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Constraining and comparing short gamma-ray burst beam profiles using gravitational waves

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GRB 170817A was markedly dissimilar to any other detected short gamma-ray burst as it was observed off-axis. This was further made evident by the information gained from the accompanying observation of GW170817. The event has since sparked discussion into the short gamma-ray burst beam profile and how it can link the observed luminosity of GRB 170817A with the rest of the observed on-axis short gamma-ray burst population. By assuming the short gamma-ray burst beam profile is universal across events, we use a fully Bayesian analysis to place constraints on beam profiles associated with cocoon, structured and simple top-hat jet models, as well as the binary neutron star merger rate. The beam profiles are constrained to reconcile the discrepancy between GRB 170817A and the rest of the on-axis population, given the distance and inclination information from GW170817 and the neutron star merger rate inferred from LIGO's first and second observing runs. We further show that these models can be distinguished from one another given a population of future gravitational wave detections of neutron star mergers with and without a counterpart, promised by the observations made by third-generation detectors.

Primary author: HAYES, Fergus (University of Glasgow)

Co-authors: Prof. HENG, Ik Siong (University of Glasgow); Dr LAMB, Gavin (University of Leicester); Dr VEITCH, John (University of Glasgow)

Presenter: HAYES, Fergus (University of Glasgow)

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