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Constraining Temporal Oscillations of Cosmological Parameters Using Type Ia Supernovae

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The existing set of type Ia supernovae (SNe Ia) is now sufficient to detect oscillatory deviations from the canonical ΛCDM cosmology.
We determine that the Fourier spectrum of the Pantheon data set of spectroscopically well-observed SNe Ia is consistent with the predictions of ΛCDM.
We also develop and describe two complementary techniques for using SNe Ia to constrain those alternate cosmological models that predict deviations from ΛCDM that are oscillatory in conformal time.
The first technique uses the reduced χ^2 statistic to determine the likelihood that the observed data would result from a given model.
The second technique uses bootstrap analysis to determine the likelihood that the Fourier spectrum of a proposed model could result from statistical fluctuations around ΛCDM.
We constrain three oscillatory alternate cosmological models: one in which the dark energy equation of state parameter oscillates around the canonical value of $w_\Lambda = -1$, one in which the energy density of dark energy oscillates around its ΛCDM value, and one in which gravity derives from a scalar field evolving under an oscillatory coupling.
We further determine that any alternate cosmological model that produces distance modulus residuals with a Fourier amplitude of $\simeq 36$ millimags is strongly ruled out, given the existing data, for frequencies between $\simeq 0.08$ Gyr$^{-1}h_{100}$ and $\simeq 80$ Gyr$^{-1}h_{100}$.

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