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Constraining the nuclear matter equation of state with heavy-ion collisions

The nuclear matter equation of state EOS is a topic of intense research on both the experimental and theoretical side since many years. It is a fundamental ingredient necessary to describe the characteristics of dense astrophysical objects, e.g. neutron stars, and cosmological events like core collapse super novae and mergers of compact stars, as well as heavy-ion collision dynamics and nuclear structure. The nuclear matter equation of state could be derived from first principle quantum chromo dynamics QCD, however, this has not been achieved, yet Neutron star masses and radii are promising observables to constrain the equation of state of isospin asymmetric nuclear matter. An important milestone, however, was the first observation of a neutron star merger event GW170817 by its gravitational wave signal. This data gave important new insights in the behavior of the equation of state of asymmetric matter. Heavy-ion collisions provide a tool to study the characteristics of dense nuclear matter in the laboratory. In the course of a heavy ion collisions at sufficiently high energies up to several times normal nuclear matter densities are reached in the overlap zone of the two nuclei. Particle production and flow are observables which are sensitive to the density and pressure reached in the heavy ion collision and thus to the nuclear matter equation of state.

In order to probe the nuclear EOS, a multitude of different systems and observables have been studied at GSI's heavy-ion synchrotron SIS18 and other facilities worldwide in the last years. In this talk an overview on the experimental and theoretical status will be given and perspectives of future experiments will be described.