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Bulk Viscosity in Neutron Star Cores with Modern Hyperonic Equations of State

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Bulk viscosity of neutron star cores is responsible for a number of interesting phenomena, e.g., r-mode stabilization [1] and magnetic inclination-angle evolution [2]. It originated because of non-equilibrium particle mutual transformations in dense stellar plasma, and strongly depends on the actual core composition. It is well-known that account for hyperons in the core dramatically increases the bulk viscosity comparing to purely nucleonic one [3]. Modern equations of state, calibrated to the up-to-date hypernuclear data (e.g., [4,5]), predict that hyperons are mainly presented in the form of Λ's and Ξ^-'s, while all the existing calculations of the non-equilibrium reaction rates ([3,6,7] and others) 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 nonequilibrium 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, for a number of realistic equations of state, by simple analytic formulas, in order to facilitate their use in applications. Possible consequences of our results for the r-mode physics are briefly discussed.

References

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