

Equation-of-State-Independent Constraints on Neutron-Star Properties from Nuclear Dipole Polarizability

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Abstract. Universal correlations between nuclear and astrophysical observables offer a means of reducing the model dependence associated with the uncertain nuclear equation of state. In this work, we construct and exploit a new relation formulated in terms of the dimensionless quantity $\zeta = \beta_{1.4} \bar{L}^{-1}$, which combines the compactness $\beta_{1.4}$ of a canonical $1.4 M_{\odot}$ neutron star with the symmetry-energy slope at saturation density. This quantity displays a systematic dependence on the electric dipole polarizability α_D of neutron-rich nuclei, providing a direct connection between finite-nucleus dipole response and neutron-star structure. The relation is analyzed using an extensive ensemble of nuclear energy density functionals, comprising relativistic point-coupling and meson-exchange interactions, together with non-relativistic Skyrme functionals. Across this diverse set of equations of state, ζ follows a pronounced exponential trend with α_D . Experimental dipole polarizability data are employed to infer constraints on ζ , which are mapped onto equation-of-state-independent bounds for the neutron-star radius $R_{1.4}$ and the symmetry-energy slope parameter L . The resulting framework provides a model-insensitive procedure for translating measured nuclear dipole polarizabilities into quantitative constraints on neutron-star properties and the isovector sector of the nuclear equation of state.