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Axion Stars: Mass Functions and Constraints

Abstract

The QCD axion and axion-like particles, as leading dark matter candidates, can also have interesting implications for dark matter substructures if the Peccei-Quinn symmetry is broken after inflation. In such a scenario, axion perturbations on small scales will lead to the formation of axion miniclusters at matter-radiation equality, and subsequently the formation of axion stars. Such compact objects open new windows for indirect searches for axions. We compute the axion star mass function based on recent axion minicluster studies and Bose star simulations. Applying this mass function, we find post-inflation axion-like particles with masses 1.8×10^{-21} eV$<$ma$<3.3\times10^{-17}$ eV are constrained by the lack of dynamical heating of stars in ultrafaint dwarfs. We also find that current microlensing surveys are insensitive to QCD axion stars. While we focus on the gravitational detectability of axion stars, our result can be directly applied to other interesting signatures of axion stars, e.g. their decay to photons, that require as input the abundance, mass, and density distribution of axion stars.