Project Description:
The X-ray light curves of black hole X-ray binaries (XRBs) have long been known to show variability on a wide range of time-scales. Using these light curves, researchers are trying to understand the underlying physics which would generate the obtained light curves. In case of black hole XRBs, a theory has been crafted to explain the properties of the short term timescale X-ray variability. The X-ray spectra are composed of power-law emission, generated by the Comptonizing corona surrounding the black hole, and a black body which is generated by the accretion disk of the black hole. The variability can be quantified using a Fourier transform of the light curve. If one does this for the light curves in different energy bands, differences in Fourier phase can be found. These ‘phase lags’ can be normalised by frequency to give a time lag between the energy bands. Using these lags one can get a better understanding of the underlying physics of the system. This however, can be very difficult to do without a physical model for the lags.

Computer models of the emission processes and the time-delays between them can be used to calculate the ‘spectral-timing’ properties across a wide range of X-ray energies, to better understand the physics that produces the time lags. A recent model (Uttley & Malzac 2021) combines the ideas that variability is driven by mass accretion fluctuations through the disk and corona, and that the disk provides ‘seed’ photons for coronal Comptonization. Because the seed photons first cool the corona and then the mass accretion fluctuations heat the corona back up, the higher energy photons lag behind the low energy photons.

The goal of this Master Project is to take this model and rewrite it from python to C/C++ into a format that can be used by standard X-ray fitting software like XSPEC. While converting the model, updates may be implemented to improve the runtime and additional physical effects and processes might be added for model completeness. Once this has been done, it can be used in combination with XSPEC to try and fit real data from the NICER X-ray instrument.

Planning:
2021:
June – July: Background Reading & Software Setup
September – October: Learn the use of Xspec, Xspec models, the python model
November – Mid April 2022: Convert python model to C/C++ (Xspec model)
& Apply Updates
2022:
Mid April – May: Fit to NICER Black Hole X-ray Binaries
June: Thesis Write-up