From Black Hole to Environment:

Galaxy Evolution over Multiple Wavelengths

Barton Theatre, Crawford School of Business, Australian National University

21-24 August 2017

POSTER ABSTRACT BOOKLET

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Spectral Energy Distributions of Active Galactic Nuclei

We present 0.1 to 30 micron spectral energy distributions (SEDs) of active galactic nuclei (AGNs). Our SEDs utilise spectra from Hubble, Akari, Spitzer, FUSE, Wuppe and ground-based facilities, with multi-wavelength photometry being used to renormalise and verify the spectroscopy. AGN SEDs from the prior literature often combine spectra from different objects to span the 0.1 to 30 micron range, whereas we have produced SEDs for individual AGNs (e.g., 3C 273). Our SEDs include spectral lines and continuum features that are often absent in AGN SED templates, and yet are sufficiently strong to impact broadband photometry of AGNs.

Brian Cho
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A Study of the Environments of Post-Starburst Galaxies

Post-starburst (also known as E+A and K+A) galaxies are thought to be in the green valley transition phase between star-forming blue galaxies and quiescent red galaxies. They are identified by their unusual spectra which are characterized by strong Balmer absorption lines and weak emission lines, indicating a period of starburst followed by abrupt quenching. However, the underlying mechanism that drives the formation of E+A galaxies still remains unclear. In order to differentiate between the different formation scenarios of E+A galaxies, extensive studies on the environments of E+A galaxies have been done, but the results still remain contradictory or inconclusive. In order to study the environments of E+A galaxies, we spectroscopically identify a large sample of post-starburst galaxies from the Sloan Digital Sky Survey Data Release 7 (SDSS DR7) using a selection criteria based on Hd equivalent width. We report our findings and discuss their implications in the context of post-starburst galaxy formation.

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Investigating the connection between AGNs and their host galaxy properties through SED decomposition

Many studies propose that the evolution of the galaxy is related to the growth of the central supermassive black hole (SMBH). One way to study the AGN-galaxy coevolution is to investigate the AGN impacts on their host galaxies. In our work, we present the study of the host galaxy properties of the X-ray selected AGNs in the CDFS via the rest-frame color-magnitude diagram (CMD). We did the AGN/host galaxy decomposition based on the SED fitting results of our well-trained AGN-galaxy hybrids, correcting the dust extinction and AGN contribution for the AGN host colors. For the AGN-dominated type 1 AGNs, it is not surprising to find that their host colors are strongly effected by the AGN contribution rather than the dust extinction, while for the host-dominated type 2 AGN, the correction for the dust extinction is larger than the correction for the AGN contribution. Furthermore, comparing with normal galaxies, AGN host colors also present bimodalities in the CMD up to z~2, but with more objects appear in the green valley. The fraction of the blue-cloud AGNs is increasing from z=0.5 to z=2, while the fraction of the green-valley AGNs is decreasing with redshifts. The preliminary result of this anti-correlation shows that the green-valley objects could be in the evolutionary stage between star-forming (blue cloud) and passive (red sequence) host galaxies, and are undergoing the quenching of star formation.

Inger Jorgensen
Gemini Observatory

The Gemini/HST Galaxy Cluster Project: Ages, metallicities and abundance ratios from z=0.9 to the present

The Gemini/HST Galaxy Cluster Project aims to map the evolution of stellar populations in passive cluster galaxies from z~1 to the present. Here we present results for seven massive clusters (M_{500} ~ 3-8 $\times$ 10^{14} $M_{\odot}$) at z=0.2-0.9. We use our high S/N optical spectra to determine line strengths and velocity dispersions for passive-bulge dominated galaxies in the clusters. The data support primarily passive evolution of the galaxies as reflected in the redshift evolution of the scaling relations between velocity dispersions and line strengths. From the age determinations based on the line strengths at representative velocity dispersions (and stellar population models), we find a formation redshift z_{form}=1.96 ± 0.2. We construct high signal-to-noise composite spectra of our data, and establish the relations between velocity dispersion, ages, metallicities [M/H] and abundance ratios [α/Fe] as a function of redshift. The scatter relative to these relations is very low, 0.08-0.17 dex in all parameters. We find some cluster-to-cluster differences in metallicities and/or abundance ratios. However, variations in stellar populations with the cluster center distances can only account for a very small fraction of the intrinsic scatter in the scaling relations. Thus, within these very massive clusters the main driver of the properties of the stellar populations in passive galaxies appears to be the galaxy velocity dispersion.

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Joint Microlensing and Reverberation Mapping analysis of HE0435-1223

It is generally believed that AGN are 'central engines' that consist of a hot accretion disk surrounding a supermassive black hole, in which gravitational potential energy is converted into radiation via viscous dissipation. The bulk of an AGN's total emission is considered to arise from a compact region close to the central black hole (the accretion disk and BLR), and is then transferred into larger scale outflows that influence the regulation of galactic star formation, and drives the well observed galaxy–black-hole coevolution. However, even a basic understanding of the structure and kinematics of the compact region, and the connection between the compact regions and the large-scale outflows remain poorly understood. This region is unresolvable due to its small size, so alternative methods have been developed to explore this region. The two main methods used for this purpose are reverberation mapping and gravitational microlensing. This project will combine these two methods for the first time in a single object (HE0435-1223), giving us an opportunity to test both methods and help form a coherent picture of the inner regions of the AGN. HE0435-1223, is a quadruply lensed, luminous AGN at a redshift of z=1.7. In this poster we will present the preliminary results of our study.

Presented by Anthea King and Kathleen Labrie

Jeong Hwan Lee
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Origin of Ultra-Diffuse Galaxies in the Hubble Frontier Fields Clusters

Ultra-diffuse galaxies (UDGs) are large galaxies with very low surface brightness. To date, most UDGs are found in the local universe including the Coma cluster. However, the origin of these UDGs has been controversial: are they inflated dwarf galaxies or failed massive L* galaxies? To address the origin of the UDGs, we search for and study UDGs in distant massive galaxy clusters, using the data in the Hubble Frontier Fields. We find a large population of UDGs in Abell S1063 and Abell 2744. Most of them are located in the faint end of the red sequence in each cluster, showing that they belong to each cluster and that they are mainly composed of old stars. A few of them have colors bluer than the red sequence, indicating that they include some young stars. The radial number density profile of the UDGs show a drop in the central regions, while that of the bright galaxies does not. We approximately estimate the virial mass, M_200, of these UDGs using the fundamental manifold given in Zaritsky et al.(2008) and Zaritsky (2017). Most of the UDGs have M_200 ~ 10^10 to 10^11 Mo, while a small number of them have M_200 ~ 10^11 to 10^12 Mo. We also estimate the total number of UDGs, N(UDG) = 770+/-114 for Abell S1063 and 814+/-122 for Abell 2744. The relation between the total number of UDGs and the virial mass of their host systems is fit very well by a power law with an index, 1.05+/-0.09. In conclusion, most of the UDGs in these massive clusters have a dwarf galaxy origin, while a small number of them are failed massive galaxies.

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A WISE View of Accelerated Galaxy Evolution in Compact Group Environment

Compact groups of galaxies are more favorable environments for galaxy interactions than clusters and loose groups, because compact groups have higher galaxy number densities and smaller velocity dispersions compared to the other environments. We use the Wide-field Infrared Survey Explorer data to study the mid-infrared (MIR) properties of galaxies in compact groups and their environmental dependence. We use a sample of 670 compact groups and their 2175 member galaxies with Mr < -19.77 and 0.01 < z < 0.0741, which are a subsample of Sohn et al. (2016) who identified compact groups and their member galaxies using a friends-of-friends algorithm. We find that the MIR [3.4]-[12] colors of early-type galaxies in compact groups are, on average, bluer than those of early-type galaxies in clusters. Moreover, we find that when compact groups have both early and late-type member galaxies, the MIR colors of the late-type galaxies in those compact groups can be bluer than the MIR colors of cluster late-type galaxies. We also find that compact groups tend to have a larger early-type galaxy fraction and bluer mean MIR galaxy colors, as compact groups are in denser environments. These trends can also be seen for neighboring galaxies around compact groups. However, compact group member galaxies always have higher early-type galaxy fractions and bluer MIR colors than their neighboring galaxies. From these results, we will discuss how compact group environment plays a role in accelerating morphology transformation and star formation quenching for their members, and how compact groups extend their lifetimes to the current epoch.

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As asserted by Rifatto et al (2001), ESO202-G23 (also known as “The Carafe”) is thought to be intermediate stage of a merger event that began some 106-109 years ago. The key evidence for this conclusion is the presence of tails and plumes in the galaxy’s outer regions and the double U shape of the Galaxy’s rotation curve derived using long slit spectroscopy, indicating the presence of two nuclei. Since then ESO202-G23 has been observed as part of the ANU Siding Spring Southern Seyfert Spectroscopic Snapshot Survey (S7) project (Dopita et al. 2015) using the ANU Wide Field Spectrograph (WiFeS) instrument on the 2.3m telescope at Siding Springs observatory and with the Australian Telescope Compact Array (ATCA). The presence of two compact radio sources at 5GHz and 9GHz with steep spectral indices supports the notion that the two nuclei identified by Riffato et al (2001) are in fact the super massive blackholes of the two precursor galaxies that collided. The S7 data indicated a LINER type spectrum for the brighter of the two nuclei but was inconclusive in regards to the second dimmer nucleus. The original WiFeS observations as part of S7 covered a 0.26 square arcminute field of view with a total exposure time of 40 minutes (Thomas et al 2017). In this poster, I will present a new WiFeS mosaic of this system, covering a 2.3 square arcminute field of view to a greater depth than the previous observation. This mosaic, complemented by the ATCA radio continuum data, will give insight into the gas kinematics surrounding the two nuclei as well as the nature of the ionisation driving the emission detected from the nuclei

Payton Rodman
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Radio Galaxy Zoo: Is Environment the Cause of Radio Jet Asymmetry?

Radio galaxies play an integral role in the evolution of their host galaxies. The physics of magnetohydrodynamic and radiative processes relevant to the radio jet-environment interaction is complex, and as a result the relationship between jet properties and those of the local environment is not yet completely understood. Asymmetric radio sources are useful observational probes of these interactions: since the bipolar jets are expected to be intrinsically identical, any observed asymmetry should arise only due to differences in the interaction with the surrounding medium.

We investigate the role of environmental asymmetry using data from the citizen science project Radio Galaxy Zoo. From a sample of extended radio sources (>100kpc), we compare radio source properties such as morphology (by Fanaroff-Riley classification), synchrotron luminosity and projected size, to local environment density measured via galaxy clustering. We compare our results to predictions from analytical models of radio jet propagation.

Payton Rodman, Ross Turner, Stas Shabala, Radio Galaxy Zoo professional and citizen scientists

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Yun-Kyeong Sheen
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Discovery of Ram-Pressure Stripped Gas around an Elliptical Galaxy with MUSE

Ram-pressure stripping studies of early-type galaxies have primarily focused on the impact on their hot gaseous halos previously. Our MUSE IFU observations vividly reveal the presence of star-forming blobs, and long ionised gas tails, around an elliptical galaxy in Abell 2670. The galaxy shows disturbed faint features and a series of star-formgin blobs in our MOSAIC 2 deep optical images. Thanks to the revolutionary wide field-fo-view of VLT/MUSE, we could simultaneously obtain IFU spectra of the blobs and the galaxy. The stars of the galaxy show no significant rotation, and yet it contains a star-forming disk of gas that is clearly rotating. Considering the disturbed low surface brightness features, reminiscent of a post-merger galaxy, it is likely that the gas was brought into the galaxy by a recent wet merger with a gas-rich companion and the star-forming blobs may also be remnants of the merger. However, the direction of the one-sided ionised tails (pointing away from the cluster centre), combined with the tadpole-like morphology of the star-forming blobs, strongly suggests that the system is undergoing ram pressure from the intracluster medium. We will present how our preliminary analysis may support a scenario in which an elliptical galaxy has undergone a wet merger, which is then subjected to ram pressure stripping.