

Can Distance Duality Violation Save Late-time Solutions to the Hubble Tension?

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The discrepancy between early- and late-Universe determinations of the Hubble constant may point to physics beyond Λ CDM or to unaccounted-for systematics. Numerous late-time modifications to the expansion history have been proposed to alleviate this discrepancy, with limited success. Recent works have shown that, when the sound-horizon and supernova calibrations are held fixed, any purely late-time resolution requires a violation of the cosmic distance duality relation (CDDR). Recasting the tension in the r_d - M_B plane, we show explicitly that distance duality, together with BAO and uncalibrated supernova data and a fixed sound-horizon calibration, determines H_0 independently of the late-time expansion history. We then test the viability of the required CDDR violation by separately constraining reciprocity violation and photon number non-conservation, deriving a new constraint on reciprocity-violating distortions of angular-diameter distances from BAO and cosmic-chronometer data. Combining this result with existing photon-number-conservation constraints, we find that the level of distance-duality violation needed to resolve the tension is strongly disfavoured by current data. We therefore conclude that, for fixed sound-horizon and supernova calibrations, no modification confined to the late-time expansion history—even one violating distance duality—can resolve the Hubble tension, pointing instead toward early-Universe physics or unresolved local systematics.

Primary author(s) : TIWARI, Yashi (Institute of Theoretical Physics, Chinese Academy of Sciences); UPADHYAY, Ujjwal Kumar (The Institute of Mathematical Sciences)

Co-author(s) : WANG, Shao-Jiang (Institute of Theoretical Physics, Chinese Academy of Sciences); Prof. POULIN, Vivian (Laboratoire Univers & Particules de Montpellier, CNRS & Université de Montpellier (UMR-5299))

Presenter(s) : TIWARI, Yashi (Institute of Theoretical Physics, Chinese Academy of Sciences)

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