Astrophysics Seminar Speakers 2016-17

David Rosario (Durham University)

Star-formation and nuclear activity in galaxies: A perspective in the era of the Herschel Space Telescope

12 October 2016

Abstract: The far-infrared Herschel Space Observatory has opened our eyes to the cold dusty Universe. Far-IR wavelengths provide arguably the best tracers for star-formation in active galactic nuclei (AGN), since luminous nuclear activity is rather inefficient at keeping dust cold. 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 of gas content in normal galaxies over time rather than a dominant role of short, intense episodes, such as star-bursts or mergers. This has important implications for the connections between galaxies and the black holes that reside at their hearts.

Sebastian Hönig (University of Southampton)

Tori, disks, and winds — the AGN dust emission at high angular resolution

19 October 2016

Abstract: Mass accretion onto supermassive black holes occurs on scales beyond the diffraction limit of any single optical/infrared (IR) telescope. Thanks to the resolution power of the VLT Interferometer, we are now tapping into the outer accretion structure of active galactic nuclei (AGN) — commonly referred to as the “dusty torus”. Several surprising results are challenging our current paradigm: While the bulk of the mid-IR emission originates from perpendicular where models would put the torus, the IR emission as a whole appears to be made of two components. In this talk I will give a basic introduction to IR interferometry and discuss what our recent results tell us about AGN unification and the physical processes that regulate accretion and feedback.

Serguei Komissarov (University of Leeds)

The Crab Nebula

2 November 2016

The Crab Nebula, one of the most iconic astronomical objects, has played and still plays a very important role in the development of modern astrophysics. The nebula was created by one of the historic supernovae almost two thousand years ago, but it is constantly invigorated by a powerful relativistic magnetised wind from the Crab pulsar. The inner part of the Crab nebula showcases a very dynamic picture of the wind interaction with the nebula. The Crab's famous jet, torus, wisps and few bright knots result from the interaction and show evidence of relativistic motion. Dynamics of relativistic plasma, properties of relativistic shock waves, magnetic reconnection, mechanism of non-thermal particle acceleration, the Crab Nebula is a unique space laboratory to study these and other topics so important in many other phenomena of relativistic astrophysics. In my talk, I will focus on some of the recent advances in the astrophysics of the Crab Nebula, describe what we have learned from these and what still remains poorly understood.

Kim-Vy Tran (Texas A&M University, USA)

From the Fourge to the Fire -- Galaxy Evolution Over 12 Billion Years

9 November 2016

Abstract: ZFOURGE and ZFIRE are sensitive surveys that track how galaxies assemble over the past 12 billion years. ZFOURGE identifies and measures cosmological distances to approximately 70,000 objects using observations at near-infrared wavelengths from the Magellan Telescope and Hubble Space Telescope. ZFIRE selects galaxies from ZFOURGE for spectroscopic follow-up with the Keck Observatory to measure how baryons cycle between stars, galactic winds, and the Inter-Stellar Medium (ISM). Here I highlight our results that include mapping how galaxies are distributed in the distant universe, taking a census of galaxies' spectral properties over cosmic time, and determining if a galaxy's evolution depends (or not) on its neighbors.

Anne-Marie Weijmans (University of St Andrews)

Mapping Nearby Galaxies at APO: an overview and first results of the MaNGA galaxy survey

30 November 2016

Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) is a galaxy survey using integral-field spectroscopy to map the stars and gas in 10,000 nearby galaxies. With integral-field spectroscopy we observe the velocities of stars and gas in galaxies, as well as their chemical composition. These observations are used to reveal the formation history of the galaxies as well as their mass distributions (including their dark matter content). As galactic archeologists, we use integral-field spectroscopy to piece together the ways that galaxies formed, evolved and interacted.

Observations for this survey started in 2014, and last summer MaNGA had its first public data release. In this talk I will give an overview of how we designed the MaNGA survey, discussing its instrumentation, observing strategy and science goals. I will also summarise the first results of MaNGA, and give an outlook on what we are working on next.

Natascha Förster Schreiber (Max Planck Institute for Extraterrestrial Physics, Germany)

Galaxy Evolution at the Peak Epoch of Cosmic Star Formation: Witnessing In-situ the Growth and Transformations of Young Galaxies

8 February 2017

Eight to eleven billion years ago, galaxies were undergoing their most rapid mass assembly phase, forming stars at prodigious rates 10 to 20 times faster than observed today in the Milky Way and other nearby galaxies. While the statistical census of surveys measuring the global properties of faint distant galaxy populations and the fossil record from stars in present-day galaxies have enabled us to pin down when galaxies formed, spatially- and spectrally-resolved in-situ observations of individual galaxies are required to understand how. I will present key results from detailed mapping of the internal structure and motions of stars and gas in young galaxies, enabled by sensitive state-of-the-art instrumentation at large ground-based telescopes and in space. I will discuss implications for our understanding of the physical processes that drive the lifecycle of galaxies at early times, and will highlight exciting prospects in the upcoming decade from the next generation of instruments and telescopes.

Francesco Shankar (University of Southampton)

Selection bias in dynamically-measured super-massive black hole samples and its consequences

1 March 2017

It has been claimed for decades that almost all galaxies in the local Universe host at their centre a super-massive black hole the mass of which appears to be tightly correlated with the stellar mass and the random motion ("velocity dispersion", sigma) of the stars of the host galaxy.

In this talk I will first highlight that significant biases affect these black hole-galaxy correlations. I will specifically show that the majority of black hole hosts have significantly higher velocity dispersions than local unbiased galaxies of similar stellar mass. Through aimed Monte-Carlo simulations and residual analysis I will then illustrate how from such biased data sets we can still infer important clues on the intrinsic correlations between black hole mass and host galaxy properties.

The Monte Carlo simulations indicate that selection effects artificially increase the normalization of the intrinsic scaling relations by factors from 3 to 50, and also strongly favour velocity dispersion as more ``fundamental'' than galaxy stellar mass or galaxy size. I will then move on discussing the main implications of these findings, in particular the comparisons with scaling relations in active galaxies, the implications for black hole radiative efficiencies, feedback from active black holes, and gravitational waves.

Ralph Wijers (University of Amsterdam)

The latest news on radio transients

15 March 2017

Radio transients at low frequencies have been declared dead numerous times in the past few years. Searches for them have indeed not been easy, but ultimately are proving that Mother Nature is not a faithful reader of obituaries. In this talk I will present a selective update on efforts to find radio transients, and on what news we learn of Nature from studying the ones we have found.

Bob Fosbury (Emeritus, previously at European Southern Observatory, Germany)

Colours from earths

29 March 2017

Planets comparable in size to that of the Earth are beginning to be discovered within the habitable zones around stars beyond the Solar System. How are we going to study such tiny, distant objects? In this talk, I will discuss the use of planetary transits to investigate the nature of their atmospheres. We have been using a local analogue of a transiting planet, namely Lunar eclipses, to develop the methods that will be needed to enable the next generation of large ground- and space-based to attempt this task on real exo-planets. Measuring the colours transmitted by their atmospheres will be key to detecting the presence of life.

Duncan Forgan (University of St Andrews)

The Disc Instability Theory of Planet Formation

5 April 2017

Abstract: Planets are assembled from the protostellar discs that surround young stars. Precisely how this happens remains a source of debate. The most commonly accepted theory of planet formation is referred to as core accretion (CA). In this model, the interstellar dust grains in the disc grow via collisions, scaling many orders of magnitude in size to form rocky protoplanets. Protoplanets with masses above a critical value (around 10 Earth masses) can then capture a large gaseous atmosphere from the disc, becoming gas and ice giants. Bodies which fail to reach this critical value do not capture a gaseous atmosphere, but instead undergo a series of giant impacts to form the terrestrial planets.

There is a competing model for the formation of substellar bodies - referred to as disc instability or gravitational instability theory (GI). In this model, the protostellar disc becomes gravitationally unstable and fragments into bound objects on relatively short timescales. The latest ALMA observations have shown us the first glimpses of discs potentially prone to fragmentation, and in one exciting example, a disc fragmenting to form stellar mass bodies.

Is GI a viable planet formation mechanism? I will show that GI struggles to form terrestrial planets, but that we cannot ignore the possibility that the exoplanet population may be dominated by CA objects, with a non-negligible number of interlopers formed via GI. To make this argument I will present a range of work, from high resolution hydrodynamic simulations of fragmenting discs which show the physical and chemical properties of disc fragments, to state-of-the-art population synthesis models. These theoretical tools are providing observers with the means to place strong constraints on the frequency of disc fragmentation, and the number of bodies orbiting stars that are formed via GI.

David Tsang (University of Maryland)

Resonant Shattering Flares As Electromagnetic Counterparts to Gravitational Wave Mergers

26 April 2017

With the recent detections of gravitational waves, the Advanced LIGO experiment has established the era of gravitational-wave astronomy. While these detections have been of massive black hole binaries (BH-BH), electromagnetic counterparts are only expected to occur for neutron star-neutron star (NS-NS) or NS-BH mergers. I will discuss a promising electromagnetic counterpart to NS mergers, Resonant Shattering Flares (RSFs), which occur when the tidal frequency of the binary inspiral matches NS core-crust interface mode frequency, leading to strong mode-excitation, crust shattering and isotropic flares with predicted luminosities of 10^47-10^49 erg/s occurring seconds before the merger.

Resonant Shattering Flares are prompt, bright, and isotropic, allowing detection from well beyond the LIGO-horizon and may be the most likely source for detectable electromagnetic counterparts to GW mergers. Coincident timing of the delay between the RSF and the gravitational-wave chirp, will not only confirm the RSF model, but also allow precise asteroseismology of the NS interface-mode, constraining the NS equation of state and nuclear physics properties near nuclear saturation.

Kunal Mooley (University of Oxford)

The Search for Radio Afterglows of Gravitational Wave Sources

3 May 2017

The recent direct detections of gravitational waves (GWs) from extragalactic binary black hole mergers by the aLIGO has opened a new window into the Universe. The impending increase in the aLIGO sensitivity together with the addition of the Advanced VIRGO (AdV) detector indicate that the mergers of compact binary systems containing neutron stars will be detected in the coming years. Maximizing the science returns from aLIGO detections will require the identification and detailed study of their electromagnetic (EM) counterparts. While distinct signatures of compact binary mergers are expected in the X-rays, optical and infrared, their timescales of evolution are extremely short (hours~day). However, with the ability to capture dust-obscured phenomena and the interactions between fast outflows and the surrounding media, radio afterglows offer unique discovery opportunities and strong diagnostics for the merger events. At the same time, poor localization of aLIGO sources and the slow evolution (months~years) of radio afterglows present challenges to the search for the radio counterparts of GW sources. In this talk I will introduce the ongoing efforts for finding EM counterparts of GW sources, especially at radio wavelengths; give a description of the expected EM signatures; and argue that radio observations are just as powerful as the optical, if not more, for detecting the counterparts of GW sources. I will end by briefly describing also the prospects of finding the radio counterparts of GW sources, such as binary SMBH mergers, relevant for space-based interferometers and pulsar timing arrays.