Dr. Carl-Johan Haster is an Assistant Professor of Astrophysics in the Department of Physics & Astronomy and the Nevada Center for Astrophysics at University of Nevada, Las Vegas. Before this, Dr. Haster was a Postdoctoral Associate at the LIGO Laboratory and the Kavli Institute for Astrophysics and Space Research at MIT, a CITA Postdoctoral Fellow at Canadian Institute for Theoretical Astrophysics, a PhD student at University of Birmingham and a MPhys student at University of Manchester.

His main research interests are all the exciting things we can learn about the extremes of our Universe through observations of Gravitational Waves (for example using the current LIGO, or future Cosmic Explorer, instruments). He is particularly interested in finding satisfactory robust connections between the observed population of compact objects, mainly black holes and neutron stars, and the astrophysical processes through which these objects are formed and evolve. Dr. Haster is also interested in exploring matter at its extremes, like what can be found in coalescing neutron star binaries, how this can be observed using as many astrophysical messengers as possible and help us find the best model for the Neutron Star Equation of State. Finally, he enjoy working on the inference methods used to analyse these gravitational wave signals, in order to improve their speed, fidelity and robustness. This will in turn be crucial for using these observations for precision tests of General Relativity as our preferred theory of gravitation, as otherwise it's easy to confuse a claimed beyondGR detection caused by a not-accurate-enough analysis.

Project title:
Gravitational-wave informed pointing of short-GRB observations

Project Bio:
Following the joint observation on 17th August 2017 of both γ-rays and gravitational waves (GWs) emitted during the merger of a neutron star binary, a new field of transient multimessenger astrophysics (MMA) was kickstarted. Plans for a next generation (XG) set of GW observatories, like the proposed US-based Cosmic Explorer, sensitive enough to observe a binary neutron star (BNS) merger around once per minute out to redshifts of ~ 2 and beyond. Such an event rate will be near-impossible to follow-up for both current (e.g. Swift) and future space-based γ-ray observatories. In reality, not all BNS mergers will be observable from Earth as short γ-ray bursts (GRBs). Even though all BNS mergers are expected to emit γ-rays, this radiation will be highly collimated and hence not visible unless pointing along, or close to, the line of sight.

A typical BNS transient detected with a XG-GW facility is expected to be observable for tens of minutes, or up to hours, before merger. In this study, I propose to investigate the potential to use the early-warning GW signal, ending a few minutes before merger, to constrain the position of the source (both sky location and distance) as well as the viewing angle of the binary orbit. With this information in hand, it will be possible to make an informed decision about the expected observability of both the γ-rays (emitted at merger) and the subsequent afterglow (most prominent in X-rays/UV/optical wavelengths during the first few minutes post-merger), as they both depend on the binary orientation. The inferred BNS location and orientation would then be compared to the true values for each simulated signal and provide a gauge for how likely Swift would be to observe the electromagnetic (EM) counterpart given an inferred binary location and orientation. These joint EM-GW observations are crucial to further our understanding of fundamental neutron star physics, BNS mergers as one of the most energetic astrophysical transients in the Universe and as independent probes of our cosmological models.