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Cosmology under the fractional calculus approach: a possible H_0 tension resolution?

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Fractional cosmology has emerged recently, based on the formalism of fractional calculus, which modifies the standard derivative to one fractional derivative of order α. It generates changes in General Relativity, particularly in the Einstein field equations. In this mathematical framework, the Friedmann equations are modified with an additional term similar to an effective curvature. The standard evolution of the cosmic species densities depends on the α fractional parameter and the age of the Universe t_U. The hypothesis is that the Universe does not contain a dark energy component. The late accelerated expansion can be sourced by the additional term in the new equation governing the cosmic dynamics. To elucidate that, we estimate stringent constraints on the fractional parameter using cosmic chronometers, Type Ia supernovae and joint analysis. We obtain $\alpha = 2.839^{+0.117}_{-0.193}$ within one sigma confidence level that can provide a non-standard cosmic acceleration at late times; consequently, the Universe would be older than the standard estimations. Additionally, we present a dynamical system and stability analysis to explore the phase-space under the assumption of different α parameters. One late-time attractor, which is physical for $1 \leq \alpha < 5/2$, corresponds to a power-law (decelerated) late-time attractor for $\alpha < 2$. Moreover, an additional point not present in GR exists, which is physical for $\alpha > 1$ and a sink for $\alpha > 2$. This solution is a decelerated power-law if $1 < \alpha < 2$ and an accelerated power-law solution if $\alpha > 2$. This last result is consistent with the mean values obtained from the observational analysis. Therefore, under the fractional calculus, it is possible to obtain modified Friedmann equations at the background level, which provide a late cosmic acceleration without introducing a dark energy component. This radical approach could be a new path to tackle problems not resolved until now in cosmology. We analyse whether fractional cosmology can alleviate H_0 tension.

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