GR 11: Relativistic Astrophysics

Time: Wednesday 15:40–17:10 Location: H 2013

GR 11.1 Wed 15:40 H 2013

Relativistic Hydrodynamics in the Context of the Hadron-Quark Phase Transition in Compact Stars — •Matthias Hanauske — Johann Wolfgang Goethe-Universität, Institut für Theoretische Physik, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

The properties of compact stars are mainly determined by two fundamental forces: Quantum chromodynamics (QCD) and general relativity. Relativistic hydrodynamical simulations of collapsing neutron stars and binary neutron star mergers depend strongly on the high density properties of the equation of state (EoS) of hadronic and quark matter. The appearance of the QCD - phase transition (the transition from confined hadronic to deconfined quark matter) will change the properties of neutron stars; eg. usually it is assumed that the loss of stability of a neutron star, exceeding its maximum mass, leads to the collapse into a black hole. However, realistic calculations within QCD-motivated models show that a neutron star collapse could be stopped before the black hole forms. Within such a collapse scenario the neutron star would be transformed into a hybrid star with a deconfined quark matter phase at its inner core. Several astrophysical observables of the Quark-Gluon-Plasma will be discussed during the talk. Whether these observables will be visible with telescopes and gravitational wave detectors depends strongly on the EoS and on the order and construction of the phase transition.

30 min. break

GR 11.2 Wed 16:30 H 2013

Constraining the Equation-of-State of Neutron Stars by Phase-Resolved X-ray Spectroscopy — •Ralph Neuhaeuser and Valeri Hambaryan — AIU, U Jena, Schillergäßchen 2, 07745 Jena, Germany

We use XMM X-ray observations of the isolated neutron stars RBS1213, RXJ1856, and RXJ0720 to measure their compactness by X-ray phase resolved spectroscopy. These objects are also called Magnificent Seven Neutron Stars. They are isolated in the sense that they neither have a supernova remnant nor any known companions. They are on the order of 1 Myr old, X-ray bright, optically faint, nearby (on the order of one to few 100 pc), and show fast proper motion. We use many XMM light curves for different energy bands and many spectra of different light curve phases. Our model assumes a thin highly magnetized atmosphere above a solid state surface with a warm surface for optical emission and two hot emitting areas near the magnetic poles for the X-ray emission. Among the free fit parameters of our model is the gravitational redshift, which is directly related to the compactness M/R (mass M and radius R). We have determined the compactness for all three objects and compare them with predictions from different equations-of-state. In addition, for at least one of the three objects RXJ1856, the distance and radius is known, so that compactness and radius can yield the true mass. This might be the first neutron star with known mass and radius. We will also discuss how to improve on the error budget.

GR 11.3 Wed 16:50 H 2013

Quadrupole Moments of Rapidly Rotating Compact Objects in Dilatonic Einstein-Gauss- Bonnet Theory — •Sindy Mojica, Burkard Kleihaus, and Jutta Kunz — University of Oldenburg

Rapidly rotating compact objects are considered laboratories to test general relativity and theories beyond. We determined observables such as the mass, the angular momentum, the moment of inertia, or the quadrupole moment for neutron stars and black holes in dilatonic Einstein-Gauss-Bonnet theory, a theory motivated by string theory. We used several equations of state (EOS) for the neutron matter and considered the dependence of the observables on the EOS and on the Gauss-Bonnet coupling constant. While there is a considerable EOS dependence for the observables themselves, the relation between the scaled moments of inertia and the scaled quadrupole moments is almost independent of the EOS, when the scaled angular momentum is held fixed.