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Enskog-theory for stochastic models with self-propelled and passive particles ALEMAYEHU GEBREMARIAM, THOMAS IHLE, Department of Physics, North Dakota State University — Macroscopic evolution equations for interacting many-body systems do not just "emerge"; they follow from microscopic laws. However, it is often difficult to quantitatively establish this link, especially for systems which cannot be described by a Hamiltonian and which do not have pairwise additive interactions. Therefore, the general form of the macroscopic equations is usually obtained by symmetry arguments. Here, using a particle-based model with discrete time evolution steps for fluid flow I show how the macroscopic transport equations can be rigorously derived from microscopic collision rules. The approach starts with the full N-particle Liouville equation and leads to a multi-particle Enskog-equation which is treated by a Chapman-Enskog expansion. No linearization or single-relaxation time approximation of the collision operator are needed. The obtained thermo-hydrodynamic equations show excellent agreement with previous numerical results. The same approach is used to study a simple model of self-propelled, swarming birds. This model was proposed by T. Vicsek et al. [Phys. Rev. Lett. **75** (1995) 1226]; it has "multi-particle collisions" where birds within some interaction range align their flying directions. I analytically analyze the collision-operator for small and large bird density, and derive the hydrodynamic equations for the density and velocity fields.

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