Population synthesis studies of high-mass X-ray binaries

2021 MSc Project

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University: *Student must be registered at UCT*

Background:

High-mass X-ray binaries (HMXBs) consist of a high-mass donor (M > 8M_{sun}) and an accreting compact object, usually a neutron star. HMXBs have been studied in detail across the whole electromagnetic spectrum, leading to the discovery of many observational trends. One of these relations is represented by the famous Corbet diagram (Fig. 2) that shows a correlation between the orbital period of a binary and the neutron star's spin period for different HMXBs. Astronomers have attempted to explain the correlation from an observational perspective, however very little work has been done to model the observed phenomena.

Fig. 1: Illustration of a neutron star accreting. material from a high mass star (HMXB).

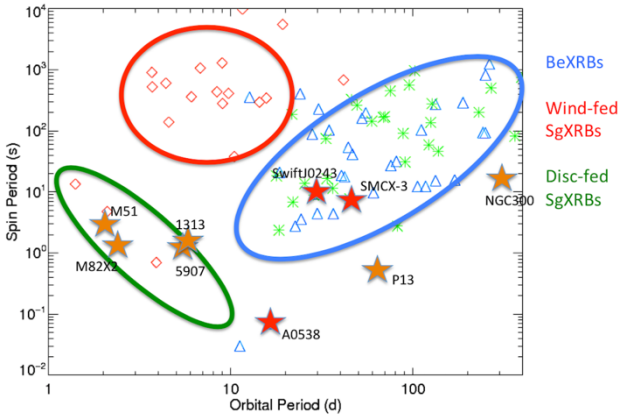

Fig. 2: Corbet diagram showing various types of HMXBs.

Project outline:

This project will utilise population simulations (SeBa) of massive binaries in an attempt to recreate a simulated Corbet diagram, as well as estimate the number of different HMXBs (disc-fed, wind-fed, and Be/X-ray binaries). Comparing observational phenomena with our theoretical simulations will improve our understanding of HMXBs and massive binary evolution.

During the MSc you will learn to run simulations with SeBa and use Python routines to extract the relevant data, as well as conduct further analysis of the simulation results. You will use a selection of parameters such as stellar mass, stellar radii, neutron star spin period, and X-ray luminosity to classify the different HMXBs and finally compare your findings with observations . A basic knowledge of python is required that will allow you to import the datasets, perform operations, and generate plots.