Non-radial vibrations of neutron stars

S.I. Bastrukov[a], I.V. Molodtsova[a], V.V. Papoyan[a,b], and F. Weber
[a] Joint Institute for Nuclear Research, 141980 Dubna, Russia
[b] Yerevan State University, 375049 Yerevan, Armenia

Non-radial oscillations of a non-rotating neutron star are studied. A neutron star is modelled by a spherically symmetric distribution of nuclear matter possessing the properties of an elastic solid bounded by Newtonian gravity. The analytic formalism describing the spheroidal gravitation-elastic vibrations is developed. Emphasis is placed on calculation of the eigenfrequencies of non-radial vibrations. First numerical estimates are presented and compared with those obtained in earlier calculations on the basis of Kelvin's hydrodynamic model.

(published in: J. Phys. **G22** (1996) L33)

Neutron Star Properties in the Thomas-Fermi Model

K. Strobel, F. Weber[a], M. K. Weigel, and Ch. Schaab

[a] Lawrence Berkeley Laboratory, Nuclear Science Division, MS 70A - 3307, Berkeley, CA 94720, U.S.A.

We have claculated within the modern nonrelativistic TF model of Myers and Swiatecki the properties of neutron star matter and compared the outcome with microscopic nonrelativistic and relativistic treatments. The main purpose of this contribution was to test this model with respect to its implications for the physics of neutron stars. It turned out that, despite its simplicity, the modern TF model shows the same features with respect to the EOS of neutron star matter as complicated nonrelativistic variational calculations. Moreover the model is in even closer, over the relevant density regions encountered in neutron stars, with microscopic relativistic EOSs. The composition of neutron star matter obtained for TF is similar to other nonrelativistic models for which the symmetry energy saturates or even decreases at higher densities too, favoring so, in contrast to relativistic models, again an increase of the neutron fraction at higher densities. The resulting gross structural properties of neutron stars (masses, redshifts etc.) are in accordance with observations. Also interesting is the finding that the limiting rotational neutron star periods computed for TF, set by either the Kepler criterion or the gravitational–radiation reaction instability, agree rather closely with the results of modern relativistic EOSs. The limiting period of a $M \sim 1.4\ M_{\odot}$ neutron star is about 1 ms, which is also in agreement with the present observations. Limiting periods of this size seem to be a general feature of EOSs computed hadronic/leptonic matter. Finally we studied the thermal evolution of neutron stars for TF. Here, somehow surprisingly, it turned out that no enhanced cooling mechanism needs to be invoked to achieve agreement between theory and observation; cooling via only the modified Urca process occurs to be sufficient. (We recall that cooling via the direct Urca process is not permitted for TF, as is the case for the nonrelativistic microscopic neutron star matter EOSs studied in this work.)