High Energy Astrophysics with the Faulkes Telescopes: Photometry of High Mass X-ray Binaries

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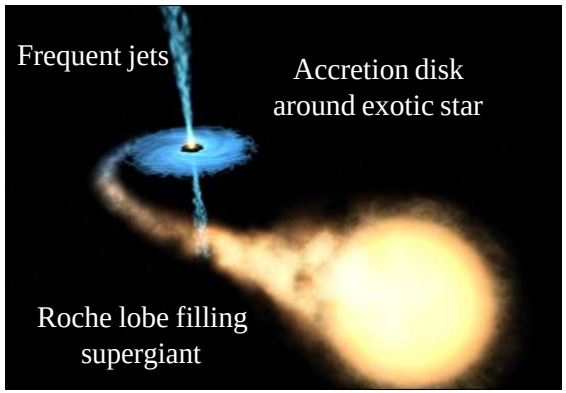
WHAT ARE HIGH MASS X-RAY BINARIES?

The Earth's atmosphere protects us from X-rays from space. So X-ray emitting objects can only be viewed from space with observatories like the XMM-Newton pictured here.

Image courtesy of D.Ducros and ESA.

Aside from the Sun, the brightest X-rays in the sky come from the X-ray binaries in which an exotic star, like a neutron star or black hole, accretes or accumulates gas drawn from a more ordinary star in orbit about the exotic star. The X-rays are produced as the gravitational potential energy of the gas is first transformed to heat and then to light.



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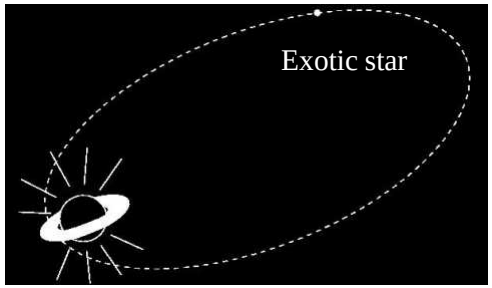
There are two main types of X-ray binaries: the Low Mass X-ray binaries (LMXBs), in which the ordinary star is a low mass main sequence star, and High Mass X-ray binaries (HMXBs) in which the ordinary star is an easily visible, optically bright, (V~ 9-16) massive star.

Of the HMXBs there are two broad classes: (1) Short period (days) SG/X-ray binaries consisting of a supergiant O- or early B-type star filling or nearly filling its Roche lobe and transferring mass via an accretion disk to the exotic star. See the artist's impression below left. (2) Long period (weeks to years) Be/X-ray binaries consisting of Be (emission-line) rapidly rotating main sequence star that transfers mass to the exotic star in a highly eccentric orbit via mass loss through stellar wind and through a centrifugally produced equatorial de-accretion disk. See the schematic below.



Be star with stellar wind and equatorial mass loss.

OPTICAL OBSERVATIONS WITH THE FAULKES AND OTHER TELESCOPES

Much can be learned about HMXBs through optical photometry and the study of their light curves. Of the most interest is to determine the orbital periods from the light curves – many of the longer periods are as yet unknown.

Knowledge of the orbital periods is important because many HMXBs will evolve to merging exotic stars, producing gamma-ray bursts and gravitational waves (GW). Knowledge of the frequency of such mergers will be necessary for the algorithms designed to detect GW with instruments such as LIGO and LISA.

Short period variation, such as that shown for RXJ 0146.9+6121 below from a single night of observation by an AAVSO (American Association of Variable Star Observers) observer, will also give us some information about the mass transfer mechanisms in HMXB systems.

Observations from school-based operation of the Faulkes telescopes when combined with observations by amateur astronomers with the AAVSO over the next few years will be used to increase our understanding of HMXBs.