THE MOST MASSIVE GALAXIES AND THEIR PRECURSORS

9th-12th February 2015
Sydney

Twitter hashtag: #MassGal15

Sponsored by an AAO Return To Work grant
MONDAY 9TH FEBRUARY

8:30am:  Registration Open

### Growth of Massive Galaxies

Session Chair: Sarah Brough

9:00am –  Warrick Couch – Welcome

9:05am  *Invited:* Mariska Kriek - Massive Galaxies out to z~2: Knowns and Unknowns

9:35am  *Invited:* Danilo Marchesini - The Progenitors of Today's Ultra-massive Galaxies Across Cosmic Time

10:05am  *Invited:* Chris Lidman - Observational constraints on the growth on brightest cluster galaxies over the last 10 billion years

10:35am  COFFEE

Session Chair: Paola Oliva-Altamirano

11:00am  *Invited:* Gabriella de Lucia - Formation and evolution of the most massive galaxies in hierarchical models

11:30am  Richard McDermid - Mapping Star Formation Histories of Early-Type Galaxies with the Atlas3D Survey

11:50am  John Stott - The KMOS Redshift One Spectroscopic Survey: The resolved Dynamics, Star-Formation and Chemical Properties of 1000 massive z~1 star forming galaxies

12:10pm  Pablo Perez-Gonzalez - Diving into the details of the SFH of z>1 dead massive galaxies

12:30pm  LUNCH

Session Chair: Amelie Saintonge

1:30pm  Sarah Wellons - The Formation and Evolution of Massive, Compact Galaxies in Illustris

1:50pm  Lee Spitler - Discovery of massive compact quiescent galaxies at z~4 with ZFOURGE

2:10pm  Sirio Belli - Deep Keck Spectroscopy of 1 < z < 2.5 Quiescent Galaxies: New Results on the Size Growth
2:30pm  Ivana Damjanov - The number density and environment of red nuggets at intermediate redshift

2:45pm  Kate Whitaker - Structure across the Star Formation Sequence at 0.5<z<2.5

3pm  COFFEE

Session Chair: Chris Lidman

3:30pm  Yuanyuan Zhang - Bright Central Galaxies (BCGs) in Dark Energy Survey Science Verification Data: Stellar Mass Growth Since z=1.2

3:50pm  Rosalind Skelton - The merger fraction of Luminous Red Galaxies

4:10pm  Daniel Groenewald - The importance of mergers to the stellar mass build-up of Brightest Cluster Galaxies

4:30pm  Sukyoung Yi - Merger relics in galaxy clusters

4:45pm  Jaehyun Lee - The significance of galaxy mergers as a function of galaxy and halo mass
**TUESDAY 10TH FEBRUARY**

### Dark Matter

Session Chair: Adam Muzzin

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Session Chair: Matthew Colless

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<td>Nick McConnell</td>
<td>Supermassive Black Holes in the MASSIVE Galaxy Survey</td>
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### Angular Momentum

Session Chair: Lisa Fogarty

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<tr>
<td>1:10pm</td>
<td><strong>Invited:</strong> Michele Cappellari</td>
<td>Angular momentum of massive galaxies</td>
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<tr>
<td>1:40pm</td>
<td><strong>Invited:</strong> Paola Oliva-Altamirano</td>
<td>The accretion histories of Brightest Cluster Galaxies: Angular Momentum and Stellar Populations</td>
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<td>2:10pm</td>
<td><strong>Invited:</strong> Thorsten Naab</td>
<td>The cosmological formation of massive galaxies</td>
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Session Chair: Louise Edwards

3:10pm   J. Trevor Mendel - Evolution of massive galaxies from the KMOS-Cluster and VIRIAL surveys

3:30pm   Davor Krajnovic - M3G: the MUSE most massive galaxies campaign

3:50pm   Lisa Fogarty - The Formation of Slow Rotating ETGs.

4:10pm   Matthew Colless - The link between structure and kinematics in SAMI massive galaxies

4:30pm   Elisa Toloba - Angular momentum and kinematically decoupled cores in elliptical galaxies at all masses

4:45pm   Duncan Forbes - Probing the Halos of Massive Early-type Galaxies
WEDNESDAY 11TH FEBRUARY

Intra-Cluster Light

Session Chair: Chiara Tonini

9:00am  Invited: Louise Edwards - Clocking BCG formation: Close companions vs. Intracluster Light

9:30am  Invited: Emanuele Contini - Properties of the Intra-Cluster Light as predicted by a semi-analytic model of Galaxy Formation

Activity

10:00am  Invited: Kim-Vy Tran - Tracking Star Formation and AGN in Distant Galaxies

10:30am  COFFEE

Session Chair: John Stott

11:00am  Invited: Amelie Saintonge - The role of gas in regulating star formation and AGN activity in massive galaxies

11:30am  Invited: Norbert Werner - The origin of cold gas in giant ellipticals and its role in fuelling AGN feedback

12:00pm  Invited: Chiara Tonini - Hierarchical galaxy assembly and its manifestations: dynamical state and star formation history

12:30pm  LUNCH

Free Afternoon

6pm  CONFERENCE DINNER

Location and further information provided on p.9
### THURSDAY 12th FEBRUARY

**Session Chair:** Kim-Vy Tran

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<tr>
<td>9:00am</td>
<td>Sune Toft</td>
<td>Sub-mm galaxies as progenitors of compact quiescent galaxies</td>
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<td>9:20am</td>
<td>Lee Spitler</td>
<td>The ZFOURGE survey: a remarkable diversity in the massive galaxy population at redshifts z = 3-4</td>
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<td>9:40am</td>
<td>Fuyan Bian</td>
<td>Luminous Lyman Break Galaxies at z~3 in Deep and Wide Field Surveys</td>
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<td>10:00am</td>
<td>Tiantian Yuan</td>
<td>ISM properties of cluster members at z =2.1</td>
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**10:20am** COFFEE

**Session Chair:** Thorsten Naab

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<td>Guillermo Barro</td>
<td>High gas velocity dispersions in progenitors of massive, compact quiescent galaxies at z~2</td>
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<tr>
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<td>Glenn Kacprzak</td>
<td>Mass-Metallicity Relation of a Virgo Progenitor at z=2.1</td>
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<tr>
<td>11:30am</td>
<td>Chiaki Kobayashi</td>
<td>Massive galaxies in cosmological simulations with a new AGN model</td>
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<td>11:50am</td>
<td>Scott Croom</td>
<td>Evolution of radio-mode feedback in the most massive galaxies</td>
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**12:20pm** LUNCH

**Session Chair:** Trevor Mendel

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<td>James Allen</td>
<td>Resolving the effect of AGN on their host galaxies</td>
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<td>1:40pm</td>
<td>Bernd Husemann</td>
<td>Are QSOs really quenching star formation in massive galaxies?</td>
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<td>2:00pm</td>
<td>Edward Taylor</td>
<td>GAMA: Deconstructing Bimodality -- what do you mean, 'quenched'?</td>
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<tr>
<td>2:20pm</td>
<td>Kevin Schawinski</td>
<td>Star formation, quenching, black hole feedback and the fate of gas reservoirs</td>
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<tr>
<td>2:40pm</td>
<td>Michael Brown</td>
<td>Star formation in the most massive galaxies</td>
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3:00pm  COFFEE

Session Chair: Sarah Brough

3:30pm  Invited: Eric Bell - Future Directions

4:00pm  DISCUSSION

5:00pm  Conference close
CONFERENCE DINNER

The Conference dinner is being held in the city centre at Doltone House- Hyde Park (Level 3, 181 Elizabeth St, Sydney) from 6-10pm. The venue is a 5 minute walk from Town Hall train station which is on the same train line as Milson’s Point station.
ABSTRACTS

MONDAY 9TH FEBRUARY

Mariska Kriek - Massive Galaxies out to z~2: Knowns and Unknowns

Danilo Marchesini - The Progenitors of Today's Ultra-massive Galaxies Across Cosmic Time

Using the UltraVISTA catalogues, we investigate the evolution in the 11.4 Gyr since z=3 of the progenitors of local ultra-massive galaxies (Mstar=6x10^11 Msun; UMGs), providing a complete and consistent picture of how the most massive galaxies at z=0 have assembled. By selecting the progenitors with a semi-empirical approach using abundance matching, we infer a growth in stellar mass of a factor of ~3.5 since z=3. At z<1, the progenitors constitute a homogeneous population of only quiescent galaxies with old stellar populations. At z>1, the contribution from star-forming galaxies progressively increases, with the progenitors at 2<z<3 being dominated by massive (Mstar~2x10^11 Msun), dusty (Av~1-2.2 mag), star-forming (SFR~100-400 Msun/yr) galaxies, but also including quiescent (i.e., post-starburst) galaxies. Most of the quenching of the star-forming progenitors happened between z=2.75 and z=1.25, in good agreement with fossil records of z=0 UMGs. The progenitors of local UMGs, including the star-forming ones, never lived on the blue cloud since z=3. We propose an alternative path for the formation of local UMGs that refines previously proposed pictures and that is fully consistent with our findings. Preliminary results on the structural evolution and the environment of the progenitors of local UMGs will be also presented.

Chris Lidman - Observational constraints on the growth on brightest cluster galaxies over the last 10 billion years

In hierarchical models of structure formation, brightest cluster galaxies are constantly accreting material from their host cluster. In these models, BCGs grow by a factor of several over the last 10 billion years, and continue to grow significantly even today. However, observations of BCGs over the past decade suggest that the growth is smaller than what the models predict, particularly at late times. In this talk, I will review results from recent observations, which suggest that BCGs do continue to accrete, but that a significant fraction of the material, particularly at late times, is distributed throughout the host cluster and is seen as intra-cluster light.

Gabriella de Lucia - Formation and evolution of the most massive galaxies in hierarchical models
Richard McDermid - Mapping Star Formation Histories of Early-Type Galaxies with the Atlas3D Survey

The Atlas3D survey comprises integral-field spectroscopy for a complete, volume-limited sample of 260 early-type galaxies observed within the local 40 Mpc volume. This K-band selected sample spans a range in mass from $10^{10}$ to $10^{12}$ solar masses, and probes two orders of magnitude in local galaxy density, giving a large range in mass and environment. Our integral-field spectroscopy covers on average more than one effective radius, providing a complete picture of most of the stellar and ionized gas content of these objects on 100pc scales. We will present new results from spectral fitting of these data to derive spatially-resolved star-formation histories for these objects, and compare these to the unique suite of multi-wavelength Atlas3D data, including neutral and molecular gas interferometric maps. We combine this information with the global properties of the sample, including accurate mass estimates, environment metrics and IMF, and try to construct a coherent picture of early-type galaxy formation.

John Stott - The KMOS Redshift One Spectroscopic Survey: The resolved Dynamics, Star-Formation and Chemical Properties of 1000 massive z~1 star forming galaxies

I will present the first results of KROSS, a major UK-led KMOS GTO survey to observe the redshifted H-alpha emission in ~1000 star-forming galaxies at z=0.8-1.5. Selecting galaxies from the star-forming "main-sequence" (stellar masses $10^{9.5}$-$10^{11.5}$ Msol and SFR 1-30 Msol/yr), KROSS will measure the resolved dynamics, chemistry and star formation in a statistical sample of galaxies in to address: (i) How does the fraction of disks evolve as a function of z and environment? (ii) are major (and minor) mergers more prevalent at high-z? (iii) How does the relation between the star-formation, stellar mass and dark halo evolve with z and environment? (iv) How does the angular momentum of galaxy disks evolve with z, stellar mass and environment; (iv) Are chemical abundance gradients of early disks stronger or weaker than local spirals? These are critical issues for developing models of galaxy formation, in particular to determine if stellar mass assembly is dominated by secular isolation or via merger-induced growth. In this talk I will show the first 500+ galaxies from the sample, which already constitutes the largest ever resolved H-alpha survey at this redshift.
Pablo Perez-Gonzalez - Diving into the details of the SFH of z>1 dead massive galaxies

We will present our latest results concerning the detailed study of the Star Formation History of massive galaxies at high-z based on the most accurate rest-frame UV/optical spectral energy distributions ever built for sources up to z~4. HST grism observations covering the J and H bands have been combined with the extensive ancillary data available in the GOODS-N region, with special mention to the ultra-deep optical spectro-photometry obtained with the Spanish GTC 10.4 meter telescope through the SHARDS project (Perez-Gonzalez et al. 2013). The combination of datasets provides, for the first time, very detailed SEDs (spectral resolution of R=50 or higher from 500 nm to 1.6 micron, a major step forward from the typical broad-band data -R~7- used for this kind of study in the past) down to very faint magnitudes for thousands of sources, offering us the opportunity to uniquely constrain the stellar population content of massive galaxies in the last 12 Gyr (from z=0 to z~4). We will especially concentrate on our quantitative characterization of the earliest phases in the formation of massive galaxies, discussing our constraints on very relevant parameters such as the age and timescale of the star formation and the very first estimation of the IMF at z>1 based on absorption indices.

Sarah Wellons - The Formation and Evolution of Massive, Compact Galaxies in Illustris

Observations at redshift z = 2 have revealed a population of massive galaxies which are considerably more compact than those of similar mass in the local Universe. How these compact galaxies formed (and subsequently evolved to z = 0) has yet to be determined, though several progenitor and descendant populations have been proposed. I will discuss how such galaxies form and evolve in Illustris, a hydrodynamical cosmological simulation which encompasses a sufficiently large volume to include rare objects, while simultaneously resolving the internal structure of galaxies. The evolutionary paths of these massive, compact galaxies are complex and varied. They generally form early, when the universe was very dense, or experience an intense central starburst. Some survive quietly to the present day, while others experience significant accretion and minor merger events which increase their sizes, and yet more are consumed by other, more massive galaxies in the intervening 10 billion years.
**Lee Spitler - Discovery of massive compact quiescent galaxies at z~4 with ZFOURGE**

Massive quiescent galaxies, with little or no star-formation, have been found in numerous quantities out to redshift $z \sim 2$, when the universe was only 3 Gyr old. The debate on how they have assembled their mass and what causes the subsequent suppression of star-formation is still ongoing, even as observational teams are looking for more distant examples of these quiescent galaxies.

In this talk I will present the discovery of quiescent galaxies at redshifts $z \sim 4$, when the universe was only 1.5 Gyr old. This discovery was made possible using products from the FourStar Galaxy Evolution Survey (ZFOURGE), which uniquely combines deep imaging ($K_s \sim 25$ AB mag) and a set of near-IR medium-bandwidth filters. The filters straddle the Balmer/4000A break up to redshifts $z = 4.2$ and enable the derivation of very accurate photometric redshifts.

The newly-discovered galaxies have high stellar masses ($\log M / M_{\odot} \sim 11$), very small sizes ($R_e \sim 0.7$ kpc) and no evidence for dust-obscured star-formation from ultra-deep Herschel/PACS 100 and 160 micron data. The high stellar masses and suppressed star-formation rates suggest extremely rapid formation at early times ($z>4$).

**Sirio Belli - Deep Keck Spectroscopy of 1 < z < 2.5 Quiescent Galaxies: New Results on the Size Growth**

One of the most puzzling aspects of the evolution of quiescent galaxies is their apparent growth in size with cosmic time. In order to investigate the nature of such size evolution, we have undertaken a new survey at the Keck observatory, taking deep rest-frame optical spectra of over 60 quiescent galaxies at $z > 1$. Velocity dispersions and stellar ages derived from our spectra, together with HST-based sizes, provide valuable insight into the evolution of quiescent galaxies. First, we find that among quiescent galaxies, the recently quenched ones are significantly larger, thus confirming the progenitor bias scenario. However, by comparing the size of the oldest galaxies at $z \sim 1.3$ with the ones directly observed at $z \sim 2$, we find that progenitor bias accounts only for half of the observed size evolution. The remaining half, therefore, must be due to physical growth of individual systems. Second, by following the evolution of galaxies at fixed velocity dispersion we detect a significant physical growth in mass and size over $0 < z < 1.5$. We measure a growth efficiency $\alpha = \Delta \log R / \Delta \log M = 1.6 \pm 0.3$, which is in excellent agreement with the expectations of numerical simulations of minor mergers. Third, by taking advantage of the MOSFIRE instrument we extend our study at $2 < z < 2.5$ and find a much steeper growth, with $\alpha > 2$. Minor mergers are not capable to cause such an efficient size growth, and some other physical process must be invoked.
Ivana Damjanov - The number density and environment of red nuggets at intermediate redshift

Compact quiescent galaxies ('red nuggets') constitute a large fraction of distant massive quiescent systems, but were thought to disappear at low redshift. However, recent studies at z~0 have shown that their number density in the nearby Universe is not well constrained. Furthermore, the link between red nuggets routinely observed at high redshift and their apparently rare local analogues (or relics?) is still missing. We discovered a population of these objects at intermediate redshift by searching the SDSS/BOSS database for photometric point sources exhibiting spectroscopic features of redshifted quiescent galaxies. The existing high-quality ground-based and HST images in the visible and near-IR wavelength range confirmed the compactness of our candidates. We augmented the SDSS/BOSS compact sample by a number of similar spectroscopically confirmed intermediate redshift systems from deep extragalactic fields surveyed by HST. All our targets populate the Fundamental Plane defined by z~0 massive passively evolving systems. I will report on the number densities of compact quiescent galaxies at 0.2<z<0.8 and explore whether the abundance of these extreme systems shows a trend with local galaxy density. The results of our study provide a set of valuable observational constraints for the models of massive galaxy assembly.

Kate Whitaker - Structure across the Star Formation Sequence at 0.5<z<2.5

A wealth of data from deep extragalactic surveys have revealed a picture where star-forming galaxies follow a relatively tight relation between star formation rate and stellar mass. This observed star formation sequence encapsulates information about feedback, gas density and gas accretion rates over cosmic time. There also exists a growing population of massive galaxies that are no longer actively forming stars, falling below the observed star formation sequence. With 3D-HST/WFC3 grism spectroscopy, CANDELS HST photometry, and deep Spitzer/MIPS 24 micron photometry, I will present a self-consistent empirical study of the rest-frame optical structures, stellar populations, and star formation rates of a complete sample of quiescent and star-forming galaxies at z=0.5-2.5. These observations help us understand the growth of massive galaxies and identify their driving mechanism, while also reconciling existing tensions with theoretical galaxy formation models.
Yuanyuan Zhang - Bright Central Galaxies (BCGs) in Dark Energy Survey Science Verification Data: Stellar Mass Growth Since z=1.2

We derive constraints on the BCG stellar to halo mass relation as a function of cluster mass/redshift and investigate the stellar mass growth of BCGs to $z = 1.2$. We use a new sample of 106 $0 < z < 1.2$ clusters that have been selected in the X-ray and confirmed with redshift follow-up from Dark Energy Survey (DES) Science Verification data. We pay particular attention to the discrepancies reported between observations and hierarchical growth scenarios combined with semi-analytical (SAM) models. This new sample allows us to probe BCG evolution over a wide range of halo mass and redshift using a single dataset. At $z < 0.9$, we find that the SAMs reproduce the observed growth of BCGs. However, at $z>0.9$, we confirm previous findings that the observed BCGs are overly-massive (bright) when compared to the models. The growth rate for BCGs in a $m_{200}=10^{13.7}$ solar mass cluster at $z=1.2$ is observed to be slower than that predicted by hierarchical growth and semi-analytic modelling.

Rosalind Skelton - The merger fraction of Luminous Red Galaxies

Luminous Red Galaxies are a key population of very massive, quiescent galaxies. In hierarchical models, mergers are a particularly important channel of growth for these galaxies, building up their mass down to the lowest redshifts, but observationally, it is still not clear when and how the mass in LRGs assembled. There has been considerable debate in the literature on how much growth has occurred since $z=1$, and whether both major and minor mergers significantly affect their mass and size evolution at late times. I will present the results of our work on the fraction of LRGs out to $z=0.7$ in close pairs, the distribution of mass and potential for growth from mergers using the rich SDSS/BOSS dataset.

Daniel Groenewald - The importance of mergers to the stellar mass build-up of Brightest Cluster Galaxies

Brightest cluster galaxies (BCGs) are the most massive galaxies in the Universe and found at the centre of galaxy clusters. The unique position of BCGs make them ideal probes to study massive galaxy formation. Models of hierarchical galaxy formation indicate that these massive galaxies grow through the repeated mergers of less massive galaxies and the merger histories of BCGs provide a critical test for current galaxy formation models. The most direct way to determine the importance of mergers in the growth of BCGs is look for mergers that will take place in the near future. This is done by searching for nearby galaxies that are likely to merge with the BCGs. I will present early results from an unprecedented sample consisting of tens of thousands of galaxy clusters (over a factor of a 100 larger than previous samples) looking back in cosmic time to a third the age of the Universe ($z\sim0.45$).
Galaxy mergers play an important role to the growth of massive galaxies. According to the classical dynamics, galaxy mergers are expected to be rare in massive clusters due to high speeds of motion. We performed a deep (r-band surface brightness limit of 28 mag/arcsec^2) imaging survey on 20 nearby rich clusters of galaxies and found that an unexpectedly large fraction of massive early-type galaxies show strong post-merger features. We attempt to understand this by realistically estimating the frequency of mergers in cluster environments and the fraction of massive galaxies that show such merger features. We ran a dark-matter cosmological volume simulation to generate halo merger trees and a hydrodynamic simulation to quantify the lifetime of merger features. Employing a state-of-the-art semi-analytic model, we finally estimate the fraction of massive galaxies that must show merger features in cluster environments. Our calculations confirm that in-situ galaxy mergers are indeed rare in clusters and suggest that many of these post-merger galaxies observed are instead relics of mergers that happened before they fell into the current cluster. It has turned out to be critical to consider realistic halo merger histories in the first place to understand the evolution of massive galaxies accurately.

As theoretical and empirical studies have consistently pointed out, galaxy mergers play a pivotal role in galaxy mass assembly histories. Its contribution is considered to be more significant in more massive galaxies. In order to quantitatively understand the origin of stellar components in galaxies, we investigated galaxy mass assembly histories as a function of galaxy and halo mass using semi-analytic approaches and halo merger trees extracted from a high resolution N-body simulation. From the use of SAM (Lee & Yi 2013), we found that the most massive galaxies (log M/M = 11.5-12.0 at z = 0), which are mostly the brightest cluster galaxies, obtain roughly 70% of their stellar components via mergers. The role of mergers monotonically declines with galaxy mass: less than 30% for log M/M = 10.5-11.0 at z = 0. We will show how the merger accretion fraction is affected by halo mass in detail. The specific accreted stellar mass rates via galaxy mergers decline very slowly during the whole redshift range, while specific star formation rates sharply decrease with time. In the case of the most massive galaxies, merger accretion becomes the most important channel for the stellar mass growth at z~2. On the other hand, in situ star formation is always the dominant channel in less massive groups.
Aaron Dutton - Lensing and dynamics of massive elliptical galaxies

Risa Wechsler - The evolution of massive galaxies and their dark matter halos

Andrew Newman - Dark Matter in Massive Ellipticals: Constraints from Lensing at the Galaxy, Group, and Cluster Scales

Gravitational lensing, especially in conjunction with other observations such as stellar kinematics, offers one of our best probes of the mass distribution inside massive galaxies. By applying a comprehensive approach that combines several observational tools in galaxy cluster cores, we have shown that it is the total density profile in BCGs that follows the NFW form -- not the dark matter density profile, which is surprisingly shallower. I will present new observations that extend this approach to a sample of group-scale halos, filling in a long-standing gap in the halo mass distribution of lenses. Coupled with earlier work using similar methods, a picture is emerging of the baryonic and dark matter density profiles in halos ranging from $10^{13}$ to $10^{15}$ Msol. These observations have recently formed the basis of detailed comparisons made by simulators from several leading groups (MPA, Zurich, Durham). I will review results from these simulations, with a focus on the various physical processes responsible for setting the inner mass distribution and the constraints arising from our unique dataset. The structure of the early progenitors of massive galaxies is likely to play a key role. Time permitting, I will describe a spectroscopic case study of such an early ($z > 2$) passive galaxy that is magnified by gravitational lensing.

Adam Muzzin - A First Look at the Interior Structure of Massive High-Redshift Galaxies using Strong Gravitational Lensing

Observations of massive galaxies in the Virgo and Coma clusters show that their light profiles have a clear dichotomy in the central 100 - 200 pc. Some galaxies have flat "cores" whereas others have "extra light". The most massive galaxies are most frequently the "core" galaxies, and it is postulated that these cores are carved out when binary black holes merge. Beyond the Virgo and Coma clusters we have little information about the central regions of massive galaxies because even with HST resolution we cannot resolve them. Here I will discuss observations of the "Rosary Lens", currently the only known example of a massive galaxies at $z \sim 2$ that has been gravitationally lensed. The lensing magnifies the galaxy by a factor of $\sim 5$, and therefore we are able for the first time to measure the structure of a massive galaxy at $z \sim 2$ with $\sim 100$ pc resolution. I will discuss results from an analysis of the HST/WFC3 imaging of this galaxy and the implications for when "cores" form in massive galaxies.
Mike Hudson - Co-evolution of galaxies and their dark matter haloes from weak lensing

Galaxy-galaxy weak lensing is a direct probe of the mean matter distribution around galaxies. The depth and sky coverage of the CFHT Legacy Survey yield statistically significant galaxy halo mass measurements over a much wider range of stellar masses and redshifts (0.2 < z < 0.8) than previous weak lensing studies. We find, for the first time from weak lensing alone, evidence for significant evolution in the stellar-to-halo mass ratio (SHMR): the peak ratio falls as a function of cosmic time, and shifts to lower stellar mass haloes. These evolutionary trends are dominated by red galaxies, and are consistent with a model in which the stellar mass above which star formation is quenched "downsizes" with cosmic time. In contrast, the SHMR of blue, star-forming galaxies is well fit by a power law that does not evolve with time. This suggests that blue galaxies form stars at a rate that is balanced with their dark matter accretion in such a way that they evolve "along" the SHMR. This can be used to constrain the mean star formation rate of the galaxy population over cosmic time.

Rachel Bezanson - Stellar Dynamics of Massive Galaxies Near and Far

Massive galaxies have evolved dramatically in the last ~10 billion years, undergoing changes in their sizes, shapes, and stellar populations. Throughout this evolution, the dynamics of individual galaxies may be their most stable property through cosmic time. In this talk I will discuss the importance of and results from dynamical measurements of massive galaxies. Direct measurements of galaxy dynamics provide invaluable tests of stellar masses, which are otherwise estimated from stellar population synthesis models. Additionally, velocity dispersion is shown to be the best predictor of a galaxy's stellar population and, in local galaxies, of its initial mass function. Furthermore, velocity dispersion may provide the most direct link between observed and simulated galaxies. Finally, I will discuss the mass fundamental plane, or the relation between stellar mass surface density, galaxy size, and velocity dispersion for all massive galaxies, regardless of morphology or stellar populations. This relation can be used to predict the dynamics of massive galaxies from photometric measurements through cosmic time, without severe progenitor biases introduced by selecting samples of massive galaxies which themselves are evolving.
**Nick McConnell - Supermassive Black Holes in the MASSIVE Galaxy Survey**

MASSIVE is a homogeneous, volume-limited, integral-field spectroscopic (IFS) survey of the most massive early-type galaxies in the nearby Universe. To date we have observed more than 50 galaxies with $K < -25.5$ (stellar mass $> 10^{11.5}$ Msun), using the 2.7m telescope and Mitchell Spectrograph at McDonald Observatory. With excellent wide-field data out to $\sim 2$ effective radii, we are poised to characterize stellar population gradients, angular momentum trends, and stellar versus total mass profiles in these extreme objects.

A key science goal of MASSIVE is to better understand the growth of supermassive black holes in giant elliptical galaxies. Is galaxy and black hole growth dominated by hierarchical merging, such that the correlation between black hole mass (MBH) and stellar mass tightens for these most massive galaxies? The MASSIVE sample includes substantial numbers of brightest group and cluster galaxies, 2nd-ranked group members, and apparently isolated objects. Do these different environments give rise to significant differences in MBH? Does the local Universe contain a substantial density of $\sim 10^{10}$ Msun black holes, beyond the few objects reported in the past three years?

In parallel with our observations at McDonald, we have observed a dozen galaxies in the MASSIVE sample with high-resolution IFSs on the Keck and Gemini telescopes. These data are being used for stellar dynamical measurements of MBH, which will be combined with existing MBH measurements for 7 more MASSIVE galaxies. Ultimately we will pair these MBH measurements with detailed stellar population analysis over a range of spatial scales, and assess the independent or interconnected roles of black hole growth, star formation, and dry stellar mass assembly in giant elliptical galaxies.

**Michele Cappellari - Angular momentum of massive galaxies**

I will describe what we know about the stellar angular momentum in massive galaxies and what this tells us about their formation.

**Paola Oliva-Altamirano - The accretion histories of Brightest Cluster Galaxies: Angular Momentum and Stellar Populations**

The current definition of Brightest Cluster Galaxies (BCGs) refers to the central dominant galaxy in a cluster. These galaxies are known for being extremely massive and are predicted to have gone through more mergers than common less massive early-type galaxies. The history of BCG evolution can be traced by their current stellar kinematics and stellar populations. In this talk, I will discuss the angular momentum and stellar populations of BCGs (as we know them today) and their relationship with their intrinsic accretion histories. This discussion will lead to the open questions and future of the field.

**Thorsten Naab - The cosmological formation of massive galaxies**
Demographics of the galaxy population change rapidly from $1 < z < 2$, when the Universe transitions from peak star formation at $z > 2$ to an era where quenching shapes galaxies as we know them today. In this talk I will discuss recent progress studying the rest-frame optical properties of quiescent galaxies at this critical epoch using KMOS - a multi-IFU near-infrared spectrograph on the VLT - and in particular the KMOS-Cluster and VIRIAL surveys, whose aim is to provide a census of quiescent galaxy kinematics at $z > 1$. I will focus on results from the first year data of both surveys, which together include velocity dispersion measurements for more than 30 massive galaxies at $z > 1.4$. The combination of kinematic measurements from KMOS and structural parameters measured from deep CANDELS and 3D-HST imaging allow us to place constraints on evolution of the fundamental plane at high redshift.

Davor Krajnovic - M3G: the MUSE most massive galaxies campaign

M3G is a dedicated observing campaign of the most massive galaxies of the Universe with the MUSE IFU at the VLT. By targeting the densest and richest known galaxy clusters, we do constrain the baryonic properties of the most massive early type galaxies in extreme environments up to 2 effective radii, thus providing robust and quantitative evidence for the importance of early gas-rich mergers and the late assembly of massive galaxy systems. The datasets (and the extracted kinematics, stellar populations, IMF), obtained via this MUSE GTO programme, will be presented together with detailed photometric and dynamical models. These data and models will be discussed in the context of state-of-the-art cosmological simulations.

Lisa Fogarty - The Formation of Slow Rotating ETGs.
Slow-rotating ETGs (SRs) are some of the most massive galaxies in the Universe. These low angular momentum systems are dominated by random stellar motions, and although they form through many evolutionary paths, it is clear that both minor and major mergers play a considerable role in their recent history. Traditionally found at the centres of high-mass halos, it is thought that SRs could form preferentially as central galaxies, consuming those around them to grow in stellar mass and lose angular momentum.

I will present my work on the SAMI Pilot Survey of three galaxy clusters. The sample consists of integral field spectroscopy of 79 early-type galaxies. In each cluster I find a constant fraction of SRs, consistent with the literature. I also find evidence that some SRs in these clusters may have formed in group environments before being accreted by their host clusters.

The full SAMI Galaxy Survey provides an unprecedentedly large IFS sample with which to further explore the formation of SRs. The survey covers a wide range in stellar mass and environment with 3400 galaxies in total. I have analysed the first 1000 galaxies of the SAMI Galaxy Survey to investigate SR formation in group environments. I find that SRs are in fact present in groups and form a large fraction of group centrals. I will present my results from this study, shedding light on the formation histories of these intriguing galaxies.

**Matthew Colless - The link between structure and kinematics in SAMI massive galaxies**

The dawn of integral-field unit (IFU) surveys is gradually changing our view of the Hubble sequence. It is now evident that stellar and gas kinematics are extremely powerful, and more physically motivated, tools for discriminating between different galaxy types, providing a more unbiased view on how galaxy structure varies with internal galaxy properties and environment. In this talk, I will present initial results on the analysis of the relation between stellar structure, gas and stellar kinematics for massive galaxies (M*>10^10 Msun) included in the IFU SAMI Galaxy Survey. I will show that the contribution of ordered and disordered motions to the total dynamical support of massive galaxies is clearly related to their stellar distribution and hence their morphology. An intriguing implication of this finding is that all galaxies, regardless of their morphology, lie on a tight relation linking total mass to internal velocity, where the latter is quantified by combining dispersion and rotational velocities. Remarkably, our results are independent of the baryonic component (gas or stars) from which Vrot and sigma are estimated. Such relation appears to be more general and at least as tight as other classical dynamical scaling relations, representing a unique tool for investigating the link between galaxy kinematics and baryonic content, and a less biased comparison with theoretical models.

**Elisa Toloba - Angular momentum and kinematically decoupled cores in elliptical galaxies at all masses**
We present the largest survey of spatially resolved kinematics of dwarf elliptical galaxies (dEs) and compare them with the volume complete sample of massive ellipticals (Es), ATLAS3D. Our sample consists of 39 dEs in the Virgo cluster studied as part of the SMAKCED stellar absorption-line spectroscopy and imaging survey. This sample is representative of the early-type population in the absolute magnitude range \(-19.0 < M_r < -16.0\).

Based on the specific stellar angular momentum \(\lambda_R\) and the ellipticity, we find 11 slow rotators and 28 fast rotators. Intriguingly, slow rotators are either found within the most massive Es or within dEs, which raises interesting questions on how these slow rotators are formed. In addition, we find two kinematically decoupled cores (KDCs) in our sample. The properties of these KDCs are very similar to those found in Es by the ATLAS3D team: inverted sense of rotation, and younger (and possibly more metal-rich) stellar population than the host galaxy. We investigate the significance of the KDCs found in dEs reported in the literature and the frequency of occurrence and estimate that KDCs are found in similar numbers in dEs and in Es. In this talk, I will discuss the implications that these two findings, the slow rotators and KDCs, have in the formation and evolution of elliptical galaxies.

**Duncan Forbes - Probing the Halos of Massive Early-type Galaxies**

The halos of nearby massive early-type galaxies hold key signatures of how such galaxies grew over cosmic time. In particular, probing the stellar populations and kinematics beyond one effective radius will directly test the scenario of growth via minor merger accretion. Here I present the latest results from the SLUGGS survey which uses the Keck telescope to measure metallicity gradients, kinematics and angular momentum profiles to 3 Re for starlight and to 8 Re for globular clusters. Our kinematic profiles are used to investigate the dark matter profiles to large radii. Finally, I compare our results with the latest cosmological zoom simulations.
**WEDNESDAY 11TH FEBRUARY**

**Louise Edwards - Clocking BCG formation: Close companions vs. Intracluster Light**

We present the results of an integral field spectroscopic-study of a sample of 16 low-redshift Brightest Cluster Galaxies (BCGs). The sample was chosen so that the Sparsepak (WIYN) field of view covers the BCG as well as the close companions and ICL within at least 50kpc from the BCG centre. The sample includes galaxies in cool core and non-cool core clusters. Absorption and emission line strengths have been measured to characterize the different stellar populations of each system. We highlight the results of Abell 407, in particular. This cluster has multiple nuclei within a stellar envelope, but none of the nuclei warrant the badge of the brightest cluster galaxy, as three have similar optical colours and brightnesses. The ICL has colours and spectral features very similar to the brightest nuclei, and is limited in extent. If close companions signal early stage mergers, and ICL the result after many galaxy interactions, then our observations are consistent with Abell 407 being caught in the act of forming a dominant cD galaxy and extended ICL at the cluster core. We compute an integrated age of the stars that make up the ICL as 9.0Gyr, a metallicity of [Fe/H] of -0.714 and a merging timescale of less than a gigayear.

**Emanuele Contini - Properties of the Intra-Cluster Light as predicted by a semi-analytic model of Galaxy Formation**

We study the formation of the intracluster light (ICL) using a semi-analytic model of galaxy formation, coupled to merger trees extracted from N-body simulations of groups and clusters. We assume that the ICL forms by (1) stellar stripping of satellite galaxies and (2) relaxation processes that take place during galaxy mergers. The fraction of ICL in groups and clusters predicted by our models ranges between 10 and 40 per cent, with a large halo-to-halo scatter and no halo mass dependence. We note, however, that our predicted ICL fractions depend on the resolution: for a set of simulations with particle mass one order of magnitude larger than that adopted in the high-resolution runs used in our study, we find that the predicted ICL fractions are 30-40 per cent larger than those found in the high-resolution runs. On cluster scale, large part of the scatter is due to a range of dynamical histories, while on smaller scale it is driven by individual accretion events and stripping of very massive satellites, $M > 1e10.5$ Msun; that we find to be the major contributors to the ICL. The ICL in our models forms very late (below $z = 1$), and a fraction varying between 5 and 25 per cent of it has been accreted during the hierarchical growth of haloes. In agreement with recent observational measurements, we find the ICL to be made of stars covering a relatively large range of metallicity, with the bulk of them being subsolar.
Kim-Vy Tran - Tracking Star Formation and AGN in Distant Galaxies

Galvanized by the advent of powerful near-infrared instruments, there has been tremendous progress made in characterizing how distant galaxies assemble their stellar mass. Multiplexing instruments such as MOSFIRE on Keck and KMOS on the VLT enable us to study galaxies at z~2 using many of the same diagnostics as at z~0. By combining near-IR spectroscopy and imaging with deep legacy surveys from, e.g. Hubble, Spitzer, and Herschel, we are able to track star formation and AGN over most of cosmic time. I review recent major observational results including evolution of the specific star formation rate, galaxy sizes, gas supply, and trends with environment. I also discuss whether we can use the same empirical relations derived at z~0 to study the high redshift universe.

Amelie Saintonge - The role of gas in regulating star formation and AGN activity in massive galaxies

Norbert Werner - The origin of cold gas in giant ellipticals and its role in fuelling AGN feedback

I will present a multi-wavelength study of the physics and origin of the multi-phase material in the cores of eight nearby, X-ray and optically bright giant elliptical galaxies. In 6/8 galaxies, we detected filamentary nebulae containing multi-phase material spanning a temperature range of at least five orders of magnitude, from ~100 K to ~10^7 K, but very little star formation. Whereas previous attempts to detect the HI atomic line in these galaxies failed, our Herschel observing program established that the far-infrared [CII] line emission is particularly strong in these systems. Looking in more detail at the rich X-ray data, we show that while the hot atmospheres of the cold-gas-poor galaxies are thermally stable outside of their innermost cores, the atmospheres of the cold-gas-rich systems are prone to cooling instabilities. This strongly indicates that cold gas in giant ellipticals is produced chiefly by cooling from the hot phase. This bimodality extends to the morphology of the hot X-ray emitting atmospheres, which look relaxed in the cold-gas-poor systems and disturbed in the systems with detected [CII] line emission. The cold-gas-free systems in our sample have higher jet powers than the [CII]-bright galaxies indicating that the fuel powering the AGN may originate in the hot X-ray emitting atmospheres of the galaxies.
These are very exciting times for the study of massive galaxies. Brand new observations from IFU surveys like SAMI are bringing unprecedented insight and statistical power into the study of the structure of galaxies, and are allowing a direct test of the theory of galaxy assembly as manifested in the connection between dynamical state and star formation.

Models and simulations have grown in complexity and precision to predict fundamental trends between galaxy structural properties, angular momentum distribution, star formation rate and feedback.

I will present the state of affairs and recent results on the investigation of the link between dynamical properties and star formation history in massive galaxies, in the theoretical context of the hierarchical assembly of structures in the cosmological scenario.
Sune Toft - Sub-mm galaxies as progenitors of compact quiescent galaxies

Three billion years after the big bang (at redshift $z=2$), half of the most massive galaxies were already old, quiescent systems with little to no residual star formation and extremely compact with stellar mass densities at least an order of magnitude larger than in low redshift ellipticals, their descendants. Little is known about how they formed, but their evolved, dense stellar populations suggest formation within intense, compact starbursts 1-2 Gyr earlier (at $3 < z < 6$). Simulations show that gas-rich major mergers can give rise to such starbursts which produce dense remnants.

Sub-millimetre selected galaxies (SMGs) are prime examples of intense, gas-rich, starbursts. With a new, mass-complete spectroscopic sample of compact quiescent galaxies at $z=2$ and a statistically well-understood sample of SMGs, we show that $z = 3 - 6$ SMGs are consistent with being the progenitors of $z = 2$ quiescent galaxies, matching their formation redshifts and their distributions of sizes, stellar masses and internal velocities. Assuming an evolutionary connection, their space densities also match if the mean duty cycle of SMG starbursts is 42 ($+40/-29$) Myr (consistent with independent estimates), indicating that the bulk of stars in these massive galaxies were formed in a major, early surge of star-formation. These results suggest a coherent picture of the formation history of the most massive galaxies in the universe, from their initial burst of violent star-formation through their appearance as high stellar-density galaxy cores and to their ultimate fate as giant ellipticals.

Lee Spitler - The ZFOURGE survey: a remarkable diversity in the massive galaxy population at redshifts $z = 3-4$

We use products from the ZFOURGE survey to construct a mass-limited census of the redshift $z=3-4$ massive galaxy population. Our deep $Ks$-band imaging allows us to define a mass-complete sample at $\log M > 10.6$, which reaches just below $M^*$ at $z=3-4$. We also use our near-infrared medium-band imaging to finely sample galaxy SEDs and derive robust photometric redshift and stellar population measurements.

We find that the massive galaxy population at $z=3-4$ is dominated by red galaxies with quiescent (45%) and dusty (35%) SEDs. Only a small fraction (15%) resemble blue star-forming Lyman break galaxies. The dusty galaxies show star-formation rates intermediate to sub-millimetre-bright starbursts and blue Lyman break galaxies. With 5 times higher number densities compared to sub-millimetre galaxies, the dusty population may represent a more typical mode of massive galaxy star formation at $z=3-4$. 

THURSDAY 12TH FEBRUARY

Lee Spitler - The ZFOURGE survey: a remarkable diversity in the massive galaxy population at redshifts $z = 3-4$
Fuyan Bian - Luminous Lyman Break Galaxies at $z \sim 3$ in Deep and Wide Field Surveys

We present a survey of most luminous Lyman Break galaxies (LBGs) at $z \sim 3$ in the NOAO Bootes fields and SDSS deep stripe field. This new survey covers an area two orders of magnitude larger than any of previous deep field surveys, which allow us to reveal a population of the most luminous LBGs at $z \sim 3$. With $L > 5L^*$ and star formation rate (SFR) $\sim 500$ M/yr, these spectroscopically-confirmed LBGs are some of the rarest and most intensive star forming systems in the early Universe. The follow-up deep spectroscopic observations, Spitzer and HST observations have revealed the physical properties, place these newly discovered galaxies in the context of galaxy growth through merger and cold flow accretion at the peak era of cosmic star formation, and provide a unique laboratory for massive galaxy formation theory.

Tiantian Yuan - ISM properties of cluster members at $z = 2.1$

As a first result from our ZFIRE survey, we have confirmed 57 cluster members at $z = 2.1$. This is by far the largest number of spectroscopically confirmed cluster members beyond redshift 2.0. It offers an invaluable laboratory to study a high-$z$ proto-cluster in exquisite detail. In this talk, I will highlight one of the most striking properties of the cluster galaxies: that unlike typical field galaxies at $z \sim 2$, the ISM conditions in the cluster members at similar redshift seem to have evolved faster such that they all lie closely to the local locus of galaxies on the BPT diagram.

Guillermo Barro - High gas velocity dispersions in progenitors of massive, compact quiescent galaxies at $z \sim 2$

The mechanisms responsible for the remarkably small sizes of the most massive quiescent galaxies at $z \sim 2$ are poorly understood. Partly because the nature of their progenitors is still unknown. Barro+13,14 used the deepest HST WFC3/F160W data to identify, for the first time, a population of massive compact star-forming galaxies (cSFGs) at $2 < z < 3$, whose small sizes, stellar structures and number densities strongly suggest that they are the immediate progenitors of such population.

These cSFGs have spheroidal morphologies and centrally-concentrated mass profiles very similar to those of quiescent galaxies. Yet, they still are strongly star-forming and heavily dust obscured, as evidenced by their H-alpha emission and far-IR (Spitzer/Herschel) colours. This strongly suggests that cSFGs are rapidly growing a dense stellar core, as those observed in quenched galaxies and, quite remarkably, this is confirmed by their gas dynamics. Barro+14b revealed that cSFGs at $z \sim 2$ have high gas velocity dispersions of $>230$km/s, consistent with the stellar kinematics of equally massive quiescent galaxies, and indicative of their large dynamical masses.
Glenn Kacprzak - Mass-Metallicity Relation of a Virgo Progenitor at z=2.1

Using the recent discovery of a Virgo cluster progenitor at z=2.1 that contains 57 spectroscopically confirmed members (Yuan et al. 2014), we present the mass-metallicity relation for the largest sample of both field and cluster galaxies at z=2 using Keck/MOSFIRE. The medium resolution MOSFIRE data allows us to compute galaxy metallicities using Halpha and [NII], while coverage of additional lines, such as [OIII] and Hbeta, provides constraints on the ionization conditions of the gas. We will discuss the evolution of the gas-phase metallicity and gas-phase conditions in the largest environmental study at z=2.

Chiaki Kobayashi - Massive galaxies in cosmological simulations with a new AGN model

In massive galaxies, quenching star formation is necessary to explain their observed stellar populations. We present a new model for the formation of black holes in cosmological simulations, motivated by the first star formation, in contrast to the merging scenario of previous works. Black holes form from high density peaks of primordial gas, and grow via both gas accretion and mergers. Massive black holes heat the surrounding material, suppressing star formation at the centres of galaxies, and driving galactic winds. The model parameters are determined from observational constraints, namely, the cosmic star formation rate history, black hole mass-galaxy mass relation, and the size-mass relation of galaxies. The black hole seed mass is \(~1000\) Msun, which is orders of magnitude smaller than that which has been used in previous cosmological simulations with active galactic nuclei, but suggests that the origin of the seed black holes is the death of Population III stars. We then obtain better agreement with the observed down-sizing phenomena, namely, the colour-magnitude relation, specific star formation rates, and the \(\alpha\) enhancement of early type galaxies. Since we reproduce the black hole mass and galaxy mass relation, smaller galaxies do not host a supermassive black hole and their star formation history is affected very little, but they can get external enrichment from nearby AGN depending on their environment. Nonetheless, the metallicity change is negligible, and the mass-metallicity relations, which are mainly generated by supernova feedback at the first star burst, are preserved.
Scott Croom - Evolution of radio-mode feedback in the most massive galaxies

Feedback from AGN seems to be a key component in suppressing star formation in massive galaxies and keeping them mostly "red and dead". We have built a new spectroscopic sample of approximately 10,000 radio galaxies up to z~1, combining data taken as part of the GAMA and WiggleZ projects. With this we are able to investigate how the environments of massive galaxies with radio emission differ from their quiescent counterparts and also measure the evolution in the luminosity function of these populations. Importantly, we are able to separate the radio galaxy population into those objects with strong emission lines - high excitation radio galaxies (HERGs), and those without - low excitation ratio galaxies (LERGS). These two populations are thought to connect to the theoretically motivated "quasar-mode" and "radio-mode" mechanisms for feedback. We will show how the evolution over cosmic time of HERGs (quasar-mode) and LERGs (radio-mode) is qualitatively different, in line with the expected theoretical picture.

James Allen - Resolving the effect of AGN on their host galaxies

It has long been thought that active galactic nuclei (AGN) play an important role in the evolution of massive galaxies. Many indirect lines of evidence suggest that AGN act to regulate star formation, resulting in the observed stellar mass distribution of high-mass galaxies and the tight relationship between black hole mass and bulge mass. However, direct evidence for AGN feedback effects have been difficult to obtain. One limiting factor has been that multi-object spectroscopic surveys, while excellent for identifying large samples of AGN, are often unable to disentangle the AGN and galaxy properties. Integral field spectroscopy (IFS) overcomes this limitation by obtaining spatially resolved data for the whole galaxy, but until recently the sample sizes available have been very small. The new wave of large-scale IFS surveys, including the Sydney-AAO Multi-object Integral field spectrograph (SAMI) Galaxy Survey, are combining the benefits of multi-object and integral field spectroscopy. The SAMI Galaxy Survey has now observed ~1000 galaxies, making it the largest survey of this type to date. For each AGN in the sample, we can measure the spatially resolved properties of the host galaxy, including the distribution of ongoing star formation and any variations in star formation history. Crucially, the galaxies are selected independently of their AGN properties, allowing us to describe AGN within the context of the general galaxy population. By comparing the properties of AGN in the SAMI Galaxy Survey to a matched sample of non-AGN, we are able to directly measure the immediate influence of an AGN on its host galaxy. I will present initial results from this analysis, and show how the completed SAMI Galaxy Survey of ~3400 galaxies will allow further progress in this field.
Bernd Husemann - Are QSOs really quenching star formation in massive galaxies?

We combine optical integral field spectroscopy with single-dish CO observation to probe the conditions for star formation in massive QSO host galaxies at z~0.1. A dedicated algorithm to deblend the bright QSO nucleus from the host galaxy allows us to measure the SFR from the extinction-corrected Halpha luminosity. Contrary to expectations we find that most of the QSO host galaxies with masses around 10^{11}\text{Msun} are lie on the main-sequence of star formation irrespective of their morphology. We find their gas depletion time scales to be higher in our QSO hosts compared to the local galaxy population at those stellar masses. This is most likely due to recently accreted gas onto massive ellipticals that are more quiescent in the local Universe. We argue that the elliptical QSOs experienced a recent minor merger based on their lower than expected gas-phase oxygen abundance. Either we capture those QSOs before they could significantly quench star formation or QSOs are not directly responsible for the presumed quenching of star formation.

Edward Taylor - GAMA: Deconstructing Bimodality -- what do you mean, 'quenched'?

In order to qualitatively reproduce the relative numbers of generically 'red' and 'blue' galaxies, numerical models of cosmological galaxy formation have had to invoke some ad hoc mechanism(s) that operate to 'quench' star formation in massive galaxies. This argument implicitly equates the terms 'red' and 'quenched'. Unfortunately, as I show, the inferred shape of the 'red' mass function depends entirely on how 'red' galaxies are selected/defined. This is unfortunate because it means that there is not even agreement about the qualitative shape of the 'red' galaxy mass function. I have attempted to redress this problem, using a mixture modelling approach, which provides new insights into the nature of galaxies with generically 'red' and 'blue' stellar populations. I will also show how 'red' galaxies (based on stellar colours) and 'quiescent' galaxies (based on the presence or absence of Halpha) are different. This has very important implications for the nature of the quenching mechanism(s). Finally, I will show how the separability of 'mass-' and 'environment-quenching' has been overstated, as has quenching in general.
Kevin Schawinski - Star formation, quenching, black hole feedback and the fate of gas reservoirs

Massive galaxies are broadly split into those forming stars on the main sequence, and those which are quiescent. The physical processes by which galaxies quench their star formation remain poorly understood. I analyze the properties of galaxies and track their evolutionary trajectories as they migrate from the blue cloud of star forming galaxies to the red sequence of quiescent galaxies via the `green valley'. I show that there must be two fundamentally star formation quenching pathways associated with early- and late-type galaxies which are intricately linked to how hydrogen gas reservoirs are destroyed or shut off. In the quenching of late-type galaxies, environment (or halo mass) is a key parameter, while for early-types, an internal mechanism such as black hole feedback is more likely. I will present recent HI observations supporting this picture.

Michael Brown - Star formation in the most massive galaxies

Although the most massive galaxies typically have negligible ongoing star formation, there is a minority of massive galaxies that buck this trend. This includes Perseus A and Centaurus A, which are often used as illustrations of AGN feedback in galaxies.
How often do massive galaxies undergo episodes of star formation? Can recent star formation contribute significantly to the growth of massive galaxies? Why does star formation occur in a minority of massive galaxies? To answer these questions, we have selected samples of massive galaxies in both galaxy clusters and from the field, and measured their star formation rates using WISE mid-infrared photometry. Perseus A is an exceptional galaxy in the z<0.1 Universe, and only 1% of brightest cluster galaxies have comparable star formation rates.

Eric Bell - Future Directions

I’ll be talking about some subset of: discovery and characterization of the most massive galaxies at early times; systematic uncertainties in the evolution of the stellar populations of massive galaxies and its impact on modelling the evolution of the massive galaxy population; can we understand or avoid biases in our understanding of the most massive galaxies?; the importance of mergers in driving the evolution of massive galaxies