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Multi-axion dynamics and a new resolution of the QCD domain wall problem

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We study the evolution of topological defects in multi-axion models and propose a novel solution to the domain wall problem of the QCD axion.

Multi-axion dynamics, arising from multiple Peccei–Quinn scalars, can lead to qualitatively different defect evolution compared to single-axion models. In particular, networks of cosmic strings and high-tension domain walls tend to form, posing a serious cosmological problem even when the low-energy theory appears to contain only a single axion field.

Applying this finding to the QCD axion, we show that introducing an additional massless or light axion that couples to gluons can resolve the notorious domain wall problem of the QCD axion. In one scenario, the new axion forms strings, and its mixing with the QCD axion confines domain walls into stable string bundles. These bundles may survive until today and generate observable signatures such as gravitational waves, cosmic birefringence, or CMB anisotropies.

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