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The inflated Chern-Simons number in spectator chromo-natural inflation

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The chromo-natural inflation (CNI) scenario predicts a potentially detectable chiral gravitational wave signal, generated by a Chern-Simons coupling between a rolling scalar axion field and an $SU(2)$ gauge field with an isotropy-preserving classical background during inflation. However, the generation of this signal requires a very large integer Chern-Simons level, which can be challenging to explain or embed in a UV-complete model. We show that this challenge persists in the phenomenologically viable spectator field CNI (S-CNI) model. Furthermore, we show that a clockwork scenario giving rise to a large integer as a product of small integers can never produce a Chern-Simons level large enough to have successful S-CNI phenomenology. We briefly discuss other constraints on the model, both in effective field theory based on partial-wave unitarity bounds and in quantum gravity based on the Weak Gravity Conjecture, which may be relevant for further explorations of alternative UV completions.

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