Re-checking the orientational isotropy of astrophysical binaries

NASSP BSc Honours project

Supervisor: Prof Rob Fender (Oxford and UCT)
rob.fender@physics.ox.ac.uk

Co-supervisor: Prof Patrick Woudt (UCT)
pwoudt@ast.uct.ac.za

Summary:

Astrophysical binaries are expected to be oriented in a random way in space. These binaries have a fundamental axis, corresponding to the direction of the orbital angular momentum, and this axis is in principle measurable in a number of ways. This is because the observational appearance of binaries can be strongly dependent on their inclination - for example the projected area of an accretion disc is very small for systems which are close to 'edge on', whereas the apparent luminosities of jets can be very large when they are directed along the line of sight due to relativistic aberration. Testing this assumption of random distributions of orientations is crucial for population studies and understanding selection biases in samples.

Project Proposal:

We shall derive a simple test to check if distributions of estimated inclination angles for binaries are consistent with an isotropic distribution in space. We can test this against inclination angles measured for a range of different classes of binary system, and a range of different methods. These include estimates of inclination angles for X-ray Binary systems, in which a main sequence companion is bound to a black hoe or neutron star, obtained variously via optical, X-ray and radio studies. We will be able to re-test whether this sample is isotropic, with a considerably larger sample than the last time this was attempted, and test if specific estimators (e.g. X-ray reflection studies designed to measure black hole spin) are also producing results consistent with expectations. Beyond X-ray binaries we may also test against other binary samples, such as Cataclysmic Variables, in which the accreting star is a white dwarf.

References:

X-Ray Properties of Black-Hole Binaries
https://ui.adsabs.harvard.edu/abs/2006ARA%26A..44...49R/abstract

Radio-loudness in black hole transients: evidence for an inclination effect
https://ui.adsabs.harvard.edu/abs/2018MNRAS.478.5159M/abstract