The Advantages of Resolution

DEX XIII with St Andrews and Lancaster

Monday 9th January 2017

11:00 - 12:30 **Theme 1: Simulations & Reionization**

Chair: Catherine Heymans

Matthieu Schaller (Durham) **EAGLE model limitations**

TBD

James Trayford (Durham) **Resolving problems: Testing property estimation techniques using mock observations of virtual galaxies at different resolutions.**

Estimating galaxy properties from what we see (aka inverse modelling) is usually the only viable way to interpret observations, but often relies on necessarily simple assumptions. These typically include idealised star formation histories, uniform metallicities, and screen models for dust. Inverse modelling is also prone to strong degeneracies: stellar age, metallicity and dust often produce similar effects on observations. A way to appreciate the deficiencies in these assumptions is to see how the estimated parameters differ for resolved and unresolved observations of the same galaxy. Predicting observations from models of galaxies (forward modelling) circumvents many of the problems, but requires a model that is suitably sophisticated, and has some resemblance to reality. The EAGLE cosmological, hydrodynamic simulations follow the formation of cosmic structure and galaxies within comoving volumes of up to 100^3c Mpc^3. The simulations generate diverse virtual galaxies at a standard mass resolution of 10^6 solar masses, and seem to reproduce many characteristics of the observed galaxy population. Adopting radiative transfer techniques, we exploit the complex star formation histories and resolved 3D geometries of these non-idealised virtual galaxies to make realistic mock observations that include the effects of dust. Using resolved and unresolved mock observations, we can test standard methods of estimating galaxy properties, and identify systematic effects that could distort our understanding of their nature.

Sergio Santos (Lancaster) **The Lyman-alpha luminosity function at z = 5.7 - 6.6 and the steep drop of the faint end: implications for reionization**

I will present new results from the widest narrow band survey search for Lyman-alpha emitters (LAEs) at z = 5.7, just after reionization. We survey a total of 7 deg^2 spread over the COSMOS, UDS and SA22 fields (Santos et al. 2016). We find over 11,000 line emitters, out of which 514 are robust Lyα candidates at z = 5.7 within a volume of 6.3 x 10 Mpc^3. Our Lyα emitters span a wide range in Lyman-alpha luminosities, from faint to bright ($L \sim 10^{42.5-44}$ erg s^{-1}) and rest-frame equivalent widths (EW$_0 \sim 25 - 1000$A) in a single, homogeneous data-set. By combining all our fields we find that the faint end slope of the z = 5.7 Lyα luminosity function is very steep, with alpha=-2.3. We compare these

results with our similar Lyman-alpha survey at z = 6.6 (Matthee et al. 2015), obtained with the same methods, and find a significant decline of the number density of faint Lyα emitters from z = 5.7 to z = 6.6, but no evolution at the bright end/no evolution in the characteristic luminosity. In addition, faint Lyα emitters at z = 6.6 show much more extended haloes than those at z = 5.7, suggesting that neutral Hydrogen plays an important role, increasing the scattering and leading to observations missing faint Lyman-alpha emission within the epoch of reionization. All together, our results suggest that we are observing patchy reionization which happens first around the brightest LAEs, allowing the number densities of those sources to remain unaffected by the increase of neutral Hydrogen fraction from z $\sim$ 5 to z $\sim$ 7.

Chris Duckworth (St Andrews)

Galaxy kinematics as a test of halo assembly bias

We are investigating the viability to interpret halo assembly bias in the context of galaxy kinematics. We are utilising galaxies with a kinematic misalignment of stellar and gas components to confirm if there is not only a dependence on geometric environment but also halo mass and clustering. According to N-body simulations, Ms/Mh is a good proxy for halo age (e.g. Lim et al. 2015) and early results suggest a correlation between this ratio and likelihood of gas and stellar misalignment.

Shegy Parsa (Edinburgh)

No strong evidence of AGN contribution to the cosmic hydrogen reionization

This work focuses on a recent study, claiming that high redshift AGNs could have played a role in hydrogen reionization at z$\sim$6. New investigations are applied and the results show very low UV emissivity from this population at z$\sim$6 and concludes that there is no evidence is supporting this scenario.

Sara Perez Sanchez (Lisbon/Lancaster)

The largest Lyman-alpha survey at z$\sim$5: the most luminous Lyman-alpha emitters after re-ionisation

I will present new results regarding the search and study of high redshift Lyman-alpha emitters just after the epoch of re-ionisation (z$\sim$5). We have selected a new sample of over 2,000 Lyman-alpha emitters in COSMOS, exploring both a narrow and a medium band, in a combined volume of $\sim 10^7$ Mpc^3. We find that our Lyman-alpha luminosity function, is in excellent agreement with previous studies at the fainter end, and that both our narrow and medium-band luminosity functions agree very well. Most interestingly, our large volume allows us to probe well into the most luminous end of the luminosity function, where we find a clear deviation from a Schechter function, best described by a power-law as it was previously found by Matthee et al. (2015) at z$\sim$6.6. We are now following-up our sample of remarkably bright Lyman-alpha emitters in order to further understand their nature and potential connection with similar luminosity sources (such as CR7) within the epoch of re-ionisation.

13:30 - 14:45 Theme 2: Dark Matter

Chair: Nuala McCullagh

Andrew Robertson (Durham)

What does the Bullet Cluster tell us about Self-Interacting Dark Matter?

...not as much as we had hoped. I will describe simulations of the Bullet Cluster, and how they can help us constrain the cross-section for dark matter - dark matter scattering. In particular, I will explain why previous work had substantially overstated the ability of

the Bullet Cluster to constrain this cross-section, in part because of inadequate resolution in simulations.

Wojtek Hellwing (Portsmouth/ Durham)

MG Millennium simulations - a new precision era in modified gravity research

I will present the details and preliminary results from on-going and planned projects regarding running a new series of very high resolution simulations in the context of modified gravity models. Previously such simulations were out of reach due to extensive numerical overhead related to modified gravity physics. Presently thanks to efforts made in DESI MG-group a new methods and much faster were implemented in N-body codes. This open a possibility to obtain simulations of MG cosmologies matching the state-of-the-art resolutions for LCDM. I will briefly discuss the possibilities the new simulations will bring.

Alejandro Benitez Llambay (Durham)

Dark 'RELHICs' in the Local Group

One distinctive prediction of the CDM cosmological model of structure formation is that the Universe must be filled with low-mass systems that collapsed at early times, which are much more than observed luminous galaxies. The discrepancy is usually reconciled by assuming that galaxies fail to form in halos below a certain halo mass, leaving a large number of systems essentially 'dark' (free of stars). The main culprit is reionization of the early Universe, which heats most of the baryons in the Universe to temperatures $\sim 10^4$ K and prevents them from condensing into stars in the shallow potential wells of low-mass halos. In this talk I will show that, at redshift z=0, there is an important population of 'dark' minihalos (halos in the mass range $10^8 < M_{200}/M_\odot < 5 \times 10^9$) that have a gaseous content which is in thermal equilibrium with the cosmic ionizing UV background, and whose thermodynamic properties are well specified, and their gas density and temperatures profiles may be predicted in detail. I compare the properties of these minihalos to those of Ultra Compact High Velocity Clouds (UCHVCs) detected in ALFALFA and conclude that most UCHVCs are not consistent with being 'dark' minihalos.

Bert Vandenbroucke (St Andrews)

The ionization structure of forming dwarf galaxies

The cosmic reionizing UV background has a significant influence on the formation of dwarf galaxies. It heats interstellar gas that has been dispersed by internal stellar feedback, and speeds up the depletion of the neutral gas reservoir from which the evolving galaxy forms stars. To model the UV background in numerical simulations of dwarf galaxies, significant approximations have to be made. Instead of properly calculating the ionization structure of the ISM for example, we are forced to adopt a more heuristic approach, whereby the ionization structure is inferred from local variables such as the density and temperature. An important drawback of this approach is that it could underestimate the effect of self-shielding: parts of the ISM could be shielded from the external UV background by surrounding neutral gas, so that gas that is assumed to be ionized in our approximate model is actually neutral. To quantify the effect of our approximation, we post-process a sample of isolated dwarf galaxy simulations with the Monte Carlo radiative transfer code CMacIonize, to calculate the actual ionization structure caused by the combined radiation of newly formed O stars, and the external UV background. We compare the actual ionization structure with the ionization structure from our approximate model to find out if radiation hydrodynamics is essential to accurately resolve dwarf galaxy formation.

David Copeland (Edinburgh)

Assessing the impact of baryonic feedback in cosmological parameter estimation

The capacity of surveys like Euclid to provide meaningful dark energy constraints is restricted by a limited understanding of the role of baryonic physics in large scale structure, namely the effects of adiabatic contraction, and supernova and AGN feedback in dark

matter haloes. This work in progress adopts a halo model that broadly parameterises the baryon impact on both the amplitude of the NFW profile, and the dependence of the profile on halo mass. A detailed Fisher analysis implies that significant degeneracies between this latter effect and cosmological parameters are limited to the spectral index. Conversely, forecasts for the dark energy parameters themselves are only moderately compromised, suggesting a tentative case for optimism. Enhanced versions of this model address the remaining possible baryon impact, for small-scales, via the introduction of flat, baryon-induced 'cores' (in lieu of cusps) in the density profile. Ultimately these modifications reinforce the conclusions drawn, but remain subject to more profound questions of model bias with respect to treatments of both baryons and cosmology. An assessment of this issue, alongside that of incorporating the additional impacts of neutrinos and modified gravity phenomenologies into this analysis, further emphasises the challenges of making robust forecasts for parameter measurements, while shining light on the most promising avenues of mitigation to pursue.

Meng Yang (St Andrews)

Dynamical disc masses of MaNGA galaxies

Measurements of dynamical disc mass provide a powerful method to decompose the structures of late-type galaxies. They provide estimates on the lower limits of the dark matter halo mass through rotation curve decompositions. In addition, the dynamical disc mass can constrain the stellar mass in galaxies, as well as the stellar mass-to-light ratio.

15:15 - 16:15 Theme 3: Galaxy Evolution

Chair: Vivienne Wild

Kate Rowlands (St Andrews)

The mechanisms for quiescent galaxy formation at z<1

One key problem in astrophysics is understanding how and why galaxies switch off their star formation, building the quiescent population observed in the local Universe. From the GAMA and VIPERS surveys we identify potentially rapidly transitioning post-starburst galaxies, and slower transitioning green-valley galaxies. At intermediate masses the quiescent population at z∼0.7 could be entirely built by either green-valley or post-starburst galaxies, or a mixture of both. The importance of the fast-quenching route may rapidly diminish at z<0.5. At high masses there is tension between the large number of candidate transition galaxies compared to the lack of growth of the quiescent population. This could be resolved if high mass post-starburst and green-valley galaxies are not transitioning from star-forming to quiescent, for example if they are temporarily coming out of the quiescent population following the accretion of gas and triggering of star formation.

Joao Calhau (Lancaster)

The growth of typical star-forming galaxies and their super massive black holes across cosmic time since z∼2

Understanding galaxy formation and evolution requires studying the interplay between the growth of galaxies and the growth of their black holes across cosmic time. Here we explore a sample of Ha-selected star-forming galaxies from the HiZELS survey and use the wealth of multi-wavelength data in the COSMOS field (X-rays, far-infrared and radio) to study the relative growth rates between typical galaxies and their central supermassive black holes, from z=2.23 to z=0. Typical star-forming galaxies at z∼1-2 have black hole accretion rates (BHARs) of 0.001-0.01 $M_{\odot}$/yr and star formation rates (SFRs) of ∼10-40 $M_{\odot}$/yr, and thus grow their stellar mass much quicker than their black hole mass (∼3.3 orders of magnitude faster). BHARs fall from z=2.23 to z=0, with the decline resembling that of star formation rate density or the typical SFR. We find that the average black

hole to galaxy growth (BHAR/SFR) is approximately constant for star-forming galaxies in the last 11 Gyrs. The relatively constant BHAR/SFR suggests that these two quantities evolve equivalently through cosmic time and with practically no delay between the two.

Rachel Cochrane (Edinburgh)

The luminosity-dependent clustering of H-alpha emitters from z∼0.8 to z∼2.23 with HiZELS

We present clustering analyses of identically-selected star-forming galaxies in 3 narrow redshift slices (at z∼0.8, z∼1.5 and z∼2.2), from HiZELS, a deep, near-infrared narrow-band survey. We quantify the clustering of the entire samples, and of H-alpha luminosity-selected subsamples, initially using simple power law fits to the two-point correlation function. We extend this work to link the evolution of star-forming galaxies and their host dark matter halos over cosmic time using sophisticated dark matter halo models. We find that the clustering strength, r_0, increases linearly with H-alpha luminosity (and, by implication, star-formation rate) at all three redshifts, as do the typical host dark matter halo masses of the HiZELS galaxies. We find a remarkably tight redshift-independent relation between the H-alpha luminosity scaled by the characteristic luminosity, and the minimum host dark matter halo mass of central galaxies. This reveals that the dark matter halo environment is a strong driver of galaxy star-formation rate and therefore of the evolution of the star-formation rate density in the Universe.

16:30 - 17:30 Theme 3: Galaxy Evolution (continued)

Chair: Vivienne Wild

Richard Bielby (Durham)

Probing galaxy groups with Absorption Line Systems

We present new MUSE observations of a galaxy group probed by a background quasar. The quasar sightline (observed with high resolution UVES spectroscopy) passes between multiple z∼0.28 galaxies, whilst showing at the same redshift low ionised metal line species, including CaII, MgI, MgII and FeII. Based on the galaxy redshifts measured from the MUSE data, we estimate the galaxies to be part of a small galaxy group with a halo mass of $\sim 6 \times 10^{12}$ Msolar. We use the MUSE data to reveal the two dimensional dynamical properties of the gas and stars in the group galaxies, and relate these to the absorber kinematics. With these data we consider four scenarios for the nature of the gas probed by the sightline absorbers: a co-rotating gas halo associated with a single galaxy within the group; outflowing material from a single group member powered by recent star-formation; and cool dense gas embedded within the intra-group medium. We find that the dynamics, alongside the galaxy impact parameters and star-formation rates, favour the latter, in which the cool gas belongs to the intra-group medium and is likely pressure confined within a warmer gas halo.

Josh Argyle (St Andrews)

Quantifying Galaxy structure through Bayesian hierarchical modeling

Photometric decompositions deal with the complexity of a galaxies structure by modelling the surface-brightness with a function derived from 2D images sometimes as the sum of individual components i.e. a bulge and a disc. This method has been very popular among astronomers for decades due to its simple interpretation of the overall structure of distant galaxies. However, this method has a number of underlying problems, which lead to poor and often catastrophic fitting outcomes. Bayesian methodologies provide a full probabilistic idea of the parameter space, which in the case of photometric decompositions, becomes poorly constrained due to an increased signal-to-noise and reduced resolution. In this talk I will present a new adaptive Markov Chain Monte Carlo algorithm to decompose

galaxy light into different structures while combining it with a proper Bayesian model selection method to extract the most likely morphology and overcome said problems. I will also present a technique that infers the overall population distribution for galaxy structures utilising the individual posterior probabilities of a sample of ∼1000 galaxies with $\log(M_*/M_\odot) > 10.0$ over the redshift range $0< z < 3$. Our model constructs a piecewise constant representation of the distribution of galaxy structural parameters which in turn grants us with a flexible description of the global structural scaling relations of the galaxy population.

Discussion ...

Tuesday 10th January 2017

09:00 - 10:15 Theme 4: Surveys, LSS & Cosmology

Chair: Nic Ross

Alexandra Amon (Edinburgh) **KiDS galaxy-galaxy lensing with low and high resolution data**

The Kilo-degree survey (KiDS) highlights the advantages of high resolution imaging, already setting tight constraints on cosmological parameters using only one third of the targeted observations. The improved resolution required by KiDS comes at a cost though and data acquisition is limited by the availability of this competitive observing time. Using 800 square degrees of lower resolution KiDS i-band data I demonstrate the potential of using less-resolved data for the study of galaxy-galaxy lensing, in a direct comparison to the same analysis using 450 square degrees of deeper, higher resolution KiDS r-band data.

Benjamin Giblin (Edinburgh) **Enhanced cosmic shear analysis with the Kilo Degree Survey**

The release of the first 450 square degrees of deep multi-band imaging from the Kilo Degree Survey, featuring accurate shape measurements for ∼15 million galaxies, is imminent. With this data, I present an extension to the conventional cosmic shear analysis. By performing "clipping" transformations on the convergence fields, I suppress the highest projected mass densities, and subsequently measure the "clipped" two-point shear correlation functions. When this statistic is combined with that of the "unclipped" analysis, and calibrated with N-body simulations, this clipping methodology can lead to significant improvements in cosmological constraints.

Mathilde Jauzac (Durham) **Hubble Frontiers Fields : A new Era for Gravitational Lensing & Cosmology**

The Hubble Frontier Fields (HFF) initiative constitutes the largest commitment ever of HST time to the exploration of the distant Universe via gravitational lensing by massive galaxy clusters. This program devotes 140 orbits of HST time to deep imaging observations of each of six cluster lenses reaching m∼29 (AB) uniformly from the optical to the near-infrared. These clusters were chosen for their strong lens properties, and are all highly disturbed objects, showing major and minor merging on-going processes, making them ideal targets to trace the Cosmic Web assembly. While combining strong and weak-lensing regimes to map the total mass with X-rays observations of the hot gas and spectroscopy of cluster galaxies to look at their direction of motion, we can thus study the dynamical scenarios in place within these massive galaxy clusters, and trace the substructures engaged. I will present a new multi-wavelength picture of the first HFF cluster,

Abell 2744. The depth of these dataset makes these clusters amazing Cosmic Telescopes, but also enables us to get an unprecedented understanding of the cluster physics. I will present a comparison of the dark matter, light and gas distributions, that will lead us to the distribution of substructures. Finally I will discuss the different clues that these observables provide on the evolution processes in massive galaxy clusters, and more globally on Lambda-CDM. If time permits, I will discuss one of the most beautiful HFF discovery, SN Refsdal, the first multiply-lensed supernovae discovered by Kelly et al. (2015) in MACSJ1149.

Marika Asgari (Edinburgh)

Systematics and weak lensing

Weak lensing measurements can be sensitive to systematics effects. Specially for a cosmic shear analysis, untreated systematic effects can produce false signals, which can bias the cosmological analysis. We test the effects of different systematics on mock data and compare that to real data.

Vasiliy Demchenko (Edinburgh)

Mapping the Matter Distribution of Cosmic Voids with Weak Lensing

I discuss the cosmological significance of voids in the large-scale structure. I explain how void profiles can be used to compare different theories of gravity and that voids are sensitive to the background cosmology. I explore the importance of voids in regards to weak gravitational lensing and compare two methods for stacking voids.

10:45 - 12:15 Theme 4: Surveys, LSS & Cosmology (continued)

Chair: Alastair Edge

Maria Manolopoulou (Edinburgh)

The XCS second data release and the clusters in the SDSS area

We present the Second Data Release of the XMM Cluster Survey (XCS) and discuss the properties of those clusters from it that fall within the footprint of the Sloan Digital Sky Survey (SDSS). Cluster candidates were confirmed optically using a "cluster zoo", with cluster redshifts and richnesses derived using the GMPhoRCC (Hood & Mann 2016) algorithm. We discuss both the X-ray and optical properties of the clusters and study how the cluster galaxy population varies with redshift and with cluster mass proxies.

Dominic Bates (St Andrews)

Clustering Redshifts & Measuring Survey Completeness

While photometric redshifts can be a useful alternative to spectroscopic redshifts, they do not perform well for dim or high redshift galaxies, and also can biased the SED or training sample choice. For calculating redshift distributions of large numbers of galaxies, an alternative is using clustering redshifts. Here, the angular crosscorrelation is measured between an "unknown sample" of galaxies, and different redshift bins of a "reference sample" containing spectroscopic redshifts (e.g. BOSS/eBOSS). The amplitude of the crosscorrelation at each redshift can be used to recover the redshift distribution of the unknown sample, free from the biases of photometric redshifts. I will briefly describe the method, and show results from our implementation, showing how we plan to use this to compute the completeness of BOSS/eBOSS as a function of magnitude and colour.

Alexander Smith (Durham)

A Lightcone Catalogue from MXXL

Upcoming galaxy surveys, such as DESI and Euclid, will take our most precise cosmological measurements. It is therefore extremely important to understand and quantify

systematics and to determine error covariances, which requires the use of many realistic mock catalogues. I will present a halo occupation distribution (HOD) mock catalogue generated from the Millennium-XXL (MXXL) simulation. The mock catalogue covers the full sky, with a r-band apparent magnitude limit of r=20.0 and median redshift z∼0.2. The luminosity function, (g-r) colour distribution, and clustering of galaxies in the mock is in good agreement with measurements from SDSS and GAMA at different redshifts. The BAO peak and realistic redshift space distortions can be seen in the galaxy clustering, making this catalogue useful for upcoming surveys.

Lee Stothert (Durham)

Mocking the PAU Survey

The PAU Survey is an ongoing narrow band imaging galaxy redshift survey. Narrow band imaging provides an accurate, homogeneous, and complete galaxy redshift sample at a fraction of the telescope exposure expense of traditional fibre based spectroscopy. This talk will discuss the performance of narrow bands in measuring galaxy spectral features using a mock catalogue, how n-body resolution limits can affect semi-analytic catalogue completeness and provide an update on survey progress.

Joey Faulkner (Edinburgh)

Learning the Universe: Using GRSPINN to predict Large Scale Structure

One of the major aims of modern cosmology is to infer cosmological parameters set(ω_i) given astronomical data D i.e. to find the posterior p(set(ω_i)| D). Via Bayes Theorem, we must be able to characterise p(D | set(ω_i)) for this to be possible. Typically this is done by using numerical simulations to predict D given cosmological parameters, then using MCMC to draw samples from the posterior. This requires a large amount of simulations to be run. We want to move onto smaller, non-linear scales which requires computationally expensive N-body simulations to get believable results. This means that MCMC is prohibitively expensive. We introduce GRSPINN (Galactic Redshift Space Powerspectrum Interpolation using Neural Networks) which can rapidly produce values for the galaxy redshift space power spectrum to high accuracy for any k, mu given a set of cosmological parameters H_0 , Ω_m ... and survey parameters M 1 , M 2 , alpha. This allows us to run an accurate MCMC in a matter of CPU minutes.

Discussion . . .

13:30 - 14:45 Theme 5: AGN, Dust & Gas

Chair: Andy Lawrence

Bitten Gullberg (Durham)

High resolution ALMA imaging of SMGs

I will present high resolution (0.03") continuum and [CII] emission line maps of four sub-mm galaxies (SMGs) selected from the ALMA-LESS and ALMA-UDS surveys. These cycle 3 observations resolve the gas and dust within the ISM of these galaxies on 0.2-1kpc scales. The data reveal a range of apparent morphologies. Though the continuum morphologies appear to be different: smooth and compact or extended and 'clumpy', comparisons with simulations reveal that all four sources are consistent with exponential disks. From the morphologies and dynamics of the gas and dust, I will show that these SMGs are most likely to contain dust disks which are smooth on scales of ∼200parsecs.

Elizabeth Cooke (Durham)

CII line search for SMGs at high redshift in the UDS

I will present the largest area search for [CII] line and dust continuum emission from submillimetre sources to date, using ALMA spectroscopy of the UDS field. Submillimetre galaxies (SMGs) are host to some of the most extreme star formation in the Universe. SMGs are predicted to be the progenitors of today's massive elliptical population and therefore provide unique constraints on galaxy evolution. In particular z > 4 SMGs may help to explain the formation of z = 2-4 compact quiescent galaxies. Current SMG samples suffer from small number statistics, large beam sizes, and discrepant selection techniques. I will present a new ALMA survey of over 1000 submillimetre sources in the UDS at half-arcsecond resolution and the latest results of our [CII] emission line search in SMGs at z = 4.4-4.5.

Fangxia An (Durham)

Extinction Correction Significantly Influences the Estimate of Lyα Escape Fraction

The Lyα escape fraction is a key measure to constraining the neutral state of the intergalactic medium and then to understanding how the universe was fully reionized. We combine deep narrow-band imaging data through the custom-made filter NB393 and the H2S1 filter centered at 2.14 um to examine the Lyα emitters and Hα emitters at the same redshift z=2.24. The combination of two populations allows us to determine the Lyα escape fraction at z=2.24. Over an area of 383 arcmin^2 in the Extended Chandra Deep Field (ECDFS), 124 Lyα emitters are detected down to NB393 = 26.4 mag at the 5sigma level and 56 Hα emitters from An14. Of them, four have both Lyα and Hα emissions (LAHAEs). We measure the individual/volumetric Lyα escape fraction by comparing the observed Lyα luminosity/luminosity density to extinction-corrected Hα luminosity/luminosity density. We revisit the extinction correction for Hα emitters using the Galactic extinction law with the color excess for nebular emission. We also adopt the Calzetti extinction law together with an identical color excess for stellar and nebular regions to explore how the uncertainties in extinction correction affect the estimate of individual and global Lyα escape fractions. In both cases, an anti-correlation between the Lyα escape fraction and dust attenuation is found among the LAHAEs, suggesting that dust absorption is responsible for the suppression of the escaping Lyα photons. However, the estimated Lyα escape fraction of individual LAHAEs varies up to $\sim$3 percentage points between the two methods of extinction correction. We find the global Lyα escape fraction at z=2.24 to be (3.7+-1.4)% in ECDFS. The variation in color excess of extinction causes a discrepancy of $\sim$ 1 percentage point in global Lyα escape fraction.

Julie Wardlow (Durham)

The ISM in high-z submillimetre galaxies as probed by PACS spectroscopy

Submillimeter galaxies (SMGs), selected at far-IR and submillimetre wavelengths likely represent an important, but short-lived phase in the growth of massive galaxies. Their redshifts (N(z) peaks at z$\sim$2) and high dust contents (SFR$\sim$1000 M$_\odot$/yr) make them faint and difficult to study at short wavelengths. I will show results from mid/far-IR spectrscopy from Herschel/PACS that probes the interstellar medium in these extreme galaxies.

Jan Scholtz (Durham)

Subtle impact of AGN feedback in high redshift galaxies

It is now widely accepted that Active Galactic Nuclei (AGN) play a vital role in a galaxy evolution. I will present results of an ongoing study of hosts of luminous X-ray selected AGN observed with ALMA and results from EAGLE simulation. We used a bayesian framework to fit log-normal distributions to our data and EAGLE AGN to find trends of star formation with X-ray luminosity and stellar mass. By comparing our data with EAGLE simulations with and without AGN feedback, we determined that AGN feedback is responsible for quenching star formation in high mass systems.

Tim Hewlett (St Andrews)

Major mergers, minor players: luminous AGN through cosmic time

To investigate any influence of galaxy mergers in triggering AGN, and on AGN luminosities through cosmic time, we present a sample of 106 luminous X-ray selected type 1 AGN over a large redshift range ($0.5 < z < 2.2$) and three orders of bolometric luminosity ($\sim 10^{44} - 10^{47}$ erg s^{-1}) from COSMOS. These are carefully host mass and redshift matched to 486 control galaxies. Morphologies are compared both quantitatively (automated measures) and qualitatively (human visual inspection). No enhancement of merger features with increasing AGN luminosity is found, in contradiction to conjecture that the most luminous AGN must be triggered by mergers. The highest redshift ($z\sim2$) AGN are slightly more likely found in galaxies exhibiting evidence of morphological disturbance compared to control galaxies, at $\sim$85% confidence level ($\sim1.2\sigma$), though this is statistically insignificant. We find no evidence in support of the major merger scheme of triggering AGN.

15:15 - 16:30 Theme 5: AGN, Dust & Gas (continued)

Chair: Andy Lawrence

David Homan (Edinburgh)

Variability in broad line emission from AGN on long timescales

Active Galactic Nuclei (AGN) are known to have variable emission over all wavelengths, with flux changes varying in both strength and duration. The origin of this variability is not fully understood, as it will require an effective model for the innermost region of the AGN, the 'central engine.' Changes in the central engine, however, can be used to investigate the structure of the rest of the AGN. Of particular interest for this presentation is the response of the Broad Line Region (BLR). On short timescales the BLR response can be used for reverberation mapping: as the ionising radiation from the central engine reaches different parts of the BLR, it increases the emission from different broad lines in turn. Through the availability of data from large surveys, such as SDSS, we are now able to investigate AGN on a timescale of decades. Recent studies indicate that on this timescale we can see structural changes in the AGN. An important class of objects where this is the case are the so-called changing look AGN. These are highly variable AGN that change between a type I and type II classification, due to the (dis)appearance of the broad Hβ (4861) component of their spectrum. In addition, it appears that at least some AGN have a strongly changing broad MgII (2798) line flux as well. This is in contrast with results from reverberation mapping studies, in which MgII has shown at most a very limited change (up to a factor $\sim$2). Combining data from different surveys (SDSS and PanSTARRS) with new observations, made mostly with the WHT, we can track the changes in AGN in greater detail. The results show that there is a broad range in the response of MgII to changes in the continuum. I will discuss these new observations, as well as what they can tell us about variable AGN.

Lizelke Klindt (Durham)

Resolving the mystery of unclassified extragalactic Fermi-LAT sources

Jet-dominated Active Galactic Nuclei (AGN), known as blazars, dominate the γ-ray extragalactic sky and are known to be the most active and violent astronomical objects. In order to correctly understand and model the dynamics of AGN it is imperative to increase the number of well classified AGN and to obtain multi- wavelength Spectral Energy Distributions (SEDs). We, therefore, carried out a multi-wavelength campaign to classify nineteen Fermi-2LAC AGN of unknown type (AGU) by establishing their optical spectra and redshift measurements, searching for variability and constructing broadband SEDs. We report on the optical spectroscopy undertaken with the Southern African Large Tele-

scope (SALT) and the SAAO 1.9-m telescope. Based on the identified spectral lines we have classified three of the sources as flat spectrum radio quasars (FSRQs) at $z > 1$ and five as BL Lacs at $z < 0.5$. In order to subcategorize the AGUs for which we have obtained the redshifts we have fitted the low-energy component (synchrotron emission) and the results correspond to the classification of the sources derived from the spectroscopic results. We also report on optical photometric observations to quantify the optical intra-day variability (IDV) nature of the sources.

David Starkey (St Andrews)

Wiggles and dots: Resolving unresolvable accretion disks in Active Galactic Nuclei The extreme distances and small sizes of AGN render their interiors unresolvable. Despite this resolution barrier, it is widely accepted that the centres of AGN host supermassive black holes surrounded by luminous accretion disks. These disks exhibit correlated variability in UV through optical light curves with a time lag that increases with wavelength. Reverberation mapping is a technique that exploits these time lags to gather information on the size and geometry of the disk. In this talk I will present a series of light curve observations of a nearby AGN (NGC 5548) and describe how statistical methods can be used to infer (interesting) accretion disk parameters. For NGC 5548, I find lags that are $\sim$ 3x larger than expected for a standard-steady-state accretion disk with the mass and accretion rate found for this object from previous studies. I will suggest a theoretically-predicted mechanism that naturally inflates the time lags by splitting the accretion disk into two misaligned structures. Self heating between these twin disks increases the photon light-travel-path and can go some way to reconciling the observed and predicted lags. Work is ongoing to Improve the tilted disk model to incorporate relativistic effects and more realistic accretion disk physics.

Discussion ...