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Varying fundamental constants cosmography

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Cosmography is a model-independent phenomenological approach to observational cosmology, relying on Taylor series expansions of physical quantities as a function of the cosmological redshift or analogous variables. A recent work [Martins et al. Phys. Lett. B827 (2022) 137002] developed the formalism for a cosmographic analysis of astrophysical and local measurements of the fine-structure constant, α, and provided first constraints on the corresponding parameters. Here we update the earlier work, both by including more recent measurements of α and by extending it to the proton-to-electron mass ratio, the proton gyromagnetic ratio, and various combinations of the three enabling the addition of the corresponding measurements to the analysis. We place stringent model-independent constraints on the first two terms of these cosmographic series, ranging from the parts per billion to the parts per million level. We illustrate the benefits of this approach with two specific applications: cosmographic constraints on a broad class of Grand Unified Theories in which varying fundamental constants unavoidably occur, and a discriminating test between freezing and thawing dark energy models.

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