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Violation of NEC in $f(\bar{R},\bar{T})$ gravity within a non-canonical theory using the modified Raychaudhuri equation

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In this work, we construct the Raychaudhuri equation in $f(\bar{R},\bar{T})$ gravity in the context of a non-canonical theory, which is the K-essence theory. We solved the modified Raychaudhuri equation for the additive form of $f(\bar{R},\bar{T})$, which is $f_1(\bar{R}) + f_2(\bar{T})$. In this solution, we use two distinct scale factors to generate two kinds of $f(\bar{R},\bar{T})$ solutions. The ongoing debate between Fisher et. al. and Harko et. al. in 2020 regarding the additive form of $f(\bar{R},\bar{T})$ provides resolution within the modified $f(\bar{R},\bar{T})$ gravity theory. By doing a viability test and examining energy conditions, we found that in the first scenario, the null energy condition (NEC) is violated between two places where the NEC is met. Furthermore, we found that this violation of the NEC has a symmetrical characteristic throughout the phase transition. These findings suggest that bouncing events may occur as a consequence of symmetrical violations of the NEC during the universe's expansion. In addition, this model indicates that resonant-type quantum tunneling might occur when the NEC is broken. The findings of the NEC violation using the power law of scale factor may have empirical significance in current observations. In the second solution, our model shows that the strong energy requirement is broken but the NEC and weak energy criteria are satisfied. The effective energy density drops but remains positive, although the effective pressure and equation of state parameters are negative. This shows that the cosmos is growing rapidly and is dominated by dark energy.

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