

Axion Acoustic Misalignment Mechanism

We established a paradigm where the (QCD) axion's novel cosmological evolution, a rotation in field space, simultaneously accounts for the observed dark matter abundance and baryon asymmetry of the Universe: axionogenesis. This rotation is initiated by explicit Peccei-Quinn (PQ) symmetry breaking active in the early Universe as predicted by quantum gravity. Through Standard Model sphaleron processes, the associated PQ charge can be transferred to a baryon asymmetry via axiogenesis or through various extensions involving B-L violation. In earlier work, we demonstrated that axion dark matter can arise from kinetic misalignment, where kinetic energy dominates over potential. More recently, we identified a novel origin of axion dark matter arising directly from axion rotation: fluctuations in axion rotation energy—sourced by adiabatic or isocurvature perturbations—manifest as phonon modes of the PQ charge condensate. These fluctuations redshift to behave as axion cold or warm dark matter. We present this axion acoustic misalignment mechanism and its implications for predictions across a range of axiogenesis scenarios.

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