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Discriminating Binary Neutron Star Population Models with Gamma-Ray Burst Data

The joint detection of a Binary Neutron Star (BNS) merger (GW170817) with gravitational and gamma-ray detectors was a milestone achievement for multimessenger astronomy, representing evidence of BNS as progenitors of short gamma-ray bursts (sGRB). While there are ~40–50 sGRBs detected annually by Fermi/GBM, only 2 confirmed BNS mergers (GW170817 and candidate GW190425) detected by LVK to date. This discrepancy challenges the assumption that BNS mergers are the sole source of sGRBs.

We present MAGGPY (Multimessenger Astronomy using GRBs and Gravitational Waves in Python), an efficient code built on the emcee Markov Chain Monte Carlo sampler used to study the connection between BNS and sGRBs. Using real GRB data from Fermi/GBM detections, the code is designed to simultaneously constrain BNS populations and high-energy emission models. Given that the sampler infers the parameter distributions necessary for the GRB emission models we can also generate mock GRB data which can be used to predict the performance of current and next generation detector networks.

By comparing 15 different population synthesis models we show how the code can be leveraged to prefer certain physical scenarios. By comparing the mock data generated from the learned distributions of each population to real data, we can constrain properties related to BNS mergers such as the local merger rate or more interestingly we can constrain the parameter representing the fraction of orbital energy converted into kinetic energy.

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