Abstract Submitted
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Phase transitions and solitons in a rule-based model of active particles THOMAS IHLE, North Dakota State University — I study the Vicsek model [Phys. Rev. Lett. **75** (1995) 1226] by means of kinetic theory. In this non-equilibrium model, self-driven particles try to align their travel directions with the average direction of their neighbours. At strong alignment, rotational symmetry is spontaneously broken and a global flocking state forms. The alignment is defined by a stochastic rule, not by a Hamiltonian. The corresponding interactions are non-additive and are typically of genuine multi-body nature. Due to this and the discreteness of the time evolution, the kinetic equations are different from the usual ones found in textbooks. I derive the phase diagram for the flocking transition and show that it agrees very well with simulations at large particle velocities and is qualitatively different from the one of a continuous version of the Vicsek-model. The theory starts with the Liouville equation, the hydrodynamic equations are derived by a Chapman-Enskog expansion. These equations contain more terms than previously postulated; their coefficients are given in terms of microscopic parameters. I show how a large-wavelength instability of the flocking state leads to an inhomogeneous soliton state which is very stable and shows a first-order phase transition to the disordered state. I determine the speed of the solitons, investigate the hysteresis of the transition and estimate the system size beyond which the first order nature of the transition should be visible in computer simulations.

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