Durham-Edinburgh eXtragalactic Workshop XII

6–7 January 2016

Wednesday 6th January

Session 1: Large Scale Structure and Gravity 1

Marius Cautun
Durham

Galactic alignments in EAGLE

We studied the alignment between the dark matter halo, the galaxy and the satellite distribution in the EAGLE hydrodynamic simulation. While the halo shows a strong alignment with both the central galaxy and the satellite distribution, the satellites are only very weakly aligned with the central. This latter alignment is a secondary effect resulting from the alignment of the halo with the central and the satellites, respectively. Thus, observationally, one can infer to a high degree the preferential directions of the dark matter halo for systems where the central and satellites are aligned.

Alexander Smith
Durham

A lightcone catalogue from MXXL

When measuring a statistic from a galaxy survey, such as DESI and Euclid, it is necessary to compensate for various systematic effects. In order to test the methods used, it is extremely useful to use realistic mock galaxy catalogues. In this talk I will outline our method for populating haloes from the MXXL simulation with galaxies with r-band luminosities and $g-r$ colours, based on the methods of Skibba et al. 2006 and Skibba & Sheth 2009. This method uses a halo occupation distribution (HOD) scheme to link galaxies to their parent halo. We are able to reproduce the luminosity function and clustering of galaxies at $z \sim 0.1$ reasonably well, and aim to add a redshift dependence to the HOD parameters.

Yan-Chuan Cai
Edinburgh

Redshift-space distortions around voids

Voids are underdensities in the cosmic web. The growth of structure around voids may be sensitive to dark energy and theories of non-standard gravity. I will show how the growth can be measured using redshift-space distortions around voids, and how this may be used to test models of modified gravity.

Jiaxin Han
Durham

The Milky Way halo mass from steady-state dynamics: shall we expect an accurate measurement?

The halo mass of the Milky Way is considered fundamental in the cosmological interpretation of Galactic observations. A large family of MW mass measurements rely on steady-state modelling of the tracer dynamics. We demonstrate that such measurements can be biased due to unnecessary and unjustified assumptions about the distribution function of tracers. To avoid such biases, we develop a first-principle method that involves minimal assumptions. Applying this method to a large sample of simulated haloes, we show that stars in galactic haloes are not in a steady-state, leading to a systematic uncertainty up to a factor of three in the halo mass measurement.

Andrew Robertson
Durham

Constraining dark matter self-interaction cross sections with colliding clusters
Self-Interacting Dark Matter has been proposed as a solution to discrepancies between N-body simulations and observations of the Milky Way dwarf satellite galaxies. However, baryons have an uncertain (though possibly influential) role on these scales, making it difficult to constrain non-gravitational interactions between dark matter particles. Colliding Clusters such as the Bullet Cluster are an ideal laboratory to investigate the particle physics properties of the Dark Matter. I will show results from simulations of colliding galaxy clusters, and discuss potential tests for the presence of additional forces in the dark sector.

Michael Wilson
Edinburgh

VIPERS: Clipping the wings of non-linear structure
I will discuss an application of "clipping" (see `http://arxiv.org/abs/1505.03865`) to the galaxy density field observed by the VIPERS survey. The inclusion of this local density transform greatly eases the modelling of the main observable - the anisotropic, redshift space power spectrum. The degree of anisotropy is dependent on the rate of infall of galaxies onto clusters (outflow from voids) and hence the gravitational force on cosmological scales. I will demonstrate that deviations from General Relativity may be much more tightly constrained with clipping than without and hence may potentially reveal modified gravity. As the VIPERS survey geometry and selection has the potential to bias our measurement I will take some time to discuss corrections for these effects and prove that our approach is robust when applied to a set of realistic mock catalogues.

Lunch

Session 2: Instrumentation and Stellar Populations

Chris Evans
Edinburgh

From EAGLE to MOSAIC: an update on plans for a MOS on the E-ELT
I will report on recent progress on work towards the MOSAIC concept for a multi-object spectrograph for the European Extremely Large Telescope (E-ELT). I will highlight some of the extragalactic cases for future observations with the E-ELT which drive the instrument requirements, and will introduce plans for the Phase A design of MOSAIC and science simulations that will start in spring 2016.

Tim Morris
Durham

Prototyping for the E-ELT: the CANARY tomographic AO system
When coupled to the phenomenal light-gathering capability of the E-ELT, the use of Adaptive Optics (AO) to provide diffraction-limited capabilities will make the E-ELT an enormously powerful astronomical tool. At the inception of the E-ELT instrumentation programme in 2007, many of the technologies and techniques required to run even the most basic of the E-ELT AO configurations had not been developed. This was especially true for MOS instruments which called for high levels of AO correction over wide fields of view, requiring Multiple-Object AO (MOAO) that had never been tested at any telescope. From the need to develop this system, the CANARY programme was born. CANARY is a multiple LGS and NGS tomographic AO system demonstrator that operates at the 4.2 m William Herschel Telescope. CANARY recreates (at $\sim 1/10^{th}$ scale) the AO configuration expected at the E-ELT and since 2010 has provided the first on-sky demonstrations of many of the operating modes envisaged for the E-ELT, including LTAO (required for HARMONI) and MOAO (required for MOSAIC). Here we will describe the CANARY programme, its performance in several operating modes, and how lessons learnt from CANARY can be applied to future E-ELT MOS instrumentation.

Richard Massey
Durham

First flight of the Balloon-bourne Imaging Telescope

I will report the first successful test flight of BIT: the Balloon-borne Imaging Telescope. Achieving space-quality imaging from above 99% of the Earth's atmosphere has been a long-standing project of both Edinburgh and Durham. Following this year's successful launch (and recovery), the project has been funded for a further test flight in 2016, then an "ultra-long duration" flight for wide-field science imaging in 2017/18.

Russell Smith
Durham

A non-universal IMF in elliptical galaxies?

Recent years have seen a number of claims that the assumption of a single universal stellar Initial Mass Function may not be valid, with giant elliptical galaxies receiving paticular attention. Studies based on integrated spectra show anomalous strengths for gravity-sensitive features, which are interpreted as evidence for an excess of low-mass stars (bottom-heavy IMF) relative to the Milky Way (Kroupa/Chabrier-like) IMF. Such a dwarf-star excess would lead to an increased stellar mass-to-light ratio, compared to canonical models. Dynamical studies (ATLAS3D) of nearby ellipticals support a mild mass excess, but this is poorly correlated with the spectorscopic constraints. Strong-lensing studies of ellipticals at $z = 0.25$ (SLACS) seem to show a strong mass excess, but the results for distant lenses are highly sensitive to decoupling stellar and dark-matter components. In this talk I present the current status of our searches for strong-lensing elliptical galaxies at LOW redshift, where the dark-matter degeneracies are almost negligible. Only three such low-z lenses are known to date, but improved implementations of our IFU-based search methods should soon yield substantial improvements in sample size. I will show first results from a programme of comparison and calibration between different methods of IMF estimation, based on these benchmark galaxies.

Padraig Alton
Durham

The stellar initial mass function: radial variations in early-type galaxies?

Recent work suggests that massive early-type galaxies may harbour an excess of low-mass stars, with implications both for key galactic properties (e.g. mass-to-light ratio) and theories of star formation. Informed by galaxy formation theory, it has been proposed that these dwarf-enhanced stellar populations might be confined to the cores of their host galaxies.
Infrared spectroscopy can be used to constrain the stellar population properties of galaxies. Using results from KMOS, I will discuss the possibility of internal variations of the stellar initial mass function within a sample of nearby early-type galaxies.

Lee Patrick
Edinburgh

Dynamics of the young massive cluster NGC 2100 using KMOS spectra of red supergiant stars

I will detail the importance of Young Massive Star Clusters (YMCs) in the context of estimating metallicities of Red Supergiants in external galaxies. The relationship between YMCs and Globular Clusters will be explored and KMOS spectra of Red Supergiants in NGC 2100 will be presented. I derive dynamical and chemical properties of the cluster and compare these with estimates in "twin" YMCs.

Coffee

Session 3: Compact Objects

David Nisbet
Edinburgh

The fundamental plane of black hole activity

AGN accreting material at a rate below $\sim 1\%$ of the Eddington limit launch radio jets. These jets instigate a feedback process that regulates the growth in the host galaxy. However, neither the mechanism that launches the jets nor the feedback process is fully understood. Two metrics that are important in improving our understanding are the duty cycle of AGN and the Fundamental Plane of Black Hole Activity. By assembling a large database of LINERs, both metrics are investigated. We find that (i) the fraction of galaxies hosting a LINER is a strong function of both stellar and black hole mass and (ii) there exists a Fundamental Plane that spans at least nine orders of magnitude of mass.

Alastair Bruce
Edinburgh

Ships that pass in the night...

We have been monitoring a group of rare, high amplitude AGN transients – some of which may be examples of microlensing due to stars in an intervening galaxy. Microlensing reveals the innermost structure of quasars that is otherwise impossible to resolve, but it is a challenge to disentangle the microlensing signals from the intrinsic quasar variability in the absence of multiple lensed quasar images. If microlensing is indeed the cause, what might we be able to learn from these events?

Benjamin Giblin
Edinburgh

Inferring the timescales of compact object binary mergers using short gamma-ray bursts

Ever since the serendipitous discovery of gamma-ray bursts (GRBs) by Cold War military satellites in 1967, researchers have sought to characterise the progenitors of these exotic, energetic events, the mechanisms behind their optical/x-ray afterglows, as well as their spectral and transient behaviour. It is now well established that the sources of short GRBs (on timescales of $\sim 2\,\mathrm{s}$ or less) are mergers between either binary neutron stars, or neutron star/black hole binaries. However, the timescale over which these compact object binaries radiate gravitational waves and ultimately merge, is a subject still fraught with confusion.
In this talk, I address the challenges associated with inferring the distribution of time delays which separate the formation of compact object binaries, and subsequent short GRB events. These include the sparsity of data and the possibility of sample contamination from long GRBs (caused by rapidly rotating core collapse supernova) . With such tough odds, can we ever hope to robustly infer from observation, the distribution of binary inspiral times, or are we condemned to theoretical simulations to solve this mystery?

Jaime Salcido
Durham

Music from the heavens; gravitational waves from SMBH mergers in the EAGLE simulation

We estimate the expected event rate of gravitational wave signals from super massive black hole mergers that could be resolved by a space-based interferometer, such as the Evolved Laser Interferometer Space Antenna (eLISA), utilising a full set of hydrodynamical simulations from the EAGLE suite. We investigate the event rate of GW signals from the SMBH merger rates in the simulations, and find that EAGLE predicts ~ 2 detections per year by a GW detector such as eLISA. We find that these signals should be largely dominated by the coalescence of black hole seeds merging between redshift $z \sim 0.5$ and $z \sim 2.5$. This is a remarkable result, since the physical parameters of the GW sources recovered from the eLISA data stream will provide us with a profound insight of the nature of SMBHs and the initial mass distribution of SMBH seeds.

Short break

Session 4: Feeding and Feedback 1a

David Rosario
Durham

The *Herschel* perspective on the co-evolution of galaxies and SMBHs

I will report on studies that bring together the very best modern multi-wavelength survey datasets, from the X-rays to the optical to the far-IR, aimed towards developing a coherent view of the growth of supermassive black holes (in AGN) and the growth of stellar content in galaxies (through star-formation). These studies build on the newest advances in our knowledge of galaxy evolution across most of the Universe's history. I will demonstrate that a positive relationship between star-formation and AGN activity is now clearly seen to $z > 2$. However, the nature of this relationship supports weak or stochastic co-evolution, driven more by the smooth increase in gas content in normal galaxies over time rather than a dominant role of short, intense episodes, such as star-bursts or mergers. I will finish with the implications of these results on our understanding of luminous AGN duty cycles and the evolution in the accretion rate density of black holes over time.

Flora Stanley
Durham

The SFRs of optically-selected QSOs and the importance of accounting for the FIR AGN contamination

Using the *Herschel*-ATLAS data products, we constrain the average SFRs for a sample of over 3000 optical QSOs from SDSS. We perform stacking in all the *SPIRE* bands in bins of redshift and AGN luminosity, covering the range of $0.2 < z < 2.5$ and $10^{45} < L_{AGN} < 3 \times 10^{47}\,\mathrm{erg\,s^{-1}}$ respectively. Using the average *SPIRE* fluxes in combination with average *WISE* fluxes of each band, we perform composite SED fitting following the methods of Stanley et al., 2015, decomposing the AGN and host contributions to the FIR. We find that, on average, the AGN can contribute more than 50% of the FIR luminosity, especially at high redshifts ($z > 1$). Additionally, we compare our results of average SFRs to those of X-ray selected AGN, the main sequence of star-forming galaxies, as well as predictions from empirical models that include variability.

Stuart McAlpine
Durham

AGN feedback and the connection to star-formation in the EAGLE simulations

We present the predicted connection relating galaxy star formation rates to the accretion rates of the central black hole from the EAGLE simulations. The relationship is found to be flat across all redshifts, as suggested by recent studies, which attribute the result to the variability experienced by black holes. We stress that in addition to this variability, the importance of the time scales over which each property is measured and the spacial region surrounding the black hole that is considered for finding an underlying relation.

Thursday 7^{th} January

Session 4 (cont): Feeding and Feedback 1b

Alastair Edge
Durham

Cold gas in cluster cores - fuelling AGN feedback

I will present the observational data we have on the mass and dynamics of cold gas from both emission and absorption lines. The connection between this gas, star formation and AGN activity indicates that there is deposition of gas from cooling of the ICM that is regulated by mechanical heating of the central AGN.

Bitten Gullberg
Durham

The mysterious morphology of MRC 0943–242 as revealed by ALMA and MUSE

I will present a pilot study of the $z = 2.923$ radio galaxy MRC 0943–242, where we combine information from ALMA and MUSE data cubes for the first time. Even with modest integration times, we disentangle the AGN and starburst dominated components. These data reveal a highly complex morphology as the AGN, starburst, and molecular gas components show up as widely separated sources in dust continuum, optical continuum, and CO line emission observations.

Nathan Bourne
Edinburgh

Revealing the obscured history of galaxy evolution with the SCUBA2-CLS

As observers we hope to understand the evolution of the galaxy population by measuring the star-formation rate (SFR) density of the Universe as a function of look-back time, and by studying relationships between SFR and other galaxy properties such as stellar mass. These analyses rely on measuring accurate, unbiased, total SFRs of galaxies at all redshifts, accounting for both escaping ultraviolet (UV) light and reprocessed far-infrared (FIR) emission from dust. As yet we have a very limited understanding of obscuration in typical star-forming galaxies at high redshifts. Galaxy samples at $z > 3$ become biased towards either FIR-bright or UV-bright tails of the population, as a result of the photometric selection techniques. I will present results obtained from the SCUBA-2 Cosmology Legacy Survey in collaboration with the ASTRODEEP consortium. In this study we strive to bring the two ends of the spectrum together by combining the deepest 450 μm survey with the latest techniques to break through the confusion limit. We show that the UV luminosity is a poor indicator of total SFR, and we evaluate UV and FIR selected samples as probes of the star-forming galaxy population from redshift $z \sim 0$ to $z \sim 6$. We explore the evolution of the obscured and unobscured SFR density and reveal the contributions from various sample selections up to $z \sim 5$.

Julie Wardlow
Durham

Lensing and *Herschel* unveil extreme star formation at $z > 2$

Over the past ~ 20 years the high-redshift Universe has been increasingly opened to scrutiny at far-infrared wavelengths, where cool dust emission from star-formation dominates. The dusty star-forming galaxies (DSFGs) and submillimeter galaxies (SMGs), selected at these wavelengths likely represent an important, but short-lived phase in the growth of massive galaxies. These DSFGs often have star-formation rates in excess of $\sim 1000\,\mathrm{M}_\odot\,\mathrm{yr}^{-1}$ and are confirmed out to at least $z \sim 6$, although their redshifts and high dust contents make them faint and difficult to study at other wavelengths. Using data from the *Herschel* Space Observatory we have identified a population of DSFGs that are strongly gravitationally lensed and therefore magnified and available for unprecedented multi-wavelength scrutiny. I will describe how this important gravitationally lensed population is identified, and present and interpret the data from our extensive multi-wavelength, multi-facility follow-up studies.

Coffee

Session 5: Census of Galaxies, Quasars and the IGM

Alice Mortlock
Edinburgh

Exploiting the combination of large datasets: the stellar mass and luminosity function

The galaxy stellar mass function (SMF) and the luminosity function (LF) are key tools for improving our knowledge of galaxy assembly, the processes of high-redshift star-formation and differentiating between competing theoretical models. Here we report the results of a study which combines the power of deep, wide-area, ground-based near-IR surveys with ultra-deep HST imaging, to accurately measure the evolving SMF and LF over a dynamic range of > 1000 in luminosity, using datasets ranging from sq. arcmins to sq. degrees in size. We present the SMF results from UltraVISTA, which incorporates de-confusion of deep *IRAC* SPLASH data using the TPHOT algorithm, and CANDELS. We take advantage of the large area data to robustly measure the high mass end of the SMF and explore issues in this mass regime, such as Eddington bias and possible missed systems.

Derek McLeod
Edinburgh

The $z = 9$–10 galaxy population in the *Hubble* Frontier Fields and CLASH surveys

The *Hubble* Frontier Fields programme has publicly released four of the six proposed cluster and parallel datasets. In this study we look to exploit this imaging in conjunction with the shallower CLASH data release, in order to search for $z > 9$ galaxies. This search of the eight available Frontier Fields pointings and twenty CLASH fields, along with the *Hubble* Ultra-deep Field, spans a total of ~ 130 square arcminutes. We determine the galaxy UV luminosity function at $z \sim 9$, and add another datapoint at $z \sim 10$, furthering the work done in McLeod et al. (2015). By more than doubling our previous sample of $z > 8.5$ galaxies, we are able to make an improved estimate of the luminosity density at $z = 9$. We find evidence to support a smoother decline in luminosity density beyond $z = 8$, and that no dramatic decline happens even by $z = 10$, contrary to conclusions by other recent studies.

Joao Ferreira
Edinburgh

Emission line galaxies in CANDELS: HI, [OI], [OII] equivalent width distributions from panchromatic broad-band photometry from $0 < z < 5$

In recent years, advances in NIR detectors have provided us with a treasure trove of deep multiband observations (e.g. CANDELS) that place the peak of star formation at $z = 2$ from UV to IR and trace the buildup of stellar mass up to ever increasing redshifts. In particular, the existence of a subpopulation of emission-line galaxies facilitates the study of star formation and gas properties at high-z, because the nebular component outshinines the continuum. Instead of using traditional spectra or narrowband photometry, we adapt the usual broadband colour-colour selection methods to scan for colour excesses due to nebular emission down to lower-mass galaxies. In this way we can simultaneously measure equivalent widths of Hα, O[II] and O[III] from $z = 0.3$ to $z = 5$ using a variety of filter combinations from u to IRAC 4.5 μm. So far we have found that the fraction of ELGs can reach up to 40% (EW> 150) at the peak of SF with EW distributions building up long tails reaching 1000 towards $z = 2$, with some evidence of increasing O[III]/O[II] ratios. Finally, Mass-redshift-EW distributions for all three emission lines are built and compared with complementary spectroscopic (3DHST) and narrowband (HiZELS) results.

Adam Carnall
Edinburgh

Selection of the highest-redshift quasars in optical surveys

Quasars with redshifts greater than six are valuable probes of the process of cosmic reionization through absorption line studies and, simply by their existence, provide important constraints on the assembly of structure in the early Universe. However we still lack a truly statistical sample of quasars at these redshifts due to their extremely low sky density and the continuum break bluewards of Lyman alpha which causes them to drop out of the bluer optical bands.

This talk relates to the results published in Carnall et al. (2015), in which we present a method for the selection of $5.7 < z < 6.3$ quasars directly from optical surveys (specifically the VST ATLAS Survey), using publicly available mid-infrared data from the Wide-field Infrared Survey Explorer (*WISE*) to exploit areas currently not covered by near-infrared photometry. We have so far discovered four quasars at $z > 6$. These objects are some of the brightest known at these redshifts which makes them lucrative targets for follow-up observations. I will discuss our ongoing work aiming to discover more and higher redshift quasars, and to analyse the properties of those we have so far detected through optical and near-infra-red spectroscopy.

William Cowley
Durham

Blending bias confuses the dark matter halo masses of bright submillimetre galaxies

We present predictions for the clustering of sub-mm galaxies, selected by their emission at 850 μm. We combine a new version of the GALFORM semi-analytic model of galaxy formation, implemented in a Millennium style N-body simulation using the WMAP7 cosmology, with a self-consistent model for calculating the absorption and re-emission of stellar radiation by dust. In the model, sub-mm galaxies reside in dark matter halos of mass $10^{11.5}$–$10^{12}\,h^{-1}\,\mathrm{M}_{\odot}$, independent of redshift (for $0.2 < z < 4$) or flux (for $0.25 < S_{850} < 4$ mJy), and evolve into $z = 0$ descendants with stellar mass $\sim 10^{11}\,h^{-1}\,\mathrm{M}_{\odot}$ and halo masses spanning a broad range 10^{12}–$10^{14}\,h^{-1}\,\mathrm{M}_{\odot}$. By simulating sub-mm imaging at 850 μm we show that confusion, due to the coarse angular resolution of single-dish telescopes at this wavelength can significantly bias angular clustering measurements, severely complicating the interpretation of such observations. This effect, which we term "blending bias" has a similar effect on the observed angular correlation function whether it is derived through the auto-correlation of sub-mm sources or via a cross-correlation with a more numerous galaxy population.

Lunch

Session 6: Large scale structure and gravity 2

Ami Choi
Edinburgh

Cosmology with the RCS lensing survey

The Kilo-Degree Survey (KiDS) is an ongoing 1500 square degree optical imaging survey on the European Southern Observatory's VLT Survey Telescope. The excellent image quality delivered thus far enables a wide range of studies from environmental-dependence of halo mass profiles to tests of gravity on large scales. I will discuss the survey status as well as the first round of science projects that take advantage of a ~ 100 sq. deg. overlap with the spectroscopic Galaxy and Mass Assembly (GAMA) Survey to investigate the matter distribution within galaxy- and group-sized halos.

Lee Stothert
Durham

Galaxy groups in the PAU survey

The PAU survey attempts to use narrow band imaging to recover galaxy redshifts up to an order of magnitude more accurately than wide band imaging can whilst not sacrificing object targeting speed as in spectroscopic surveys. This allows the construction of a large galaxy catalogue at the expense of relatively little observation time. The PAU survey has begun to construct a catalogue as deep as i-band < 23, that will eventually extend over hundreds of square degrees. This is large when compared to spectroscopic surveys of similar depth, e.g. VIPERS, covering only 24 square degrees. Galaxy groups give us an insight into how galaxies trace the underlying dark matter halos. I will discuss the use of such a catalogue for identification of galaxy groups, utilising Durham semi-analytic mock lightcones.

Wojciech Hellwing
Portsmouth

The peak activity in the Universe as seen from the perspective of environment and galaxy size

Peculiar velocities of galaxies reflect continued action of gravity working throughout the whole cosmic expansion history. This indicates that velocity-based probes and observational statistics are, in principle, very well posed to be sensitive to even very moderate modifications to the standard laws of GR. Whether it be a theory of modified gravity (MOG) or a model of an interacting Dark Energy, the cosmic galaxy velocity field should be still sensitive to produced deviation from standard growth of structures scenario. I am going to present a class of velocity-based observational statistics that can be used to test GR on intermediate cosmological scales. I will also discuss weak and strong points of various probes and give some prospects for the future.

Claudio Llinares
Durham

Oscillations in scalar fields - can we use them to detect modified gravity?

We can measure dark energy, but we do not know what it is or where it comes from. One possible explanation is based on modifying Einstein's theory for gravity. The literature provides several alternative models that were designed for this purpose. The next step after proposing these models consists in finding new observables that can help us in differentiating between them. Cosmological simulations are essential to carry on with this task in the non-linear regime. The standard approach when running such simulations is to assume the so called quasi-static approximation, in which the time derivatives of the extra degree of freedom are neglected. Relaxing this approximation notably increases the technical difficulties that we need to overcome in order to run simulations. However, it includes a completely different set of observables in the discussion. I will describe the techniques that we use to simulate modified gravity beyond the static approximation and show results from cosmological simulations which will could be a starting point to develop new tests for modified gravity.

David Edwards
Edinburgh

The phase space of a cosmological scalar field

When considering a Friedmann-Robertson-Walker universe containing a scalar field, the phase space of such a system would appear to be 4 dimensional. Motivated by the attractor nature of simple, slowly rolling inflationary trajectories, Remmen and Carroll recently showed that it is possible to consider the space of the scalar field and its time derivative as an effective two dimensional phase space when dealing with the "vanilla" model of a canonical, minimally coupled scalar field. In this talk I will review this previous work, paying particular attention to the question of why this previous result is important. After this, I will move on to more recent work, extending the result to the general Horndeski theory. I will finish with specific examples of common cosmological models where this can be applied.

Ruari Mackenzie
Durham

The CMB cold spot: a spectroscopic view

We present a redshift survey aimed at investigating the supervoids which are proposed to explain the CMB Cold Spot. Our 3 night survey campaign carried out with 2df/AAOmega contains redshifts of 6000 galaxies up to $z = 0.5$. The purpose of the survey is to assess how unusual these underdensities are and what affect, if any, they have on the significance of the Cold Spot. Combining this work with upcoming *HST*/COS observations as well as archival data to further probe the Cold Spot may provide new insight on the baryonic physics of the supervoids.

Coffee

Session 7: Feeding and feedback 2

Michal Michalowski
Edinburgh

Massive stars formed in atomic hydrogen reservoirs

I will discuss the process of gas inflow on galaxies and subsequent fueling of star-formation. Using recent ATCA HI observations I will show that galaxies showing anomalous metal-poor regions (gamma-ray burst host galaxies) have substantial atomic gas reservoirs, and are deficient in molecular gas. This suggests that star formation in these galaxies may be fuelled by recent inflow of metal-poor atomic gas. This is controversial, but can happen in low-metallicity gas near the onset of star formation because cooling of gas (necessary for star formation) is faster than the HI-to-H_2 conversion.

Stephanie Bartle
Durham

MISSING: have you seen the photons?

The low-redshift intergalactic medium (IGM) holds many important clues that we hope will complete our understanding of cosmology. In light of recent improvements in the estimated evolution of the cosmic ultraviolet background (UVB) and recent observations from the Cosmic Origins Spectrograph (COS) we can examine the column density distribution statistics of the low-redshift Lyman-alpha forest to determine the value of the metagalactic photoionization rate by comparison with cosmological simulations of the IGM. Recent work has controversially suggested that values for the hydrogen photoionization rate should be 2–5 times higher than what we predict from current state-of-the-art models. Is this true? If so, what does this mean for our observations and theoretical predictions? Finally we discuss the implications this higher value for photoionization rate (and hence UVB), has on feedback in galaxies.

James Trayford
Durham

Colour by numbers: modelling observables for numerically-simulated galaxies

The colour-magnitude diagram (CMD) is one of observational astronomy's most fundamental diagnostic plots. For a galaxy population the colour magnitude diagram encodes information about star formation, stellar mass and chemical enrichment, but is also subject to many degeneracies and systematic effects. Using stellar population synthesis and numerical simulations, we may study the translation between physical and observable properties and gain insight into how colour-magnitude distributions are established. We show that the EAGLE suite of hydrodynamical simulations yields galaxy colours in good agreement with observation at low redshift ($z \sim 0.1$), and demonstrate how the CMD builds up over cosmic time. We also investigate the effects of dust attenuation, exploiting the detailed 3D Inter-stellar media (ISM) of > 3000 EAGLE galaxies at $z = 0.1$ using radiative transfer calculations. We find that the dust corrections obtained this way are complex, and generally indescribable by simple screen models. This has possible observational implications, particularly for proxies of star formation.

Tim Green
Durham

A photometric census of "activity" in brightest cluster galaxies

The unique environment inhabited by Brightest Cluster Galaxies (BCGs) can lead to a self-regulated feedback cycle between the radiatively cooling intracluster medium and star formation & AGN activity in the BCG. However the prevalence of "active" BCGs, and details of the feedback involved, are still uncertain. We have performed an optical, UV and mid-IR photometric analysis of the BCGs in > 1000 clusters at $0.03 < z < 0.5$, selected from the ROSAT All Sky Survey. Using Pan-STARRS PS1 3pi, *GALEX* and *WISE* survey data we look for BCGs with photometric properties which deviate from those of the bulk population of passive BCGs - indicative of AGN and/or star formation activity within the BCG. We find that whilst the majority of BCGs are consistent with passivity, at least 15% of our BCGs show a significant colour offset in at least one colour. Where available, supplementary spectroscopy reveals the majority of these BCGs show strong optical emission lines. Finally, a connection is shown between BCG "activity" and x-ray luminosity of the host cluster, with BCGs showing a colour offset preferentially found in the more x-ray luminous clusters.

End of workshop