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R-mode instability windows for realistic models of hyperon stars

One of the promising solutions to the r-mode stability problem is to account for hyperons in the deepest layers of neutron stars (NSs). The presence of hyperons allows for a set of powerful non-equilibrium (lepton-free) reactions, which can dramatically increase the NS bulk viscosity, and thus suppress the r-mode instability. Modern equations of state, calibrated to the up-to-date hypernuclear data, predict that hyperons are mainly presented in the form of Λ's and Ξ^-'s (Σ^-'s are optional), while all the existing calculations of non-equilibrium reaction rates have been performed for $\Sigma^-\Lambda$ hyperonic composition.

In the present work we fill this gap by calculating the bulk viscosity for $npe\mu\Lambda\Xi^-$ matter. A number of viscosity-generating non-equilibrium reactions is considered, some of them have never been studied in the neutron-star literature before. The calculated reaction rates and bulk viscosity are approximated by simple analytic formulae, in order to facilitate their use in applications. We also calculate the instability windows for several NS models with modern equations of state and for a set of NS masses. We argue that, even within conservative assumptions about the superfluid properties of baryonic matter, the calculated bulk viscosity allows one to explain observations of many rapidly rotating NSs in low-mass X-ray binaries.

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