

Recurrent axion star collapse and their cosmological constraints

Wednesday, 8 May 2024 14:30 (10 minutes)

Axion-like dark matter whose symmetry breaking occurs after the end of inflation predicts enhanced primordial density fluctuations at small scales. This leads to dense axion minihalos (or miniclusters) forming early in the history of the Universe.

Condensation of axions in the minihalos leads to the formation and subsequent growth of axion stars at the cores of these halos. If, like the QCD axion, the axion-like particle has attractive self-interactions there is a maximal mass for these stars, above which the star rapidly shrinks and converts an $\mathcal{O}(1)$ fraction of its mass into unbound relativistic axions. This process would leave a similar (although in principle distinct) signature in cosmological observables as a decaying dark matter fraction and thus is strongly constrained. We place new limits on the properties of axion-like particles that are independent of their non-gravitational couplings to the standard model. Future spectroscopic surveys may test this scenario or place stronger bounds on axion parameters.

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Session Classification: Session 11