Project Title:
Modelling and searching for binary neutron stars in gravitational wave data

Supervisor(s):
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Project Description:
An outstanding problem in nuclear physics is the equation of state of dense nuclear matter as can be found in neutron star cores. Heavy-ion collider experiments probe neutron rich nuclei but densities in neutron star cores will be several factors higher. The signature of neutron star equation of state will be present in GWs from neutron stars in a variety of different environs: peak frequencies in supernova waveforms, asteroseismology of neutron star glitches and inspiral, merger and post-merger waveforms produced by merging neutron star binaries. Of these the latter sources offer the best opportunity not only because they produce very loud signals but also because we should be able to model the emitted signal in different phases accurately enough to disentangle the signature of nuclear equation of state from other astrophysical effects.

The goal of the PhD project is to start with waveforms produced by numerical simulations of neutron star binary mergers and produce an accurate analytical model of the signal. We will first characterise the spectrum of the post-merger signal and identify salient features that can be related to the physics of merger. Once we understand the spectrum we will then fully characterise the time-domain phasing of the signal and use the model to probe the equation-of-state of dense nuclear matter. With such a signal model it should be possible to measure the neutron star radius to within a few km for events detected by advanced LIGO and Virgo and hence constrain the equation of state to a level that is better than what is currently known.

To discuss this project further, please contact:

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