# Thesis proposal

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## 1 Research project Plan

In my thesis I will focus on the search for binary blackhole mergers (BBHs). A very important part of the detection of these events lies in the availability of inspiral-merger-ringdown waveform models for BBH mergers. To calculate these waveforms we mostly rely on Numerical Relativity (NR). Although this method is really precise it's also very time conceiving with sometimes even months of generation time. One way to attack this problem is by using surrogate modeling to generate these waveforms. This model relies on a basis of a few NR waveforms and interpolates this basis to find the eccentric waveforms for a certain range of eccentricity.

Surrogate modeling has been proven very useful for generating GW signals, however most research lays the focus on generating non-eccentric waveforms. The main reason for this is that it's believed that most eccentricity gets lost during the long inspiral causing mostly circular radiation in the frequency-band of our detectors. However this is not always the case. BBH mergers in dense environments could cause eccentric waveforms. The eccentricity can give us lots of information about the environment of the merger. Eccentricity can be caused by multiple scenarios. For example the formation of BBHs by dynamical capture or a hierarchical triple. I will lay my focus on generating eccentric waveforms to improve the search for BBH mergers in dense environments.

Surrogate modeling is a numerical way to model a waveform that uses a simpler, approximating model to make a prediction on a more complex system (which is very time expensive). In the process of surrogate modeling we start by seeking the minimal number of NR waveforms needed for an accurate surrogate waveform. For the waveforms we target a 2d parameter space with eccentricity $\in \{0, 1\}$ and a mean anomoly $\in \{0, 2\pi)$. Next we choose m datapoints within our parameter space. This will be our greedy data. We also choose m time-samples that best define the waveform. For this we use the Emperical Interpolation Method (EIM). This will be our emperical data. At every emperical point we will generate a waveform at the greedy datapoints. Last we evaluate the accuracy of the surrogate model by testing one of the randomly chosen datapoints in the parameter space.

——————— To be added: Rough schedule with 5-6 milestoned and supervision plan ———————