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Confining collective motion DENIS BARTOLO, ANTOINE BRICARD, JEAN-BAPTISTE CAUSSIN, ENS Lyon, DEBASISH DAS, UCSD, CHARLES SAVOIE, VIJAYAKUMAR CHIKKADI, ENS Lyon, KYOHEI SHITARA, Kyushu University, OLESKAR CHEPIZHKO, Odessa National University, FERNANDO PERUANI, 61030775, DAVID SAINTILLAN, UCSD — Confined active materials are often found to display self-organization in the form of a macroscopic steadily rotating vortex, yet a unified description of the formation and structure of this pattern based on microscopic interaction rules remains lacking. We use a combination of experiments, numerical simulations and theory to address this question in the case of a confined population of colloidal rollers. We first demonstrate experimentally that upon increasing density this system undergoes a continuous phase transition from a dilute isotropic-gas phase to a heterogeneous polar-liquid phase. In the ordered phase, the entire population self-organizes into a single vortex lying at the onset of a phase separation.Numerical simulations confirm the existence of this non-equilibrium phase transition, and make it possible to single out the very ingredient responsible for the emergent-vortex structures: the competition between alignment and repulsive interactions. Building on this observation, we also establish a continuum theory and lay out a strong foundation for the description of emergent collective behavior in a broad class of motile populations constrained by geometrical boundaries.

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