RESEARCH TRAINING GROUP
Models of Gravity

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Modified Friedmann Equations from Tsallis Entropy

Abstract

We first review the deep connection between gravity and thermodynamics, historically. Inspired by the fact that for a gravitational system the entropy must be generalized to the non-additive entropy, we introduce the concept of the Tsallis entropy. Taking the entropy associated with the apparent horizon of the FRW Universe in the form of Tsallis entropy, and assuming the first law of thermodynamics holds on the apparent horizon, we derive the corresponding Friedmann equations. We also examine the validity of the generalized second law of thermodynamics. Then, by calculating the difference between the surface degrees of freedom and the bulk degrees of freedom in a region of space, we again arrive at the modified Friedmann equation which is the same as one obtained from the first law of thermodynamics. We also study the cosmological consequences of the Tsallis cosmology. Interestingly enough, we find that this model can explain simultaneously the late time acceleration in the Universe filled with pressureless matter without invoking dark energy, as well as the early deceleration. Besides, the age problem can be circumvented automatically and is estimated larger than the age of the Universe in standard cosmology.