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Cosmic strings and domain walls of the QCD quark condensate with and without a hidden axion

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The chiral quark condensate of QCD, which spontaneously breaks the anomalous axial symmetry, gives rise to axionic type global string-wall systems. If a Peccei-Quinn type axion exists in the theory, the axionic strings are in general accompanied by winding of the QCD quark condensate. Depending on the axion model the winding can proceed either in the η' or in the pion direction. This determines the structure of fermionic zero modes and the anomaly inflow which has important astrophysical consequences. We point out that η' and pion string-wall systems exist in pure QCD, independently of the hidden axion. Strikingly, even if a hidden axion exists, the early cosmology can be entirely dominated by string-wall systems formed by the QCD quark condensate. We also discuss their role in the QCD phase transition and in heavy-ion physics.

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