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From Relativistic Heavy Ion Collisions to Neutron Star Mergers - the Equation of State of Dense Matter as signalled by Gravitational Waves

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General relativistic astrophysics and elementary particle and nuclear physics are strongly connected and their results are interdependent. Although the physical systems are quite different, the 4D-simulation of a merger of a binary system of two neutron stars and the properties of the hot and dense matter created in high energy heavy ion collisions, strongly depend on the equation of state of fundamental elementary matter. Neutron star mergers represent optimal astrophysical laboratories to investigate the QCD phase structure using a spectrogram of the post-merger phase of the emitted gravitational waves. These studies can be supplemented by observations from heavy ion collisions to possibly reach a conclusive picture on the QCD phase structure at high density and temperature. As gravitational waves (GWs) emitted from merging neutron star binaries have just been detected, it is important to understand the main characteristics of the underlying merging system in order to predict the expected GW signal. Numerical-relativity simulations of merging neutron star binaries helps in studying the emitted GWs and the interior structure of the generated hypermassive neutron stars. The spectral properties of emitted GWs are then studied with the appearance of the hadron-quark phase transition in the interior region of the hypermasive neutron star and the results are confronted with the simulation results of high energy heavy ion collisions.

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