Institutul Național de Fizică și Inginerie Nucleară
Horia Hulubei

IFIN-HH

Seminar general

Constraining the nuclear equation of state with neutron stars and binary neutron star mergers

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Compact stars, such as neutron stars, strange stars and hybrid stars, are fascinating astronomical objects that enjoy much scientific interest for astrophysics, nuclear physics and general relativity communities. For the nuclear physics community they hold the potential to reveal the effective interactions in regimes that Earth laboratories cannot explore. The maximum mass of compact stars constrains the high-density domain of the equation of state and serves as a diagnostic tool for the composition of matter, in particular nucleation of hyperons and quarks.

The detection of several massive pulsars in binary systems with white dwarfs fixed a lower limit for the maximum mass, approx. $2M_{Sun}$. The intermediate density part of the neutron star equation of state has been recently constrained by the measurement, in the GW170817 event corresponding to gravitational waves emitted during the inspiral phase of two merging NS, of the tidal deformability. Combining these measurements with those of NICER for PSR J0030+0451 with $R(1.44^{+0.15}_{-0.14}\ M_{Sun})=13.02^{+1.24}_{-1.06}$ km and $R(1.34^{+0.15}_{-0.16}\ M_{Sun})= 12.71^{+1.14}_{-1.19}$ km (68.3%) and J0740+6620 with $R(2.08 \pm 0.07\ M_{Sun})=13.7^{+2.6}_{-1.5}$ km (68%) and $R(2.072^{+0.067}_{-0.066}\ M_{Sun})=12.39^{+1.30}_{-0.98}$ km resulted in constraints for densities in the range $1.5\ n_{sat} < n < 3\ n_{sat}$.

We have recently shown that a set of relations between global parameters of static and rapidly rotating neutron stars holds also when temperature effects are accounted for.

By adopting the scenario in which a hypermassive compact star remnant formed in a merger evolves into a supramassive compact star that collapses into a black hole once the stability line for such stars is crossed, we exploited these relations in order to extract, from the GW170817 event, an upper limit on the maximum mass of static, cold neutron stars for the typical range of entropy per baryon and electron fraction characterizing the hot hypermassive star.

Joi, 17 februarie 2022, ora 10^{00}

Zoom & Sala de seminar Prof. Marius Petrașcu (DFN)