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Emergence of cosmic space with Barrow entropy, a non-equilibrium thermodynamic description.

Recently, a novel modification in the conventional area-entropy relation has been introduced by Barrow, as $S = (A/A_0)^{1+\Delta/2}$, by taking account of the quantum gravitational deformation effects on the black hole's surface. Recent literature has adopted this horizon entropy to the cosmological domain, leading to significant insights. In this line of thought, we formulated the law of emergence, which elucidates the dynamics of the universe having Barrow entropy for the horizon in the context of equilibrium thermodynamics. However, when considering Barrow entropy (a non-Bekenstein entropy), an additional entropy generation arises owing to the non-equilibrium thermodynamics. The corresponding field equation bears an effective coupling strength, which connects the geometry with an effective energy-momentum tensor. On accounting this, the law of emergence in non-equilibrium description has been formulated. In addition, the consistency of the derived laws has been checked in the context of entropy maximization. Interestingly, it is found that the non-equilibrium entropy generation rate decreases gradually, and the universe evolves to an equilibrium state of maximum entropy corresponding to the de Sitter epoch.

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