Elastodynamical Properties of Nuclear Matter from the Observed Activity of Neutron Stars

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In this paper, the large-scale motion of nuclear matter inside of neutron stars is studied. The theoretical framework is based on the idea that stellar nuclear matter is an elastic Fermi continuum possessing the properties of a compensated magneto-active plasma. The fundamental dynamical equations of motion of the self-gravitating matter are taken to be the equations of nuclear elastodynamics, formulated in the macroscopic theory of nuclear collective processes.

A variational method is presented for calculating the frequencies of gravitational-elastic spheroidal (s-modes) and torsional (t-modes) vibrations of a neutron star, which are illustrated in Figs. 1 and 2. The study is supplemented with

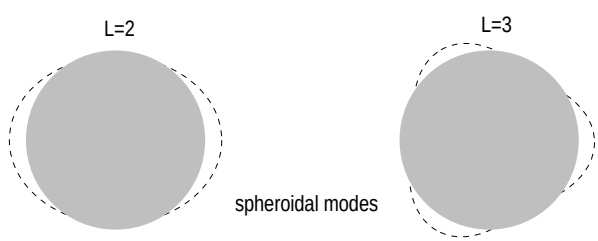

Figure 1: Quadrupole ($L = 2$) and octupole ($L = 3$) spheroidal, non-radial eigenmodes of a neutron star.

a stability analysis with respect to linear stellar deformations.

The effectiveness of the elastodynamical method is illustrated by calculating both the periods of global gravitational elastic vibrations within the standard homogeneous model as well as the oscillation periods of a family of realistic models of neutron stars, constructed for relativistic equations of gravitational equilibrium and nuclear matter equations of state which account for the numerous theoretically proposed phases of dense matter inside neutron stars. The motions of the magnetized Ae phase of neutron star matter are described using the magneto-hydrodynamical approach, which is used to calculate the frequencies of toroidal and poloidal Alfven oscillations. It is emphasized that magneto-plasma vibrations can significantly affect the electromagnetic activity of pulsars.

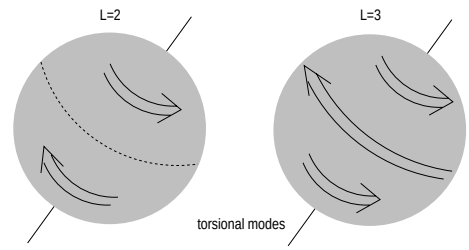

Figure 2: Quadrupole ($L = 2$) and octupole ($L = 3$) torsional, non-radial eigenmodes of a neutron star.

References

[1] S. I. Bastrukov, I. V. Molodtsova, D. V. Podgainyi, F. Weber, V. V. Papoyan, Phys. Part. Nucl. 30 (1999) 436.