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The TRGB Luminosity as a Probe of the Axion–Electron Coupling: Constraints and Theoretical Uncertainties

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Red-giant evolution is sensitive to non-standard channels of energy loss and therefore provides a probe of new physics. Such losses increase the luminosity of the tip of the red-giant branch (TRGB), enabling constraints on the axion–electron coupling g_{ae} . In this talk, we present cluster-specific stellar-evolution calculations with MESA for 27 Galactic globular clusters, including the implementation of axion emission and its impact on the predicted TRGB luminosity. Particular attention is given to the assessment of theoretical uncertainties associated with thermal-neutrino emission, electron conduction, radiative opacity, nuclear reaction rates, convection, and other modelling assumptions. We examine how these theoretical uncertainties affect the predicted TRGB luminosities and the resulting constraints on the axion–electron coupling.

We briefly outline the joint profile-likelihood analysis used to compare these predictions with TRGB measurements for 24 clusters, after excluding three hot-flasher systems. Retaining shared uncertainties as correlated nuisance parameters, we obtain a 95% confidence-level power-constrained upper limit of $g_{ae} < 6.4 \times 10^{-14}$.

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