We use GZ2 to measure the demographics of galaxies at z~0.1 and establish the relative populations of galaxies along the Hubble sequence, anchoring the observations which models of galaxy evolution must be able to reproduce.

The SkyMapper View of Red Spirals
Christian Wolf

In the integrated light of stellar populations the Balmer break at 365 nm is driven by recent change in star formation rate, while it is virtually insensitive to actual star formation level and the mean age of the stellar population. The SkyMapper filter set contains two u-filters ('u' and 'v'), which bracket this break. The SkyMapper Survey will thus obtain a half-sky Balmer break image and map where in nearby galaxies star formation is increasing or decreasing, whatever the current level. Deeper exposures on groups and clusters that harbour many red spirals will provide a more in-depth view of the role of environmental factors.

Major mergers on massive early-type galaxies in clusters
Sukyoung Yi

Major mergers provide an important channel for morphology transformation. In the hierarchical merger paradigm, major mergers are supposed to be rare at low redshifts and in massive clusters. The recent observational study of Sheen et al. (2012) however found a large fraction (~40%) of massive early-type galaxies in massive clusters at z=0.1 showing morphological signs of major mergers, which is in contrast to the theoretical expectation. We present a theoretical explanation to this apparent controversy. We use cosmological volume simulation to trace dark matter clusterings and semi-analytic modeling technique to trace galaxy formation. We also investigate on the lifetime of major merger features using hydrodynamic simulations. The conclusion is that we can reproduce the fraction of galaxies with merger features. They are not likely the merger remnants in situ in the current cluster but merger relics from previous, smaller halo environments where mergers were easier. The work was published in A&A (Yi et al. 2013) and covered in Science (Editor's choice section).

Multi-wavelength properties of Dwarf galaxies in the Local Volume I. Deep Near-Infrared Surface Photometry and Properties
Tye Young
In hierarchical structure formation scenarios, large numbers of low mass non-baryonic dark matter halos in the distant past were important building blocks for the high mass galaxies observed today. Dwarf galaxies in the Local Volume/Local Sphere of Influence (LV/LSI) (D < 10 Mpc) represent the closest analogue to these dark matter halos. Indeed, these surviving dwarfs are thought to be the optical manifestation of this previous dark matter halo population. As such these dwarfs through their star formation histories and mass compositions, represent an excellent opportunity to study galaxy formation and to trace the initial conditions of the LSI. Our project aims at a deep near-IR imaging analysis of all Local Volume HI Survey (LVHIS) galaxies, which were not targeted by Kirby et al. (2008). Using the IRIS2 detector on the 3.9m AAT, we obtained data for a sample of 40 LSI galaxies, most of them located in the denser galaxy environments like the Centaurus A and Sculptor groups. This poster presents results from our H-band photometry of these 40 LV galaxies. We probe the galaxies to a surface brightness of ~25 mag arcsec-2, or 40 times fainter than 2MASS. We perform photometry of all detected sources deriving the observed total magnitude, effective surface brightness and best fitting sersic parameters. Physical parameters are inferred from these quantities by using the best available distances in the literature; and these are compared to the neutral gas mass, gas distribution and environmental parameters such as isolation.