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On the Testability of the Quark-Hadron Transition Using Gravitational Waves From Merging Binary Neutron Stars

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Elementary particles such as quarks and gluons are expected to be fundamental degrees of freedom at ultra high temperatures or densities, while natural phenomena in our daily lives are described in terms of hadronic degrees of freedom. Massive neutron stars and remnants of binary neutron star mergers may contain quark matter, but it is not known how the transition from hadron matter to quark matter occurs. Different transition scenarios predict different gravitational waveforms emitted from binary neutron star mergers. If the difference between the equations of state only occurs at sufficiently high density, it is expected that the difference between waveforms mainly appears in the merger or the post-merger phase rather than in the inspiral phase. The typical frequency of gravitational waves after the coalescence is higher than 2 kHz, which is difficult to observe using current detectors. In this work, we performed Bayesian model selection for two scenarios proposed as representatives in Fujimoto *et al.* (2023) and investigated whether observations with future detectors will allow us to identify the correct model. We assume that the relatively low density equation of state around the nuclear saturation density is completely known from accumulated observations. Under this assumption, we find that it is reasonable to expect to be able to identify the correct transition scenario with third-generation detectors or specialized detectors with high sensitivity at high frequencies designed for post-merger signal observation, *e.g.*, NEMO (Ackley *et al.* 2020).

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