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MACROSCOPIC ROTATIONS FOR NEUTRON STARS WITH A DEFORMED EFFECTIVE SURFACE

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In this report we present the macroscopic model for neutron stars (NSs) described as a perfect cold liquid drop at equilibrium within the Tolman-Oppenheimer-Volkoff theory modified by the Kerr and Hartle approaches for slow azimuthal angular frequency around the symmetry axis. We take into account the NS surface deformation within the leptodermic approximation [1]. Introducing the dimensionless frequency, we use the linear perturbation approach to derive the GRT Kerr metric in the spherical coordinates outside and inside of the NS. The second-order partial derivative differential equation for with respect to spherical variables and is solved in a separable form in terms of a separation variables constant as a measure for the NS perpendicular-to-axis angular momentum, internal density larger or of the order of that of the nuclear matter, Schwarzschild and gravitational radii. The surface gradient terms are taken into account through the energy density accounting for the density gradient term with the interparticle interaction constant for the macroscopic equation of state (EoS) within the Extended Thomas Fermi (ETF) approach but with a strong gravitation. The angular momentum and the moment of inertia (MI), , are macroscopically calculated in the adiabatic approximation in terms of the statistically averaged and a correlation contributions by involving the time–azimuthal gravitational coupling. The correlation term becomes significant for a strong gravitational NS field which leads to a significant change of the Schwarzschild asymptote, in contrast to the statistically averaged MI. These MI contributions and total energy are the sums of the volume and surface components obtained through the ETF energy density. We show the volume «V» and surface «S» contributions into the total statistical and correlational MI parts for the NS with its deformed surface in units of the uniform sphere MI with the same mass and radius . There are restrictions of the total MI with and without surface component due to a strong gravitational field because of the correlation and surface contributions. For small NS surface deformations, one can approximate them by spheroidal shapes with a small focus distance. The separation constant value for the symmetry breaking is taken finite. The correlation and surface contributions to the MI are significant in the physical regions of the NS radius.
As perspectives, our analytical macroscopic approach can be generalized to many-component deformed rotating systems, in particular to involve the isotopic symmetry energy like for a neutron-proton system. The quark structure of the neutron star interior accounting for a strong gravitation is a challenge for a future work.

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