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Non-extensive statistics solution to the cosmological lithium problem

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Big Bang nucleosynthesis (BBN) theory predicts the abundances of the light elements D, ^{3}He, ^{4}He and ^{7}Li produced in the early universe. The primordial abundances of D and ^{4}He inferred from observational data are in good agreement with predictions, however, the BBN theory overestimates the primordial ^{7}Li abundance by about a factor of three. This is the so-called 'cosmological lithium problem'. Solutions to this problem using conventional
astrophysics and nuclear physics have not been successful over the past few decades, probably indicating the presence of new physics during the era of BBN. We have investigated the impact on BBN predictions of adopting a generalized distribution to describe the velocities of nucleons in the framework of Tsallis
non-extensive statistics. This generalized velocity distribution is characterized by a parameter q, and reduces to the usually assumed Maxwell-Boltzmann distribution for $q = 1$. We find excellent agreement between predicted and observed primordial abundances of D, ^{4}He and ^{7}Li for $1.069 \leq q \leq 1.082$, suggesting a new solution to the cosmological lithium problem. We encourage studies to examine sources for departures from classical thermodynamics during the BBN era so as to assess the viability of this mechanism. Furthermore, the implications of non-extensive statistics in
other astrophysical environments should be explored as this may offer new insight into stellar nucleosynthesis.

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