PhD Project: Accretion in Be X-ray binaries

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Background:
Be X-ray binaries comprise a neutron star accreting matter from the equatorial outflow (decretion disk) of a massive, hot main sequence star (called a Be star). These binaries typically have wide, eccentric orbits. In some cases, accretion occurs on regular intervals, consistent with the orbital period of the binary. At other times, Be X-ray binaries show giant outbursts, which cover a significant portion of the orbit.

Besides their intrinsic interest as bright X-ray and optical sources, Be X-ray binaries are thought to be a pathway for the evolution of double neutron star binaries, and hence a source of transient gravitational wave emission. In order to fully understand the potential of such systems as gravitational wave emitters we need to have a good handle on their evolution. In mass transferring binaries, like Be X-ray binaries, the mass transfer drastically changes the evolutionary paths of the individual stars.

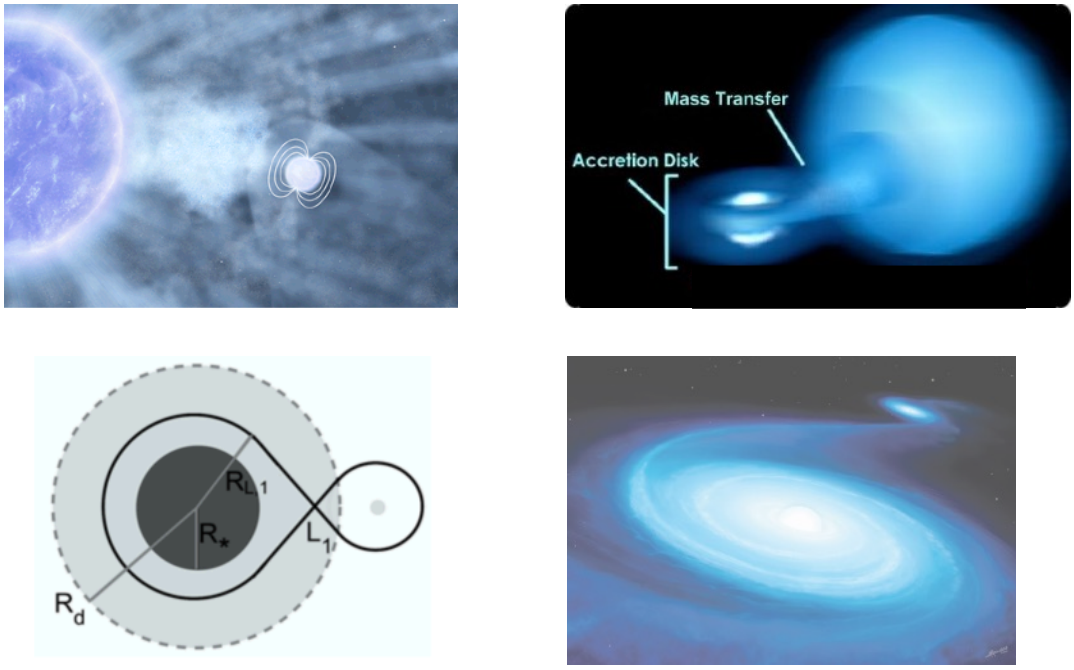

Figure: Different types of mass transfer. Disc Roche lobe overflow (bottom right) is a poorly understood mass transfer mechanism.

Project:

In this project we will use a wide variety of observational and modelling conclusions (e.g. Monageng et al. 2017, Okazaki & Negueruela 2001, Martin et al. 2014) around the mass transfer mechanisms of Be X-ray binaries to write an analytical recipe for Be X-ray binary mass transfer (disc Roche lobe overflow) that can be included in models of population synthesis.

We will work towards a recipe for mass transfer that agrees observed properties of Be X-ray binaries, such as changes in the neutron star spin period over time, the X-ray signatures of mass transfer during different types of outburst, the long-term optical signatures of the Be star disc. The model should address changes in the neutron star spin period, magnetic field and moment of inertia if relevant, and should also account for changes in orbital parameters and mass loss from the binary.

The project may have both observational and computational components, depending on the interest of the student. The recipe should be coded for inclusion in the binary population synthesis code, *SeBa.* (Portegies Zwart & Verbunt 1996, Toonen et al. 2012, Toonen & Nelemans 2013).