



Contribution ID: 401

Type: Talk in the parallel session

Understanding Axion Miniclusters: Formation and observational signatures

Friday, 9 July 2021 09:06 (12 minutes)

Axion dark matter can be produced by the decay of cosmic strings, leading to large amplitude, small scale density perturbations in the axion field. These perturbations form the seeds for axion “miniclusters”: small and dense dark matter clumps, with mass $M \approx 10^{-12} M_{\odot}$. The seeds go on to form minicluster halos via hierarchical structure formation. By comparison between the semi-analytic Peak-Patch model and N-body simulations, we show that these minicluster halos are too diffuse to produce a detectable microlensing signal. However, the halos also tend to have dense substructures due to the survival of the initial seeds. The dense substructures are formed by direct collapse in the radiation dominated epoch, and are morphologically distinct from the later-formed halos, and thus may have density profiles that enable them to produce their own lensing signal. Using our analytic model and simulations, we investigate this possibility and study in detail the formation, evolution, and survival of the minicluster seeds.

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Session Classification: Dark Matter Detection

Track Classification: Dark Matter: Dark Matter Detection