PRAGUE AGN SEMINAR SERIES
February – May 2022
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Astronomical Institute of the Czech Academy of Sciences

14th February
13:00 CET

- ***Relic Nuclear Star Clusters and their hidden Super-Massive Black Holes***
- Presenter: **Dr. Karina Voggel**
- Affiliation: Université de Strasbourg, France
- Relevant paper: Voggel *et al.*, (2022; A&A-658A-152)
- ***Abstract:***

I will summarize the current state of the field of surviving nuclear star clusters and what the future holds for these objects with the advent of large surveys such as Euclid. These former Nuclear Star Clusters (NSCs) end up in the halos of massive galaxies when they are stripped of their surrounding stars by tidal forces. Many of these former nuclei contain "hidden" SMBHs, a signpost of their past in the centers of a large galaxy. I will show how can can identify surviving nuclei and use them to trace galaxy and SMBH formation.
I will in particular show NGC7727, a system that has two potential nuclear star clusters, one in the photometric center of the galaxy and one offset by only 500pc. Using high-resolution MUSE data, we detect a SMBH in each Nucleus, confirming that the offset nucleus is the relic of a galaxy that has merged with NGC7727. This is the first dynamically confirmed dual SMBH system at a separation of less than a kpc. The orbital parameters of the SMBHs show that it is in an advanced state of merging and it will constitute a ∼1:25 mass ratio SMBH merger and produce a gravitational wave event. The discovery of this offset SMBH is another confirmation that many SMBHs exist outside the centers of galaxies that have not been discovered yet but are a crucial element for our understanding of black holes as well as galaxy assembly.

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21st March
13:00 CET

- ***Do Radio Active Galactic Nuclei Reflect X-ray Binary Spectral States?***
- Presenter: **Dr. Emily Moravec**
- Affiliation: Green Bank Observatory, USA
- Relevant paper: Moravec *et al.*, (2022; arXiv-220211116)
- ***Abstract:***

Over recent years there has been mounting evidence that accreting supermassive black holes in active galactic nuclei (AGNs) and stellar mass black holes have similar observational signatures. Further, there have been investigations into whether or not AGNs have spectral states similar to those of X-ray binaries (XRBs) and what parallels can be drawn between the two using a hardness-intensity diagram (HID). To address whether AGN jets might be related to accretion states as in XRBs, I will present the results of recently published work where we explore whether populations of radio AGNs classified according to their (a) radio jet morphology, Fanaroff-Riley classes I and II, (b) excitation class, high- and low- excitation radio galaxies, and (c) radio jet linear extent, compact to giant, occupy different and distinct regions of the AGN HID.

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4th April
13:00 CEST

- ***A spectral model of accretion ejection: the JED-SAD model applied to X-ray binaries and AGN***
- Presenter: **Samuel Barnier**
- Affiliation: Université Grenoble Alpes, France
- ***Abstract:***

I will present the JED-SAD model, a spectral model stemming from self-similar magnetized accretion ejection solutions around black holes. In the JED-SAD model, the inner region is an inner Jet Emitting Disk (JED, Ferreira 1997), playing the role of the hot corona, and the outer region is a Standard Accretion Disk (SAD, Shakura & Sunyaev 1973). The JED-SAD can explain both the spectral evolution of the disk and dynamical evolution from the jet observed during X-ray binaries outbursts. I built spectral tables of the JED-SAD model and will present their application to both X-ray binaries observations and the non-linear correlation between the UV and Xray observed in AGN samples.

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11th April
13:00 CEST

- ***Measuring black hole mass and the expansion rate of the Universe with X-ray reverberation mapping***
- Presenter: **Dr. Adam Ingram**
- Affiliation: Newcastle University, UK
- Relevant paper: Ingram *et al.*, (2022; MNRAS-509-619)
- ***Abstract:***

Stellar-mass black holes accreting gas from a binary partner (X-ray binaries) and supermassive black holes accreting gas from their host galaxy (active galactic nuclei, AGN) can emit a huge X-ray flux from the vicinity of the black hole event horizon. This can be exploited to probe the strong field regime of General Relativity and measure the properties of the black hole: its mass and angular momentum. For all but two objects in the Universe, the vicinity of the accreting BH is far too small to directly image, necessitating the use of mapping techniques that exploit rapid X-ray variability. I will talk about X-ray reverberation mapping, which utilises the relativistically broadened iron emission line that results from centrally emitted X-rays reflecting from the disk. Modelling the light-crossing delay between reflected and directly observed X-rays returns a black hole mass measurement. I will summarise our efforts to measure the mass of stellar and supermassive black holes with our X-ray reverberation mapping code RELTRANS, including our first proof-of-principle constraint on Cygnus X-1. I will then describe how we can use RELTRANS for an even more ambitious goal: measuring the Hubble constant, H0. This is possible because the shape of the reflection spectrum depends on the intensity of illuminating flux, meaning that modelling with RELTRANS can effectively turn bright nearby AGN into standard candles. New, independent methods to measure H0 are currently highly desirable because modelling of the cosmic microwave background returns an H0 value in >4 sigma tension with the value derived from the traditional distance ladder. I will show that the statistical precision required to prefer one of these two discrepant values is achievable with a sample of ∼25 AGN. I will discuss the improvements to our model that are required to achieve such a measurement in reality.

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Time TBD

– ***X-raying the winds of massive stars using high mass X-ray binaries***
– Presenter: **Dr. Victoria Grinberg**
– Affiliation: European Space Agency, ESTEC, the Netherlands
– ***Abstract:***

We are made of stardust—or, at least in significant parts, of material processed in stars. Hot, massive giant stars can drive the chemical evolution of galaxies and trigger and quench star formation through their strong winds and their final demise as supernovae. Yet optical and X-ray measurements of the wind mass loss strongly disagree and can only be reconciled if the winds are highly structured, with colder, dense clumps embedded in a tenuous hot gas. In (quasi-)single stars, however, wind properties are inferred for the whole wind ensemble only; no measurements of individual clumps or clump groups are possible, limiting our understanding of wind properties. Luckily, nature provides us with perfect laboratories to study clumpy winds: high mass X-ray binaries. The radiation from close to the compact object is quasi-point like and effectively X-rays the wind, in particular the clumps crossing our line of sight.

In this talk, I will show how we can use a variety of observations of some of the brightest X-ray binaries to constrain wind properties. Low resolution, high cadence observations combined with simulations reveal the dynamics of clump movements and the large-scale wind structure. Time- and absorption-resolved high resolution X-ray spectroscopy reveals the composition of the multicomponent wind plasma, the layered temperature profile and comet-like structure of clumps. Future X-ray telescopes such as XRISM and Athena will revolutionise the field, allowing us to observe individual clumps in bright sources and, for the first time, make faint sources accessible for high resolution spectroscopy. This will provide us with a sample of HMXBs that will allow us to compare wind properties in massive stars of different stellar (sub-)types and at different radii, thereby directly testing theories of clumpy wind formation and evolution.