PhD Student: Pieter van Oers

- outreach pages for this project , by Pieter van Oers

Start Date: Jul 2009
End Date: Jun 2012
Responsible Advisor: Phil Uttley and Ian McHardy (Southampton)
Co-Advisors: Sera Markoff (Amsterdam), Jörn Wilms (FAU Erlangen-Nuremberg)

Supermassive black holes, a million to a billion times more massive than our sun, lurk in the centre of nearly every galaxy. When they feed by `accreting' gas from their environments, they form an `active galactic nucleus' or AGN, one of the most significant power sources in the universe. Although these processes are now a crucial element in theories of galaxy formation, we still understand very little about how AGN evolve over time and form jets. The key problem is that AGN are expected to evolve over time-scales of millions of years or longer, so that we only see them at a `snapshot' point in their lives, and can't see a complete picture. Also, we do not understand why only a fraction of AGN show powerful radio-emitting jets while most show only weak radio emission: does the production of jets represent a particular stage in the lives of all AGN, or are these AGN unusual, perhaps with high black hole spin? "Black Hole Grand Unification" is a new paradigm which seeks to link the different faces of AGN with similar properties seen from the accreting stellar-mass black holes in black hole X-ray binary systems (BHXRBs) in our own galaxy. These systems evolve through different accretion 'states' which show distinct properties such as spectra dominated by thermal blackbody or power-law - possibly non-thermal - emission (from accretion disc or a hot `corona' respectively), and importantly, show either powerful persistent jets, ejections of jet material or very weak jets. In the Black Hole Grand Unification paradigm the different faces of AGN are large scale analogues of the stellar-mass black holes in these different states, and if this analogy holds we can learn how the AGN evolve over cosmologically important time-scales by studying the much faster (days to months) evolution of the BHXRBs.

The aim of this project is to test and refine the powerful new Black Hole Grand Unification paradigm to shed light on how AGN evolve over cosmic time. The study of BHXRBs is a key goal of the network, and the PhD student will take part by collating templates of BHXRB behaviour as a function of accretion state. By applying theories of how these properties scale with black hole mass, the student will then predict how the corresponding AGN should look, for comparison with existing large multiwavelength surveys of AGN. In this way, the student will discover whether Grand Unification provides a complete description of AGN behaviour and evolution or whether other ingredients (environment, spin) are needed. The advisors Dr. Uttley and Prof. McHardy are experts in AGN astrophysics and multiwavelength data analysis, especially surveys, and have worked extensively on the comparison of AGN and BHXRBs. The

student will also spend time visiting Prof. Wilms at FAU to compile the BHXRB spectral templates, and towards the end of the project, the student will make a comparison with neutron star systems with Dr. Wijnands of UvA, to identify which aspects of the scaling are unique to black holes and which ones are general for all accreting objects.

An overview talk on the current state of the project as presented at the Collaboration Meeting in September 2010 in Istanbul can be found here .

Related publications

{jumi [media/publications/publications_p11.html]}