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Bayesian model averaging for nuclear symmetry energy from effective proton-neutron chemical potential difference of neutron-rich nuclei

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The data-driven Bayesian model averaging is a rigorous statistical approach to combining multiple models for a unified prediction. Compared with the individual model, it provides more reliable information, especially for problems involving apparent model dependence. In this work, within both the non-relativistic Skyrme energy density functional and the nonlinear relativistic mean field model, the effective proton-neutron chemical potential difference $\Delta\mu^*_{\rm pn}$ of neutron-rich nuclei is found to be strongly sensitive to the symmetry energy $E_{\rm sym}(\rho)$ around $2\rho_0/3$, with ρ_0 being the nuclear saturation density. Given discrepancies on the $\Delta\mu^*_{\rm pn}$–$E_{\rm sym}(2\rho_0/3)$ correlations between the two models, we carry out a Bayesian model averaging analysis based on Gaussian process emulators to extract the symmetry energy around $2\rho_0/3$ from the measured $\Delta\mu^*_{\rm pn}$ of 5 doubly magic nuclei ^{48}Ca, ^{68}Ni, ^{88}Sr, ^{132}Sn and ^{208}Pb. Specifically, the $E_{\rm sym}(2\rho_0/3)$ is inferred to be $E_{\rm sym}(2\rho_0/3) = 25.6^{+1.4}_{-1.3}\,\text{MeV}$ at 1σ confidence level. The obtained constraints on the $E_{\rm sym}(\rho)$ around $2\rho_0/3$ agree well with microscopic predictions and results from other isovector indicators.

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