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Peer Review

Review of: "Superexcitability in Chiral Oscillators with Spatial Degrees of Freedom"

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This engaging preprint proposes a simple yet expressive “c-spin” model that couples positional and orientational dynamics to reveal a rich repertoire of active-matter phenomena, notably robust vortex/antivortex complexes with spin–momentum locking and an apparent coexistence of an ordinary synchronization transition with a topological activation of defects. The strengths are clear: a transparent agent-based formulation, a convincing qualitative and statistical characterization across regimes (types 1–3), compelling robustness demonstrations, and an illuminating exploration of system-size effects that morph single vortices into intricate transport networks. That said, several points need tightening to meet the paper’s ambitious claims: (i) provide a precise, quantitative definition and measurement protocol for the topological charge and “dissipationless” transport (energy/entropy budgets, fluxes), and clarify the protection mechanism beyond phenomenology; (ii) formalize the phase-transition picture (order parameter manifolds, homotopy where applicable, finite-size scaling), and benchmark against known BKT/Kuramoto/swarmalator results; (iii) reconcile an apparent inconsistency in the scaling law for the onset of type 2 states (the text states $\Delta\_low(N)=aN$, but subsequent arguments and the $N=1000$, $\Delta\approx0.01$ example imply $\Delta\_low\approx a/N$, with $a\approx12$); (iv) expand on numerical details (integrator, timestep, convergence, sampling statistics, error bars) and report uncertainty on fitted exponents/coefficients; and (v) temper comparisons to topological insulators or substantiate them with linear-response/edge-mode analogs or continuum reductions. With these clarifications, especially a rigorous treatment of invariants, scaling, and energetics, the manuscript would offer a compelling, well-grounded contribution linking active synchronization to topological organization. As for experiments related to your proposal, see my recent articles in Physica B (2025), BioSystems (2025, 2026), https://authors.elsevier.com/a/1mShj14z5IH28t (will expire soon), as well as arXiv (note similarity with a thresold transition).

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Declarations

Potential competing interests: No potential competing interests to declare.