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Signatures of first order phase transitions and of spins in neutron star mergers

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With the detection of GW170817 we have observed the first multi messenger signal from two merging neutron stars.
This signal carried a multitude of information about the underlying equation of state (EOS) of nuclear matter, which so far is not known for densities above nuclear saturation. In particular it is not known if exotic states or even a phase transition to quark matter can occur at densities so extreme that they can't be probed by any current experiment.
In this talk we will show how the information carried in the gravitational wave signal of GW170817 can be used to constrain the EOS at densities above saturation and what we can learn about the possible existence of phase transitions. We will also comment on how we can use future gravitational wave detections in order to set limits on the existence of neutron stars having a quark matter core.
Finally, we will discuss the detectability of a hadron-quark phase transition taking place in a neutron star merger event. Starting from a fully consistent description of matter having a first-order phase transition to quark matter at finite temperatures, we will demonstrate what imprint a hadron-quark phase transition would leave on the gravitational-wave signal. We will conclude by showing that a hot and dense core of quark matter is formed in such a simulation and will also briefly comment on how this is related to the phase diagram of quantum chromodynamics.

Additionally, we will report on recent results of neutron star mergers with spin and show how part of the mass ejection in a neutron star merger can be suppressed when the neutron stars have spins $\simeq 0.28$.

Keywords

Compact Object Mergers

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