

Induced Domain Walls of QCD Axion, and Gravitational Waves

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We show that heavy axion domain walls induce domain walls of the QCD axion through a mixing between the heavy axion and the QCD axion, even when the pre-inflationary initial condition is assumed for the QCD axion. The induced domain walls arise because the effective θ parameter changes across the heavy axion domain walls, shifting the potential minimum of the QCD axion. When the heavy axion domain walls collapse, the induced QCD axion domain walls collapse as well. This novel mechanism for producing the QCD axions can explain dark matter even with the axion decay constant as small as $\mathcal{O}(10^9)$ GeV. In particular, this scenario requires domain wall collapse near the QCD crossover, potentially accounting for the stochastic gravitational wave background suggested by recent pulsar timing array observations, including NANOGrav. Using this mechanism, it is also possible to easily create induced domain walls for string axions or axions with a large decay constant, which would otherwise be challenging. We also comment on the implications for cosmic birefringence using induced axion domain walls.

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