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Primordial Black Holes, Dark Matter, and Gravitational Waves from QCD axion and axion-like particles

Monday, 11 December 2023 14:50 (15 minutes)

This talk is based on the papers arXiv: 2309.01739 and 2307.08185. I present a new mechanism of primordial black hole (PBH) formation from QCD axion in the context of the Peccei-Quinn symmetry breaking during inflation. The axion string-wall network re-enters horizon sufficiently late, so the closed domain walls that naturally arise in the network are sufficiently large to collapse into PBHs. Besides, free axions from the collapse of open walls bounded by strings account for dark matter. This framework yields a PBH abundance of 2.56% in dark matter. This fraction is independent of axion parameters and re-entering horizon temperature, as it is determined by the fixed proportion of closed walls in the network, governed by percolation theory. Intriguingly, our PBHs can naturally explain the gravitational microlensing events observed by the OGLE collaboration. In addition, the collapse of string-wall network will release gravitational waves (GWs), which is drastically different from that in the scaling regime. For certain parameter space of axion-like particles, such GW spectra can possibly explain the reported nHz stochastic GW background and can be tested by various GW interferometry experiments.

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