DAY ONE

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INVITED TALK 1

Content and structure of galaxy halos

R. Ibata

Abstract: Gravitational lensing experiments have now confirmed the expectation that galactic halos are gigantic structures extending several hundred kpc in radius. These vast dark matter structures, by far the most massive components of galaxies, are also the least well understood. Over the last decades, a painstaking census of their rare or tenuous baryonic tracers has revealed the hot and cold gas, satellite galaxies, globular clusters, planetary nebulae as well as more smoothly distributed stars that constitute the visible part of galaxy halos. I will review these findings, examining the role of environment and evolution in the observed properties. Particular attention will be given to what has been learned from the population of nearby galaxies.

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The Extended HI Environment of M31

Robert Braun

Abstract: We have imaged the extended HI environment of M31 with an unprecedented combination of high resolution and sensitivity using the Westerbork array, the Green Bank Telescope and the individual dishes of the WSRT array. We detect a wide range of distinctly non-disk-like components associated with M31. A sub-set of the features within 30 kpc appear to be tidal in origin. A filamentary "halo" component is concentrated at the M31 systemic velocity and appears to extend into a diffuse filament connecting M31 and M33. This appears to be a trace neutral component within the WHIM cosmic web. A population of discrete clouds is detected out to radii of about 150 kpc. Discrete cloud line-widths are correlated with HI mass and are consistent with a 100:1 ratio of dark to HI mass. These are likely the gaseous counterparts of low-mass dark-matter satellites.

Globular Cluster Sub-Populations and Galaxy Assembly

Jean Brodie

Abstract: Globular clusters are excellent tracers of the major star forming episodes in a galaxy's history. Studies of the sub-populations in extra-galactic globular cluster systems are providing important constraints on the epochs and dominant mechanisms of galaxy assembly. I will discuss current ideas on globular cluster/galaxy formation in the light of recent results from HST and Keck observing programs.

Globular cluster swapping in the Centaurus and Hydra I galaxy clusters

Michael Hilker

Abstract: Deep VLT photometry (V,I) of globular clusters in the central region of the Centaurus and Hydra I galaxy clusters is presented. The globular cluster candidates in both clusters are not spherically distributed around the central galaxies, but seem to be spread out in tidal tail-like structures. This would point to strong interactions between the major cluster galaxies. Low surface brightness fan-like structures around many of the bright galaxies support this scenario. Also a large population of low surface brightness dwarf spheroidal galaxies has been detected in both clusters.

Interestingly, the intergalactic globular cluster candidates are predominantly blue, even slightly bluer than the outer halo globular clusters of the major galaxies. This can be interpreted in two ways: either they are very metal-poor (around –2 dex), or they are quite young. A final answer can only be given with follow-up observations.

Halos of Early-Type Galaxies in Different Environments

Aaron Romanowsky

Abstract: We present observational constraints on early-type galaxy halos using X-ray emission and kinematical constraints from stars, planetary nebulae and globular clusters. We measure the amounts of mass and angular momentum in the halo for galaxies in different environments, testing for the effects of stripping, accretion, and other interactions. We also look for remnant kinematical substructure around these galaxies and M31.

Investigating dark matter halos of galaxies from the COMBO-17 survey

Martina Kleinheinrich

Abstract: Galaxies are embedded in dark matter halos that extend far beyond their optical parts. The structure and physical properties of these dark matter halos can be inferred from either dynamical studies of satellite galaxies or from weak gravitational lensing. However, currently satellite studies are restricted to isolated galaxies while weak lensing has already been applied to investigating dark matter halos of galaxies in different environments. We apply weak lensing studies of galaxies to the COMBO-17 survey. Studies of the galaxy population are among the main goals of COMBO-17 and it is indeed particularly well suited for weak lensing studies. Deep R-band imaging under best seeing conditions is complemented with accurate photometric redshifts and spectral classification from 17 optical filters. The survey covers four fields which span a large range of different environments ranging from the extremely empty Chandra Deep Field South to a field containing the supercluster! Abell 901/902. We study lens galaxies at z=0.2–0.7 and quantify the radial profile of the dark matter halos as well as the connection between properties of the dark matter halos and properties of the luminous parts of the galaxies like luminosity, color or stellar mass. The redshifts will allow us to quantify the environment of the lens galaxies and to also study the influence of the environment on the dark matter halos.

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INVITED TALK 2

Outflows and recycling through the ages

Joss Bland-Hawthorn

Abstract: In modern cosmology, 'feedback' has become a catch-phrase for anything we do not understand about the universe. The primary mechanism for feedback is thought to be galaxy winds. The latest simulations have begun to consider the role of winds from pre-galactic history to the present day. But how much do we actually know about galaxy winds in the nearby universe? Are they common or rare; do they blast out beyond the galaxy halo, or leak out into the IGM; do winds carry much mass, energy, dust, metals; is the material recycled; is it the big or small bulges which provide most of the feedback? This will be an illustrated guide to a complex field where some of these questions may find an answer.

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Lyman alpha blobs in a Large-Scale Structure at z=3.1

Yuichi Matsuda

Abstract: We present wide-field (32' x 24') and very deep Lyman alpha imaging in and around the proto-cluster region at z=3.1 discovered by Steidel et al. with the prime-focus camera on the 8.2 m Subaru telescope. We detected 283 candidates of strong Lyman alpha emitters (LAEs) at z=3.1 with the observed equivalent width larger than 170 A, and 83 candidates of Lyman alpha absorbers with deficit in the narrow-band image. These objects have a belt-like high surface density region extended over 60 Mpc in comoving scale. We also detected 35 candidates of extended Lyman alpha nebulae, so called Lyman alpha blobs (LABs) with spatial extents larger than 30 kpc in physical scale and Lyman alpha luminosity brighter than 6 x 10^{42} erg/s. The two previously known giant LABs are the most luminous and the largest ones in our survey volume of $1.3x10^5$ Mpc^3. We revealed the internal structures of the two giant LABs and discovered some bubble-like features, which suggest that intensive starburst and galactic superwind phenomena occurred in these objects in the past. These 35 LABs show a continuous distribution of spatial extents and Lyman alpha luminosity. The distributions of average surface brightness and morphology are widespread from relatively compact high surface brightness objects to very diffuse low surface brightness ones. One third of them are apparently not associated with ultra-violet continuum sources that are bright enough to produce Lyman alpha emission, assuming a Salpeter initial mass function. The sky distribution of these LABs is very similar to that of LAEs and likely to be more concentrated into the high surface density region of these LAEs. This suggests that these LABs may be the phenomena related to dense environment at high redshift.

Hot gaseous halos and their dependence on activity in the underlying galactic disks

Matthias Ehle

Abstract: We report on results of XMM-Newton observations of nearby actively star-forming galaxies that form part of a multi-wavelength (X-ray, radio continuum, HI and optical) study of different phases of the extra-planar ISM in spiral galaxies. We are investigating the interdependence of the properties of gaseous halos and the level and distribution of star formation in underlying galactic disks and address the question if a threshold value for energy input into the disk ISM exists which enables a star formation driven outflow. We note that tracers of different phases of the ISM (hot and warm gas, magnetic fields and cosmic rays) are simultaneously found in all our cases of detected halos. Our X-ray study especially aims at assessing the importance of galactic halos as repositories of a metal-enriched hot medium and their significance in terms of galactic chemical evolution and possible metal enrichment of the intergalactic medium.

Gas in the halo of spiral galaxies

Filippo Fraternali

Abstract: Recent observations have shown that the disks of spiral galaxies are surrounded by thick layers or halos of both neutral and ionized gas, which extend out to large distances (up to 10–15 kpc) from the plane and show peculiar kinematics. The rotation is non-cylindrical, lagging behind (by about 25–50 km/s) with respect to the gas in the disk.Furthermore, a fraction of this halo gas shows strong non-circular motions (possibly inflow) of up to more than 100 km/s. These results come from HI and optical line observations of spiral galaxies viewed either edge-on (e.g. NGC 891) or at intermediate inclination angles (e.g. NGC 2403, NGC 4559).

The origin and nature of the gas complexes found around these nearby galaxies are still a matter of debate. It is likely that they are the analogue of the so-called Intermediate and High Velocity Clouds (IVCs and HVCs) of the Milky Way. They can either be the result of super-bubble outflows from the galactic disk or of accretion from intergalactic space. The latter may be due to a continuous inflow of primordial gas or to minor mergers with small satellites. It is hoped, therefore, that the study of such halo gas will provide important clues for understanding the evolution of galaxies and their relation with the surrounding environment.

Recycling in the environment of galaxies: the formation of Tidal Dwarf Galaxies

Pierre-Alain Duc

Abstract: Many recent studies towards the close and far environment of galaxies have revealed the presence of matter of galactic origin: metal-enriched HI clouds, molecular gas, dust, intergalactic stars, that were pulled out from galaxies by various mechanisms. Part of that material will fall back and refuel the parent galaxies. However, a fraction of it may be directly recycled in the intergalactic medium. This is the case of the Tidal Dwarf Galaxies. TDGs are made of stars and gas pulled out into the intergalactic medium during tidal interactions. Although discovered more than one decade ago, the studies carried out during the last year were decisive in understanding the nature of these objects. First of all, it was realized that the prominent TDGs, usually located near the tip of tidal tails, which have a mass in excess of 10^9 Msun and are particularly rich in atomic and molecular gas, form very differently than the less massive but more numerous tidal condensations that shows up on optical images of interacting systems. Whereas numerical simulations have for long been able to reproduce the latter objects, we have just been able to build the more massive TDGs, using codes with realistic initial conditions. Observationally, TDGs may not be so easily distinguished as they may be mistaken with material projected along the line of sight. We have however found new criteria to unambiguously identify genuine galaxies forming in tidal tails. After having reviewed these new results, I will discuss what TDGs can tell about the distribution of dark matter both in the disk and in the halo of galaxies.

DAY TWO

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INVITED TALK 3

Cooling, Pre-heating and Feedback

Frazer Pearce

Abstract: I will review current arguments about the effect of gas cooling and pre-heating on the observable state of galaxy clusters and groups. This will lead to the contention that some form of energy feedback, whether from supernovae, stellar winds or AGN is required in order to prevent too much gas cooling and forming stars. I will review the leading contenders for the form of this feedback and discuss how this effects the local environment of the galaxies.

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Galaxy-Halo Gas Kinematic Connection at 0.5 < z < 1

Glenn Kacprzak

Abstract: It is our goal to understand the stellar-halo gas kinematic connection which could indicate whether halos are static remnants of formation or are constantly changing via accretion of the intergalactic medium or due to reprocessing of interstellar gas. We have expanded a pilot study of 5 galaxies (Steidel et al. 2002, ApJ, 570, 526) which now consists of a sample of 30 galaxies with $z < 1$. Keck HIRES Mg II quasar absorption profiles are used to study the halo gas kinematics and WFPC-2 images along with Keck LRIS spectra of the galaxies have been obtained. We will explore possible kinematic correlations with impact parameters, galaxy inclination, Hubble type, and ionization conditions and discuss the implications of the extended gaseous environments of galaxies.

How do Galaxies Get Their Gas?

Dusan Keres

Abstract: Based on the results from the cosmological simulations we see that gas can enter galaxies through one of two modes: through the conventional "hot" mode where gas is initially heated to the virial temperature close to the virial radius as it enters a galaxy halo, and then must cool to galactic temperatures and through a previously unappreciated "cold" mode where the gas is never heated to the virial temperature. The cold mode dominates in small galaxies while the hot mode dominates in massive galaxies. Overall the cold mode becomes increasingly more important at higher redshifts. The hot mode dominates in high density environments and the cold mode dominates in low density environments. Cold mode accretion is very filamentary. The rapid decrease in the global SFR towards low redshift is driven by a rapid decrease in cold mode accretion and to a lesser extent by a decrease in hot mode accretion.

Early Stellar Mass Growth in Cosmological Simulations

Romeel Dave

Abstract: The growth of stellar mass in the Universe is now being traced directly using rest-frame optical and near-IR observations of galaxies out to high redshifts. Here I present a detailed comparison of these observations with galaxies drawn from a suite of the latest Gadget2 simulations. These simulations (and virtually all such hydro simulations to date) produce an abundance of stellar mass at early times, and have no trouble reproducing the observed numbers of large, old galaxies. Thus the early growth of stellar mass is a generic feature of hierarchical cosmologies, and current observations present no challenges in this regard. This result is at odds with some semi-analytic models, and I will discuss possible reasons. Simulations do have some difficulties, namely the "Feedback Problem" (too many small galaxies), and the "Frosting Problem" (large old galaxies continue to have a tiny smattering of star formation, so are too blue). While these issues suggest feedback models need improvement, the overall growth of stellar mass in the universe appears to be well-represented in our simulations.

Cool cores in galaxy groups

Ewan O'Sullivan

Abstract: Chandra and XMM have vastly improved the degree of detail with which we are able to observe galaxy groups and clusters, in the process radically changing the estimated mass deposition rates in cooling flows. We have used a sample of 24 galaxy groups observed by XMM and Chandra to study cooling at the low end of the mass scale, and the interaction of group dominant galaxies

with their surroundings. High resolution spectral and spatial mapping allows us to identify structure in the cores of the groups, and look for the signatures of AGN and dynamical heating, gas mixing, and past mergers. We are also able to derive accurate 3-dimensional models of the group halo and profile properties such as entropy, cooling time and mass deposition rate within the cooling radius. These measurements provide a new and interesting insight into the interaction between groups and their dominant galaxies.

Signs of Galactic Feedback in the High Redshift IGM

Michael Rauch

Abstract: We'll discuss some recent observational results about the impact of galaxies on the properties of the general high redshift (z∼3) intergalactic medium (IGM). Galaxies inject bulk motion, heat, turbulence, metals, and radiation into the surrounding IGM, gradually building a complex multiphase medium that retains a partial memory of former galactic mischief. Using observations of QSO absorption lines with the Keck and Magellan telescopes we are investigating the IGM large scale structure as function of density and scale and describe some global changes over time, speculating on the galactic feedback effects that may have caused them.

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INVITED TALK 4

The Intergalactic Medium

Trevor Ponman

Abstract: Intergalactic gas plays a dual role in studies of galaxy evolution. On the one hand, it can directly affect the development of galaxies: it provides a potential reservoir of gas to fuel continuing star formation within galaxies, but may conversely be responsible for removing interstellar gas from galaxies, through processes such as ram pressure stripping. Secondly, the heavy elements and thermal properties of the IGM provide a coded record of the history of galaxy formation. In this review, I will examine both aspects of this two-way interaction between galaxies and their surrounding gas, with an emphasis on galaxy groups and clusters, where these processes and properties are most readily observed.

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Detections of Warm-Hot Intergalactic Medium in the vicinity of our Galaxy

Fabrizio Nicastro

Abstract: In this contribution we will present the current evidence for a very large amount of baryonic matter in the form of a Warm-Hot filamentary web of intergalactic gas (WHIM), both in our own Local group, and at redshift larger than zero, up to a distance of about 120 Mpc. We will present the exceptionally high quality Chandra high resolution spectrum of the blazar Mkn 421, and the first secure detections of two WHIM filaments at redshifts larger than zero. These detections allow us to estimate a total baryonic mass in each filament of $\sim$ (2–5) $\times$ 10^{12} solar masses, and a number density of dN/dz = 67, more than three times that estimated in the UV through OVI absorption. Based on these two detections, finally, we derive an average mass density, in units of critical density in the Universe, of $Omega_b = (0.017 - 0.038)[O/H]_{-1}$, virtually all the 'missing baryons' at z $<$ 2.

Sharp images of groups, Chandra/XMM nncover New Intricacies

J. Vrtilek

Abstract: Groups and poor clusters are the locus of most galaxies in the present-day Universe and the building blocks from which clusters form. Owing to the lower temperature of their intracluster gas, X-ray emission from groups produces strong lines from a broader range of elements than do hotter clusters. Here we show results from an examination of several X-ray bright groups, mostly from the Hickson, AWM, and MKW lists, pertinent to issues of current interest in the study of both groups and clusters: the distribution of heavy elements, the presence and nature of X-ray cavities and their relation to radio observations, the presence of cooling cores, and X-ray signatures of recent galaxy interactions.

Galaxy Wakes – Theory and Oobservations

Irini Sakelliou

Abstract: As a galaxy moves through the medium of the surrounding group/cluster, physical processes take place that modify the properties of the galaxies and their host clusters. For example, galactic gas (ISM) may be stripped; cluster gas (ICM) is accreted onto and behind the moving galaxy; the ISM and ICM may get compressed and heated due to the galactic motion and the creation of shock waves.

The stripped ISM and accreted ICM concentrate into a dense wake, that trails behind the moving galaxy. Thus, galactic wakes have the potential to disclose the galactic motion in clusters of galaxies when combined which redshift data.

This talk will present :

(a) the results of galaxy-ICM interactions as predicted by our new hydro-simulations, their observables, and the most favourable conditions for wake generation.

(b) a comparison of the above with our X-ray data (XMM and Chandra) of such systems

(c) new results of our program to use wakes as tracers of the galactic motion in clusters to probe of the group/clusters dynamics, by using deep X-ray observations.

Ram Pressure Stripping of Disk Galaxies in Clusters

Elke Schumacher

Abstract: The environment has an important influence on the evolution of galaxies. Comparative observations of disk galaxies in clusters and of those in the field reveal mainly differences that are connected with their gas contents. E.g., cluster galaxies often show HI deficiency, truncated HI and Hα disks, but undisturbed stellar disks.

A favoured process to explain these observations is ram pressure stripping, the removal of the galaxy's own gas by the "wind" it feels while moving through intra-cluster medium. This process is investigated by means of hydrodynamical simulations.

We want to study the signatures and effectiveness of the stripping process. We compare the simulation results with analytical estimates and search for simple correlations between e.g. wind strength and gas loss. Special interest is paid to the fate of the stripped material.

Environmental effects on Virgo spirals

Bernd Vollmer

Abstract: We have studied the influence of the cluster environment on Virgo cluster spirals. Since Virgo is the nearest cluster in the northern hemisphere we dispose of multiwavelength observations (Radio continuum, CO, HI, Hα) of Virgo spiral galaxies with resolutions of the order of 1 kpc. Most of these data contain velocity informations. On the other hand, we have developped an N-body code, which includes the effects of ram pressure stripping. The comparison between the simulated and observed gas distributions and velocity fields permits us to interpret our observations and to disentangle the effects of ram pressure versus galaxy-galaxy interactions. We have now a sample of 6 Virgo galaxies that are affected by ram pressure stripping. I will present cases of active (we might have detected the shock) and past ram pressure stripping and cases of mixte interactions, i.e. ram pressure stripping together with galaxy-galaxy gravitational interactions. I will show that we are now at the point where we can start to think about the gas physics of these interactions (evaporation, phase mixing, change of phase, star formation).

DAY THREE

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INVITED TALK 5

Galaxy properties in different environments (observational)

Michael Balogh

Abstract: I will review what we have learned about how galaxy properties (e.g. morphologies, gas content, star formation rates, masses and ages) depend on their environment, through observations. In particular, a detailed description of these correlations in the local Universe are now available from the 2dF galaxy redshift survey and the Sloan digital sky survey, and I will provide a summary of these recent findings. The tremendous amount of previous and ongoing work on clusters and groups at higher redshifts will be reviewed in light of these local data. Finally, future prospects for observational study will be discussed.

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The Dwarf Low Surface Brightness Galaxy Population of the Virgo Cluster

Jon Davies

Abstract: Cold Dark Matter models of structure formation predict the presence of many more small dark matter halos around individual galaxies and in galaxy clusters than have been detected. Also, the hierarchical growth of structures in these models predicts that the formation of galaxy clusters occurs through assembling of smaller structures, i.e. groups.

With the aim of investigating these theoretical predictions, we carried out a deep B band CCD survey of part of the Virgo Cluster to very low surface brightness levels (average sky noise $\sim$26 B mag/sq arcsec). We specifically developed an automated detection algorithm and optimized our selection criteria in order to study the population of dwarf low surface brightness galaxies in the cluster, down to absolute magnitudes comparable to those of the Local Group dwarfs ($-14 <= M_B <= -9.5$). Over a survey area of $\sim$ 14 sq deg we identified 257 dwarf galaxies (105 not present in previous catalogues), consistently with a much steeper Luminosity Function than observed for the field.

In order to investigate the nature of these galaxies we carried out I band and HI line follow-ups and compared our results with less dense environments. Different galaxy evolution processes are

discussed in relation to these results. A galaxy in a cluster can be subject to many different processes that are not at work (or less likely to occur) in the field: direct collisions, galaxy-galaxy or galaxy-cluster tidal interactions, high/low-speed encounters between galaxies, ram pressure stripping by the Intra-Cluster-Medium (ICM), pressure confinement and combinations of the above. We discount most of these as primary evolutionary influences. We suggest, instead, that the numerous high-speed encounters experienced by galaxies in clusters can account for the properties of the dwarfs in our sample; accelerated star formation, rather than gas stripping mechanisms, is thought to be responsible for the consumption of the gas.

Galaxy structure, star-formation history, and environment

Michael Blanton

Abstract: Using a large sample of galaxies from the SDSS spectroscopic survey, I demonstrate that galaxy environment is fundamentally related to galaxy star-formation history (as measured by the galaxy luminosity and color) but only secondarily related to galaxy structure (as measured by the galaxy surface brightness and profile shape). I compare these results to predictions of SPH simulations, which suggest that dividing the galaxy population into central galaxies and satellite galaxies results in a natural interpretation of the relationship between density, color, and luminosity.

Galaxy Groups in the Sloan Digital Sky Survey

Andreas Berlind

Abstract: Theoretical models of galaxy formation assume that galaxies are subject to different physical mechanisms once they merge into larger systems of groups and clusters. For example, they experience dynamical friction and tidal stripping of stars, as well as mergers with other galaxies. These physical mechanisms could be responsible for the observed dependence of galaxy properties on environment. We test these ideas in a large sample of galaxy groups and clusters selected from the SDSS spectroscopic sample. In particular, we focus on the properties of central and satellite galaxies in groups of different masses and different larger-scale environments.

The cosmic 'Butcher-Oemler' effect

Eric Bell

Abstract: One of the most important observational findings of the last 20 years was the discovery that distant clusters of galaxies have a substantially larger fraction of star-forming galaxies than is typical at the present day – the Butcher-Oemler effect. This has been frequently interpreted in terms of physical processes such as harassment and ram-pressure stripping, which operate primarily in cluster environments. We use the COMBO-17 photometric redshift survey, yeilding 25000 galaxies with photometric redshifts accurate to dz$\sim$0.03, to explore the evolution of the relative fraction of star-forming vs. non-star-forming galaxies in low density environments for the first time over the interval $0<z<1$. We find that the star-forming galaxy fraction is larger in low-density environments than in dense environments by typically 40%. Importantly, there is an increase in non-star-forming galaxy fraction from $z=1$ to the present day in low-density environments: there is a Butcher-Oemler effect in the field as well as in clusters. While cluster-dependent processes must clearly play important roles in driving galaxy evolution, our results suggest that the Butcher-Oemler effect may be driven by physical processes such as galaxy merging, which operate primarily in field environments.

The environment of E+A galaxies in the local universe: further clues from the 2dF Galaxy Redshift Survey

Warrick Couch

Abstract: The enigmatic "E+A" galaxies, with their strong Balmer-line absoprtion signature superimposed upon an E-galaxy type spectrum, are conspicuous examples of systems which have undergone recent dramatic evolution in their star formation activity. Whilst the initial discovery of such objects in the cores of distant rich clusters has highlighted the importance of this high density environment in triggering this rapid evolution at earlier epochs, it is not so clear that this is the case at low redshift. In an attempt to better quantify the environments of E+A galaxies in the local universe and thus further understand the astrophysical mechanisms responsible for their formation, we have conducted a large, environmentally-unbiased survey of E+A's at low redshift using spectra from the 2dF Galaxy Redshift Survey. In this talk we present the results of this study, which include robust measures of the local environments, clustering properties and luminosity function of these objects, together with clear insights into their morphological nature.

DAY FOUR

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INVITED TALK 6

Galaxies and their environments: expectations from hierarchical models

Rachel Somerville

Abstract: Can hierarchical models naturally explain why galaxies seem to 'know about' their environment even on scales of several Mpc? I will discuss what we know about the dependence of the properties of dark matter halos on local density, and how this might affect galaxy properties. I will then review theoretical expectations about the relative importance of various physical processes for galaxy transformation, such as merging, ram pressure stripping, tidal stripping, and harrassment. Finally, I will discuss whether state-of-the-art CDM-based galaxy formation models reproduce the observed correlations in the local universe, and present predictions for how galaxy-environment correlations depend on redshift.

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Galaxies in Low Density Environments

Duncan Forbes

Abstract: I present initial results from two surveys focusing on isolated and group galaxies. The Group Evolution Multiwavlength Survey (GEMS) is a wide-field optical, HI, X-ray study of 60 nearby groups. The aim is to understand both galaxy and group evolution via observations and modelling. The isolated galaxy study concentrates on a sample of 40 early type galaxies. These galaxies are compared to their high density environment counterparts to better understand their evolutionary history.

The Role of Gas in Galaxy Groups

Virginia Kilborn

Abstract: The majority of galaxies in the Universe lie in groups, yet there has not been a comprehensive census of the contents of groups to date. The GEMS study is a multiwavelength investigation of nearby groups that have existing ROSAT x-ray data. In particular, wide-field neutral hydrogen imaging has been made of these groups, leading to the discovery of both faint gas-rich galaxies that have been missed in previous optical surveys, and new group members for which the redshifts were previously unknown. The neutral hydrogen distribution provides clues to the evolutionary history of the groups, including the importance of interactions to the evolution of individual group members. A comparison of the HI to X-ray emission on a group scale is made for the first time in this environment, allowing a comparison of the hot and cold gas.

The Dwarf Galaxy Population in Group Environments

Marla Geha

Abstract: We present results from an on-going survey to study the dwarf galaxy population in a large sample of nearby galaxy groups. Galaxy groups were identified in the Sloan Digital Sky survey and are defined to have four or more members with measured Sloan redshifts. Using the Las Campanas du Pont 2.5m telescope, we have targeted these groups with multislit spectroscopy in order to establish group membership for objects down to an absolute magnitude of Mv $<$ –15. We discuss properties of the dwarf population, such as the faint-end luminosity function slope, early-to-late type fractions and dwarf-to-giant ratios, in these low-density environments.

Infrared views of massive field galaxies with Spitzer: the GOODS

Leonidas A. Moustakas

Abstract: Beginning in February 2004, the first Spitzer Space Telescope observations in the GOODS fields will begin. These data are the deepest planned with Spitzer, and allow normal star-forming galaxies to be detected to redshifts beyond 3. From recent HST and ground-based work in the GOODS fields, we have been studying massive field galaxies at redshifts around 1–2, some of which are extremely old, and others of which appear to feature dramatic, but highly obscured star formation. The Spitzer data on these sets of objects will be invaluable to probe the nature of both these sets of objects, which it should do with ease. This new infrared view into massive galaxies at high redshift is key to unfolding details about how the environments that galaxies find themselves in influences their star formation characteristics, and the modes by which they 'assemble'. In this talk, I will present some of the earliest results on this research from the Spitzer/GOODS Legacy project.

The Internal Kinematics of Galaxies in Compact Groups

Claudia Mendes de Oliveira

Abstract: We will discuss some new results from a study of the internal kinematics of galaxies in Hickson compact groups (HCGs), obtained from Fabry-Perot observations, concerning the determination of the evolutionary stage of the groups, the Tully-Fisher relation for 25 HCG galaxies, the internal kinematics of several tidal dwarf candidates and the presence of newly discovered intergalactic HII regions in the intragroup medium of HCG 16, HCG 31 and the Stephan's quintet.

Brightest Cluster Galaxies and their Environment

Sarah Brough

Abstract: Brightest cluster galaxies (BCGs) are the most massive galaxies at all epochs, therefore, hierarchical models of structure formation suggest that they must have assembled their stellar mass most recently. We are investigating the mass evolution of BCGs and how that depends on their environment, using a large sample of BCGs in X-ray selected clusters with redshifts $0.02 < z < 0.8$. We observe that the BCGs in the most X-ray luminous clusters show no evidence of mass growth since $z \sim 1$, in contrast to those in the least X-ray luminous clusters which show a wide range of mass growth in the same time interval. To verify the possibility that these galaxies have undergone accretion in their recent past we have examined the structural properties of our sample and will present a projection of the BCG Fundamental Plane here.

Galaxy Environments: An Ultraviolet Perspective from the Galaxy Evolution Explorer

David Schiminovich

Abstract: I will present new results from the Galaxy Evolution Explorer (GALEX), an ultraviolet survey mission, emphasizing observations of star formation in environments ranging from isolated galaxies to groups and rich clusters. I will discuss how these new data are being used to understand the strong dependence of star formation on local density both in the local universe (z∼0) and at moderate redshift (z∼1).

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INVITED TALK 7

Galaxy Transformation Processes

Ben Moore

Abstract: I will review the latest theoretical, numerical and observational work that aims to describe the transformation of galaxies between morphological types. Can we explain the Morphology-Density relation and Butcher-Oemler effects as a product of late time environmental processes or are galaxy types set simply by the early and rapid formation times of massive cosmic structures?

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Mapping the stellar populations of E/S0s with SAURON in field and cluster environements

Harald Kuntschner

Abstract: I will report results from the SAURON 2D integral-field survey of the kinematics and stellar populations of a representative sample of nearby E, S0 and Sa galaxies drawn from both cluster and field environments. The survey is aimed at determining the intrinsic shape of the galaxies, their orbital structure, the age and metallicity of their stellar populations, and the frequency of kinematically decoupled cores. Here in this talk I will focus on the star-formation history of early-type galaxies as inferred from line-strengths maps and stellar population models, and thus probe the fossil record of their evolution in different environments (cluster and field).

Environmental effects in hierarchical structure formation; the origin of dwarf spheroidals

Lucio Mayer

Abstract: We present results of high resolution N-Body/SPH simulations which study the evolution of realistic models of dwarf galaxies subject to tidal stirring and stripping, ram pressure and photoionization by the cosmic UV background at high redshift as they orbit within the dark halo of the primary system. Both the individual and the combined effect of all these mechanisms is studied for the first time, including radiative cooling and star formation. As a complimentary approach, we also study a population of satellites in a full cosmological galaxy formation simulation. We show that tidally induced non-axisymmetric instabilities turn rotationally supported disky dwarfs into pressure supported systems resembling dwarf spheroidals. The combination of stripping by tides and ram pressure, together with gas consumption by star formation, dramatically lowers the gas content, matching the values found for dSphs even for systems whose mass is high enough to be barely affected by the UV background. Extended star formation histories with periodic bursts triggered by tidal shocks at pericenters of their orbits occur in dwarfs orbiting at larger distances for which stripping is not so efficient. The latter dwarfs are also those that accrete later in cosmological simulations. The properties of the dSph satellites of the Milky Way are thus naturally explained as a result of these environmental mechanisms once we place them in the context of hierarchical structure formation.

The formation of S0 galaxies

Alfonso Aragón-Salamanca

Abstract: In order to understand how S0 galaxies form, we have been following three complementary approaches. First, we are studying the Tully-Fisher relation of Spiral galaxies falling into clusters at $0.2<z<0.8$, since these galaxies are the putative progenitors of present-day S0s. Second, we are studying the Tully-Fisher relation of present-day S0s in different environments. Third, we have analysed the properties of the Globular Cluster systems in nearby S0s. The combined results of these studies are painting a very coherent picture: spiral galaxies falling onto (rich) clusters are transformed into present-day cluster S0s via a process that involves a period of enhanced star formation, exhaustion of the gas reservoir and end of star formation, followed by passive ageing of their stellar populations. In this talk I will present the evidence gathered so far and its interpretation.

DAY FIVE

What did todays passive galaxies do in the past?

Bianca Poggianti

Abstract: The population of passively evolving galaxies in the local universe consists of galaxies with a variety of past star formation histories. Solid evidence for this comes from observations of galaxies in dense environments such as clusters, which simultaneously allow to investigate physical processes internal and external to galaxies and the influence of the hierarchical evolution of cosmological structures. I would like to present several results regarding the variation of galaxy properties and their evolution with redshift as a function of the **galaxy mass/luminosity**. This would draw together results at different redshifts, including my recent work on giant and dwarf galaxies in the Coma cluster and the evidence we have found for significant effects of the interaction with the intracluster medium in Coma; a discussion of the downsizing effect based on the evolution of galaxy colors, color-magnitude sequence and spectral properties (if time would allow, I'd like to show these both for cluster and field); and (possibly) include also results from an ongoing study of dwarf galaxies in distant clusters.

Isolated galaxies versus Compact Groups

Lourdes Verdes-Monetenegro

Abstract: The AMIGA project (Analysis of the Interstellar Medium in Isolated GAlaxies) is building a multiwavelength database for a large and reasonably complete sample of isolated galaxies in the northern sky. It is intended to serve as a template or control sample of galaxies with ISM properties unaffected by external perturbation. It should provide a better defined baseline for evaulating the effects of external stimuli ("nurture" effects) on samples of galaxies in denser or interacting environments. The source list of approximately n=800 galaxies is drawn from the Catalogue of Isolated Galaxies (CIG: Karachentseva 1973) with refined evaluations of isolation and galaxy morphology. The database will contain LB, HI, FIR, and radio continuum measures for the entire sample, as well as CO and Halfa data for a redshift limited subsample composed of 200 galaxies. We report here on a comparison between CIG galaxies with members of galaxies in dense interacting compact groups.

Post-starburst Galaxies at Intermediate Redshifts

Kim-Vy Tran

Abstract: We isolate post-starburst (E+A) galaxies at intermediate redshifts (0.3¡z¡1) to understand how star-forming galaxies evolve into passive, early-type systems in both the cluster and field environment. We find E+A's make up a significant fraction (11galaxy population at z¿0.3, and that ¿30undergone an E+A phase by z 0. We also find evidence in clusters of a decreasing characteristic E+A mass with redshift, similar to the decrease in luminosity of rapidly star-forming field galaxies since z 1 ('down-sizing"). In comparison, only 3intermediate redshifts are E+A's. Although the E+A fraction in the field is lower than in clusters, the E+A phase is still an important link between emission line galaxies and absorption line systems in this environment: we estimate that 25field had an E+A phase at z¡1.

E+A Galaxies and the Formation of Early Type Galaxies at z∼0

Yujin Yang

Abstract: E+A galaxies, whose spectra have deep Balmer absorption lines but no significant [OII] emission, are the best candidates for an evolutionary link between star-forming, gas-rich galaxies and quiescent, gas-poor galaxies. Yet their current morphologies are not well known. We present HST/WFPC2 observations of the five bluest E+A galaxies (z∼0.1) in the Zabludoff et al. sample to study whether their detailed morphologies are consistent with late-to-early type evolution and to determine what drives that evolution. The morphologies of four galaxies are disturbed, indicating that a galaxy-galaxy merger is at least one mechanism that leads to the E+A phase.

Two-dimensional image fitting shows that the E+As are generally bulge-dominated systems, even though at least two E+As may have underlying disks. In the Fundamental Plane, E+As stand apart from the E/S0s mainly due to their high effective surface brightness. Fading of the young stellar population and the corresponding increase in their effective radii will cause these galaxies to migrate toward the locus of E/S0s. E+As have profiles qualitatively like those of normal power-law early-type galaxies, but have higher surface brightnesses. This result provides the first direct evidence supporting the hypothesis that power-law ellipticals form via gas-rich mergers. In total, at least four E+As are morphologically consistent with early-type galaxies.

We detect compact sources, possibly young star clusters, associated with the galaxies. These sources are much brighter (M_R = –13) than Galactic globular clusters, have luminosities consistent with the brightest clusters in nearby starburst galaxies, and have blue colors consistent with the ages

estimated from the E+A galaxy spectra (several 10^8 yr). Further study of such young star cluster candidates might provide the elusive chronometer needed to break the age/burst-strength degeneracy for these post-merger galaxies.

Early Galaxy Clustering Results from the DEEP2 Redshift Survey

Alison Coil

Abstract: I will discuss early results from the DEEP2 Redshift Survey on galaxy clustering at z$\sim$1 as a function of color, spectral type and luminosity. We find that red, absorption-dominated, passively-evolving galaxies are more strongly clustered than blue, emission-line, actively star-forming galaxies. Intrinsically brighter galaxies also cluster more strongly than fainter galaxies at z$\sim$1. We find that the galaxy bias for the DEEP2 sample is $\sim$1.0–1.2. I will also discuss measurements of angular galaxy correlations in our DEEP2 photometric data and the dependence of galaxy clustering on redshift and color.

The epochs of early-type galaxy formation in clusters and in the field

Daniel Thomas

Abstract: Using our models of absorption line indices that account for variable abundance ratios, we derive ages, total metallicities, and element abundance ratios of 126 early-type galaxies in various environments. The data are analyzed by comparison with mock galaxy samples created through Monte Carlo simulations taking the typical average observational errors into account, in order to eliminate artifacts caused by correlated errors. We find that all three parameters age, metallicity, and α/Fe ratio are correlated with velocity dispersion. We further find evidence for an influence of the environment on the stellar population properties. Massive early-type galaxies in low-density environments appear on average several Gyrs younger and $\sim$0.1 dex more metal-rich than their counterparts in clusters. No offsets in the α/Fe ratios, instead, are detected. With the aid of a simple chemical evolution model, we translate the derived ages and α/Fe ratios into star formation histories. We show that most star formation activity in early-type galaxies is expected to have happened between redshifts $\sim$3 and 5 in high density and between redshifts 2 and 3 in low density environments.

The Morphology-Density Relation in Clusters

Andrew Benson

Abstract: Inspired by detailed observations of the cluster CL0024, we present model calculations for the formation and evolution of clusters and their environs, including detailed tracking of the properties of galaxies within this region. Observations show a dependence of morphological mix on local density within the cluster, suggesting that it is local density which drives morphological transformation rather than radial position within the cluster. Using an analytical model to accurately follow the orbits of infalling field galaxies, we examine the importance of a variety of physical mechanisms which may be responsible for establishing this morphology-density relation. We will present conclusions on which physical mechanisms (if any!) are effective in establishing the observed correlation.

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INVITED TALK 8

The Evolution of Galaxies in Groups

Richard Bower

Abstract: Starting from the CNOC2 galaxy redshift survey, we have created a spectroscopic catalogue of galaxies in groups at z $\sim$ 0.4. I this talk, I will compare the properties of these group galaxies with the properties of galaxies in local groups (selected from the 2df-grs) and with the field galaxy population both locally and at intermediate redshift. I will use this data to assess the role of the group environment in driving the decline in the cosmic star formation rate.

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Galaxy Evolution During Half the Age of the Universe

Marcel Bergmann

Abstract: We are carrying out a large project aimed at studying the evolution of cluster galaxies over the last half of the age of the universe, based on deep optical spectroscopy obtained with the two Gemini Telescopes, combined with multi-color imaging from the Hubble Space Telescope and Gemini. We are targetting 14 X-ray bright galaxy clusters over the redshift range 0.15–1.0 and will obtain spectroscopy of 30–50 galaxies per cluster, of all morphological types. The spectroscopic observations for ten of the clusters have already been obtained, with time allocated during 2004A to observe the remaining four. The spectra are of very high quality, and have sufficient resolution to derive velocity dispersions and line index strengths, as well as rotation curves in some cases. With this many galaxies per cluster, we are able to measure both the zero-points and the slopes for the Faber-Jackson, Tully-Fisher, and Fundamental Plane scaling relations for each of the clusters.

We will present an overview and status report of the project, as well as results from (at least) the first three clusters analysed, at redshifts z=0.28, z=0.4, and z=0.83.

Panoramic Imaging and Spectroscopy of Cluster Evolution with Subaru (PISCES)

Tadayuki Kodama

Abstract: We'll present some initial results from an on-going distant cluster project with Subaru called PISCES (Panoramic Imaging and Spectroscopy of Cluster Evolution with Subaru). Our sample consists of 15 X-ray selected clusters at 0.4<z<1.3, and the good complete data have been obtained for 5 clusters (CL0939[z=0.41], CL0024[z=0.40], CL0016[z=0.55], RXJ0153[z=0.83], and RXJ0849[z=1.27]) so far. The uniqueness of this project is its wide-field coverage due to the large-format optical camera, Suprime-Cam, which provides a 34'x27' view corresponding to 10–15 Mpc on a side, well beyond the virial radii of our target clusters. Based on the current data-set, we'll present the following two key analyses: (1) Mapping the large scale structures in and around the distant clusters to view the hierarchical build-up of the clusters, and (2) Looking into the environmental and time variations of galaxy properties along the large scale filaments (based on the colour-magnitude diagrams and the luminosity functions) to trace the histories of mass assembly and star formation in galaxies, with a particular emphasis on the "down-sizing" effects.

The Proximity Effect Around High Redshift Galaxies

Antonella Maselli

Abstract: Recent observations have shown that the intergalactic medium (IGM)is more transparent to Ly-alpha photons close to Lyman Break Galaxies (LBGs) than at large distance from them, ie a proximity effect. Cosmological simulations including winds from LBGs have been so far unable to explain this trend. By coupling such simulations with the radiative transfer code CRASH, we investigate whether the addition of the ionizing radiation emitted by LBGs can increase the transmissivity by decreasing the neutral hydrogen fraction in the inner Mpc of the galaxy halo. The transmissivity as a function of distance is roughly reproduced only if LBGs are identified with dwarf galaxies (with masses around 10^9 solar masses) which are undergoing a vigorous (50 solar masses per year) burst of star formation. Similar star formation rates in larger galaxies are not sufficient to overwhelm the large recombination rates associated with their denser environment. If so, photoionization partly reconciles theory with observations, although we discuss a number of uncertainties affecting both approaches.

SIRTF/IRAC Observations of High-Redshift Galaxy Clusters

Adam Stanford

Abstract: We present new deep SIRTF/IRAC imaging of high-redshift galaxy clusters. These data sample the rest frame near-IR down to several magnitudes below L*, allowing better estimates to be made of the stellar mass component of the galaxies in the clusters. This information will allow us to investigate the evolution in the M/L ratios for cluster galaxies from z $\sim$ 1 to low redshift when coupled with existing ground-based studies.