Astrophysics Seminar Speakers 2021-22

Johannes Buchner (Max Planck Institute for Extraterrestrial Physics)

Revealing the hidden lives of supermassive black holes and their host galaxies

6 October 2021

Supermassive black holes with their extreme gravity are some of the most exotic and fascinating objects in our Universe. By indirectly stumping the growth of massive galaxies, they are also thought to be a crucial ingredient in the lives of galaxies. Studying supermassive black holes, their central engine, their growth over cosmic time and the co-evolution with their host galaxies is a challenging multi-wavelength endeavour. X-ray selection cleanly and efficiently identifies growing black holes. I will highlight population synthesis based on X-rays and discuss it reveals the hidden lives of the most heavily obscured supermassive black holes and the hidden lives of galaxies outshone by their bright quasars.

Charlotte Angus (Niels Bohr Institute, University of Copenhagen)

Exploring exotic transients in modern surveys

20 October 2021

The advent of wide-field time-domain optical surveys has changed the landscape of transient astronomy. Not only have they dramatically increased the rate of transient discoveries, they have allowed us to unearth new, previously unheard of, transient classes. The wide variety of different survey strategies available play a pivotal role in how we can probe the physics behind these new and exotic transients. In this talk I will demonstrate how two different surveys have done this. The Dark Energy Survey (DES), using deep multi-band imaging, has significantly broadened the definition, and understanding of Superluminous Supernovae (SLSNe), unveiling the nature of pre-peak bumps, while the high cadence, Young Supernova Experiment (YSE), designed to probe the earliest transient epochs, has uncovered a rapidly evolving tidal disruption event uniquely hosted by an intermediate mass black hole. These two complementary approaches allow distinct insights into the nature of some of the most extreme physical processes in the Universe, and help us to prepare for future surveys, such as LSST.

Shany Danieli (Princeton University)

Towards a better understanding of low-mass galaxies beyond the Local Group

3 November 2021

Low-mass galaxies provide an essential testing ground for theoretical predictions of cosmology. Their number densities, structures, and internal dynamics can be extremely insightful for studying dark matter and galaxy formation on small scales. Recent advances in telescope instrumentation and image analysis techniques have enabled systematic investigations of such low surface brightness galaxies beyond the Local Group. I will present results studying low-mass galaxies, namely dwarf galaxies and ultra-diffuse galaxies, beyond our local galactic neighborhood, uncovering their significant diverseness and new astrophysical puzzles. I will discuss several follow-up studies of individual ultra-diffuse galaxies, focusing on their dark matter content and intriguing populations of globular clusters. I will end by presenting two ongoing wide-field imaging surveys using the Dragonfly Telephoto Array and the Dark Energy Camera on the Blanco telescope. These complementary surveys, targeting different galaxy luminosities and redshifts, will play a key role in mapping the census and properties of the general population of low-mass galaxies.

Gisella Clementini (INAF OAS Bologna)

Stellar variability in the Gaia era

24 November 2021

The last couple of decades have seen a true revolution in the field of stellar variability thanks to the increasing number of ground/space-based facilities and surveys that have been collecting multi-epoch photometry over large portions of the sky. A leading role in this revolution is played by Gaia, the ESA cornerstone mission that monitors the whole sky since July 2014, obtaining astrometric parameters (positions, parallaxes and proper motions) and multi-epoch photometry in three different pass-bands (Gaia G, G_BP and G_RP) of sources down to a limiting magnitude G = 21 mag. The spacecraft also simultaneously collects spectroscopy with the Radial Velocity Spectrometer (RVS) of the sources brighter than V ~ 16 mag.

In the first half of 2022, the second instalment of Gaia third data release (DR3) will publish time series multi-band photometry and parameters for about 14 million sources of more than 20 different variability types. Epoch radial velocities from the RVS will be also released for about 2000 RR Lyrae stars and Cepheids. We discuss some of the Gaia DR3 variability results, focussing more specifically on the RR Lyrae stars and Cepheids, in light of the impact these variable stars have on the definition of the cosmic distance ladder and the study of resolved stellar populations in and beyond the Milky Way.

Stephan Rosswog (Stockholm University)

Neutron star mergers as cosmic factories of heavy elements

8 December 2021

Neutron star mergers had long been suspected to produce gravitational waves, gamma ray bursts and -by some- to produce heavy "rapid neutron capture" or "r-process" elements. While overall convincing, all these conjectures were only based on indirect arguments and none was proven by direct observations. This changed on August 17, 2017: a gravitational wave signal from a merging neutron star binary was detected, closely followed by a short burst of gamma-rays and week-long transients across the electromagnetic spectrum coming from the radioactive decay of freshly synthesised r-process elements. In this talk I will give an overview over neutron star mergers, their roles as precious laboratories for (astro-)physics and I will focus in particular on their role for the production of heavy elements.

Suzanne Aigrain (University of Oxford)

From origins to life: Towards nearby Exo-Earths by way of young Neptunes

9 February 2022

Finding planets similar to the Earth orbiting nearby stars, so that they can be characterised in detail, is the key driver for both the PLATO space mission, which will search 40% of the visible sky for years at a time to search for planetary transits, and the Terra Hunting Experiment (THE), which will monitor the radial velocities of a few dozen carefully selected targets for a full decade. Stellar activity is one of the main limiting factors for both surveys, as it induces variations in the light and RV curves roughly two orders of magnitude larger than the planetary signals of interest. My group use data-driven, but physically and statistically principled methods, particularly Gaussian Processes, to model stellar activity and planetary signals simultaneously and disentangle the two. This novel approach is already enabling us, for the first time, to measure masses for transiting planets discovered by K2 and TESS around young stars, where the ratio of stellar activity and planetary signals is similar. These are precious, in-situ probes of the key processes which shape the overall exoplanet population, such as photo-evaporation. Looking towards the future, existing observations of the Sun-as-a-star can be used to optimize our strategies for finding Earth-like planets with PLATO and THE.

Ricarda Beckmann (University of Cambridge)

Galaxy cluster cooling flows under the influence of AGN

2 March 2022

Massive galaxy clusters are filled with hot gas, the so-called intra-cluster medium. Despite short cooling times, this gas shows little sign of cooling and star formation. Instead, observations show stable temperature profiles close to hydrostatic equilibrium at large radii, and complex multi-phase gas with low star formation rates in the cluster centre. This multi-phase gas hints at a complex cooling cycle. Understanding its properties might hold the key to understanding why massive galaxy clusters avoid strong cooling flows over long periods of time. Much work over

recent years has shown that there is no simple solution to the cooling flow problem, and that a complex combination of energy injected via the cluster's central active galactic nucleus (AGN), turbulence, large-scale cosmological gas inflows and non-thermal physics such as magnetic fields and cosmic rays all work together to produce the observed multi-phase gas. In this talk, I will review the current state-of-the-art of the field, and present my own recent work on understanding how the energy injected by the cluster's central AGN, thermal conduction and cosmic rays contribute to the shifting energy balances in the cluster.

Rita Tojeiro (University of St Andrews)

The galaxy-halo connection in the cosmic web

27 April 2022

Over the last two decades, extragalactic surveys have mapped the positions of millions of galaxies over extraordinary volumes, in an effort to understand the dynamics, composition and underlying rules that govern our Universe. Galaxies and the dark matter halos in which they reside are intrinsically connected, and that relationship holds information about key processes in galaxy and structure formation: understanding it is key to unlocking the full statistical power of forthcoming redshift surveys and their cosmological analyses. In this seminar, I will consider how the galaxy-halo connection might depend on its position within the cosmic web - the familiar decomposition of large-scale structure in filaments, knots and voids. I will finish by introducing the forthcoming DESI survey, and the role DESI will play in unravelling the galaxy-halo connection within the cosmic web.

Rob Fender (University of Oxford)

Towards precision calorimetry of black hole jets: lessons from ThunderKAT

18 May 2022

Black holes are ubiquitous throughout the universe, being born at the earliest times, lurking at the centres of galaxies, roaming undetected through local space, and at the heart of the most extreme astrophysical transients: GRBs, TDEs and gravitational wave bursts. It is the interaction between two coupled phenomena in the direct environment of the black hole, accretion and outflow, which largely determine how we observe these bizarre objects. Relativistic outflows or jets are usually detected via the synchrotron signature associated with relativistic electrons, and the radio band is the best place to see this signature. In this talk I will highlight new advances in the understanding of jets, their power and their propagation through the ambient medium. This will be discussed in the context of jets from stellar mass black holes in binary systems, but has a broader context applicable to all black holes. In particular I will focus on what three years of observations with MeerKAT, as part of the ThunderKAT project, have revealed to us about the large-scale propagation and deceleration of powerful jets from the very moment of launch to their terminal deceleration in the interstellar medium approximately one year later.