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Coarsening dynamics of a spinor condensate in the broken-axisymmetric phase

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Non-equilibrium systems underpin a range of phenomena and can often evolve to form emergent structures. Understanding these fundamental processes advances our grasp of complex physical behaviour, and remains a central challenge of physics. One method to drive a system out of equilibrium is via a quench, such as dropping temperature or applying a magnetic field. If this instantaneous shift is done over a phase transition, it breaks a symmetry in the system. This forces the system to locally choose a new ground state, forming domains. One rich aspect of these dynamics is involved in the late-time ordering of these domains. As domains grow and compete for the equilibrium phase, their growth can become scale-invariant, with domain size growing according to a universal scaling law $L(t) \sim t^{1/z}$.

We study the universal coarsening dynamics of spin domains in a ferromagnetic spin-1 condensate in a two-dimensional geometry. The system can be quenched by tuning external Zeeman fields, giving rise to a variety of magnetically ordered phases. When the system is magnetised perpendicular to the applied Zeeman fields, the ordering of spin domains is well understood and yields a universal coarsening exponent of $z \approx 1$. Our study focuses on how the late-time dynamics shift as we tune the magnetisation out of the plane and in line with the applied field. With large enough tilt out of the perpendicular plane, the system crosses over to a different universality class with universal coarsening characterised by $z \approx 2$. We further analyse the role of topological defects (vortices) in the coarsening behaviour.

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