

Bias with a Timer: Axion Domain Wall Decay and Dark Matte

We explore the interplay of the post-inflationary QCD axion and a light scalar field for the axion domain wall decay and dark matter (DM). The scalar field possesses a nonzero vacuum expectation value (VEV) during inflation, so that its interaction with the axion effectively serves as an explicit Peccei-Quinn (PQ) violating term. At a temperature below the PQ phase transition, the effective PQ violating interaction generates the axion potential which generally contains multiple degenerate vacua leading to the formation of the axion string-domain wall networks. The following QCD phase transition provides another contribution to the axion potential making domain walls decay before they dominate the Universe. Later, the scalar field starts to relax to the minimum of its potential with a vanishing VEV, turning off the effective PQ violating interaction so that the axion potential is aligned with the QCD vacuum. We keep track of the evolution of the axion-scalar system and discuss the production of the axion DM through the domain wall decay and the (trapped) misalignment. We find that the string-wall network in some cases can decay due to its structural instability, rather than the volume pressure, and the correct axion DM abundance is realized with the decay constant larger than that of the conventional post-inflationary QCD axion without fine tuning.

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