The panchromatic variability properties of Quasars

It is currently thought that most massive galaxies in the Universe host in their nuclear regions black holes that are million or even billion times more massive than our Sun. These exotic astrophysical objects are thought to grow their masses over long periods of time by swallowing gaseous matter from their immediate environments. During this process an accretion disk is formed that funnels the material onto the black hole, thereby feeding it and increasing its mass. The infall of matter onto the compact object via the accretion flow is also accompanied by the release of huge amounts of energy that can be observed at various parts of the electromagnetic spectrum with characteristic signatures that define the population of Active Galactic Nuclei (AGN).

Understanding in detail the physics of the accretion process onto supermassive black holes remains a major challenge of current astrophysical research and one of the central objectives of the TALES Doctorate Network. Recently, it has been realised that temporal information may hold the key for understanding the inner structure and physics of accretion flows. This is based on the fact that the accretion process is by nature highly dynamic, i.e. ever changing with time, which observationally translates to a “flickering” of the emitted flux at any wavelength, i.e. continuous variations with time around a mean value. By studying the variability timescales of AGN at different wavelengths we learn about the geometry of the different energy emitting components of the accretion flow (e.g. accretion disk, X-ray corona, outflows). Moreover, the simultaneous modelling of the variability amplitudes at different wavebands and timescales provides physical information on the dynamics of the accretion flow and the interplay between its different components.

This project will leverage state of the art observations and novel statistical modelling techniques to provide a comprehensive study of the flux variability properties of AGN populations at X-ray, ultraviolet and optical wavelengths as a function of the mass of the black hole and the Eddington ratio of the accretion flow. New physically-motivated models of the dynamic accretion flow (developed within the TALES Doctorate Network) will be used to interpret the observations above and learn about the geometry of the X-ray/UV/optical emitting regions and their mutual interplay. The project will use new multi-epoch X-ray data from the eROSITA All Sky Survey and archival XMM-Newton observations to produce X-ray light curves of large ($\sim10^6$) AGN populations on timescales that range from few hours to years. New Bayesian inference methods will be developed to model the above light curves and measure the ensemble (averaged over populations) variability statistical properties. A large component of the doctorate project will be the interpretation of these observations using physically motivated reverberation mapping simulations available to the TALES consortium or by constructing semi-empirical models that link the X-ray with the UV/optical variability.

The doctoral candidate will be based at Institute of Astronomy Astrophysics Space Applications and Remote Sensing (IAASARS) of the National Observatory of Athens (NOA) in Athens, Greece, and will be supervised by Dr. Antonis Georgakakis (NOA) and Prof. Iossif Papadakis (University of Crete). The doctoral candidate will enrol at the PhD programme of the Dept. of

Physics of the University of Crete that will also award the PhD degree. Foreseen secondments include the Max-Planck Institute for Extraterrestrial physics (MPE), the University of Naples Federico II and industrial partners of the TALES Doctorate Network.