

Neutron Stars, Quark Stars and the QCD Phase Transition

Neutron stars are the final endpoint in the evolution of ordinary stars. They are extreme astrophysical objects with the largest density encountered in the present universe. Rotation-powered neutron stars are regularly observed as pulsars and have gigantic magnetic fields. Gravity is so strong, that effects from general relativity are important.

The properties of neutron stars, as mass and radius, are determined by an interplay of strong interactions (quantum chromodynamics QCD) and gravity. We give an outlook to the new physics being probed by neutron stars. The inner core of neutron stars contains matter at extreme baryon densities. It is expected that there are new phases appearing, probably accompanied by a first order phase transition. The dense interior of compact stars might be filled with exotic matter be it in the form of hyperons, Bose condensates or a plasma of quarks and gluons. Compact stars might exist which are just made of quarks alone, so called strange stars. QCD matter at high baryon density relevant for compact stars will be explored in relativistic heavy-ion collisions as with the FAIR accelerator Facility at GSI Darmstadt in the near future. We outline the possible signatures for the presence of a new form of matter in compact stars by the emission of neutrinos, gravitational waves or gamma-rays and its relevance for future experiments on earth and in space.