Ultraluminous X-ray sources and their equally powerful jets/winds

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Despite numerous investigations at various wavelengths and much theoretical work, the nature of ultraluminous X-ray sources (ULX) has remained elusive. ULXs are compact variable sources in the disk of a few nearby galaxies showing isotropic luminosities higher than the Eddington limit of a stellar-mass black hole (BH). Possible explanations for ULXs include beamed X-ray emission (geometrically or relativistically) into our line of sight, truly super-Eddinton emission, or Intermediate-Mass Black Hole (IMBH) accretors in between the stellar and AGN variety. One key property for our understanding of this phenomenon comes from our discovery of huge shock-ionized nebulae/lobes that surround many ULXs and microquasars akin to the giant radio lobes that are being inflated by the most powerful Fanaroff-Riley FRI/II-type radio galaxies and quasars. These ULX bubbles are more than 100 times more energetic than normal supernova remnants and suggest mechanical inflation by continuous relativistic winds or jets that must carry as much power as the X-ray photons. If X-ray beaming plays a role, then many such bubbles should exist with faint X-ray sources, i.e. there should be a large number of ULXs being beamed away from us. One such object is the extremely powerful microquasar S26 in the galaxy NGC 7793 (Pakull, Soria & Motch 2010, Nature 466, 209; Soria, Pakull, Motch et al. 2010, MNRAS 409, 541), and several other outstanding candidates have recently been identified by us.

To begin with, the PhD student will analyse recent data of S26 and of other newly identified ULX bubbles as well as planned observations with the FORS imaging spectrograph on the ESO VLT and with the XMM/Newton and Chandra X-ray observatories. The optical data include images in several narrow band filters (H_alpha, [OIII], [OI]) and medium resolution long-slit spectra of the objects. The intensity and velocity structure of various emission lines will be used to measure electron temperature, density and ionisation structure of the nebula. The data will allow to study the relevant heating and ionisation processes and to measure the energetics of these outstanding bubbles. Based on the acquired knowledge of relevant astrophysical processes at work (e.g. photoionization and interstellar shock physics and the acceleration of relativistic particles) and by acquainting her/himself with the intricacies of X-ray/optical observational astronomy, the student will be in the position to actively participate in our ambitious project to identify and study ULX bubbles with the goal to understand how accretion onto BHs can result in very high photon luminosities as well as generating huge mechanical (jet) power.

The student will learn to work with scientific data acquired with space-borne (XMM-Newton and CHANDRA) and ground-based (ESO-VLT) telescopes using reduction/analysis software that is available at the Observatory. (S)he will participate in a world-wide collaboration including collegues working at European and overseas astronomical research institutes. A taste for model building and programming would be an advantage. Interest in the physics of black-hole and their energy feedback to the interstellar medium is required. The work on a related project supervised by MWP and CM earned the distiction of the best Master-2 thesis at the faculty of physics at Strasbourg University in 2011.