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Axion Domain Walls, Small Instantons, and Non-Invertible Symmetry Breaking

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Non-invertible global symmetry often predicts degeneracy in axion potentials and carries important information about the global form of the gauge group. When these symmetries are spontaneously broken they can lead to the formation of stable axion domain wall networks which support topological degrees of freedom on their worldvolume. Such non-invertible symmetries can be broken by embedding into appropriate larger UV gauge groups where small instanton contributions lift the vacuum degeneracy, and provide a possible solution to the domain wall problem. We explain these ideas in simple illustrative examples and then apply them to the Standard Model, whose gauge algebra and matter content are consistent with several possible global structures. Each possible global structure leads to different selection rules on the axion couplings, and various UV completions of the Standard Model lead to more specific relations. As a proof of principle, we also present an example of a UV embedding of the Standard Model which can solve the axion domain wall problem.

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