PhD student: Pablo Cassatella

- outreach page for this project , by Pablo Cassatella

Start Date: Jan 2009
End Date: Dec 2011
Responsible Advisor: Phil Uttley (Southampton)
Co-Advisors: Tomaso Belloni (INAF), Jörn Wilms (FAU Erlangen-Nuremberg)

Update: **The highest ranked candidate for this position has accepted the position.**

The X-ray emission from black hole X-ray binary systems originates mostly from close to the stellar-mass black holes in these systems, in the central powerhouse where a huge amount of potential energy is released from gas falling into the black hole. Although this region is the most important energetically, surprisingly little is known about its structure, except that it consists of a central accretion disc and an extremely hot plasma 'corona', and that the relative importance of these components varies as the systems evolve through different `states' which are linked to the rate of accretion of gas on to the black hole. We also know that this X-ray emission can vary extremely rapidly, on time-scales as short as milliseconds, and that these variations are probably due to turbulence in the flow of gas towards the black hole. If we look in different X-ray energy bands, we see that variations at different energies track each other, but with time delays, which vary depending on the state and other properties of the X-ray emission. We think these time delays are produced by the propagation of different `signals' through the emitting region. Firstly, the slower delays can be caused by the fluctuations in the gas flow as it spirals in towards the black hole, lighting up different regions (with different X-ray energies) at different times. Secondly, the shortest delays can be caused by the travel time of X-ray photons from the hottest plasma to the cooler disc, which then reflect off the disc to produce a delayed signal. We are now at the stage where we can model these processes quite well and use the time delays like a `radar' to map out the structure of the X-ray emitting region and the flow of gas on to the black hole.

The aim of this project is for the PhD student to develop this model to map the regions close to black holes in their different states. The student will also apply the same model to neutron star systems, where we expect differences in structure due to emission from the neutron star

surface, and the student will compare their results with those from spectral fits to the X-ray data to produce a complete picture of the central engines of these fascinating objects. The project advisor Dr. Phil Uttley is a leading expert in modelling X-ray variability from black holes, and will provide most of the training. The student will also spend some time visiting INAF to learn about X-ray timing phenomenology in different X-ray binary systems and states from co-advisor Dr. Tomaso Belloni, and towards the end of the project will work with Prof. Joern Wilms at FAU on the spectral modelling which will be tied in with the variability modelling.

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 .

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