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Parameters sensitivity analysis of the Chiral Mean Field Model from Neutron Star Observables

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We present a Fisher–information–based sensitivity analysis of the Chiral Mean Field (CMF) model parameters using neutron star observables as macroscopic probes of dense QCD matter. Building upon the MUSES framework, we developed a workflow that integrates the CMF, Lepton, and QLIMR modules to generate cold, β-equilibrated equations of state by smoothly merging a CMF core with the SLy crust, and to produce the corresponding stellar sequences. From these, we extract masses, radii, compactnesses, and tidal deformabilities, whose logarithmic derivatives with respect to each CMF parameter and the central energy define a dimensionless, Fisher-inspired sensitivity matrix. A principal-component analysis (PCA) of this matrix identifies the effective combinations of microscopic parameters that most strongly govern neutron-star structure. This framework establishes a reproducible, data-driven approach to quantify parameter sensitivities in dense-matter models and to guide future Bayesian inference of nuclear information from multi-messenger astrophysical observations.

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