

Pressure and state functions of self-propelled particles including hydrodynamic interactions

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Self-propelled particles, such as E. Coli bacteria or self-diffusiophoretic swimmers are one of the easiest examples of active systems. These particles are able to convert intrinsic or environmental free-energy into systematic self-propulsion and are therefore permanently driven out of thermodynamic equilibrium. Nevertheless, pressure, the mean mechanical force acting on a confining wall, is still well-defined. Assuming Brownian Dynamics, the pressure of self-propelled spherical particles does even fulfill an ideal gas-like state function, independent of the explicit wall-particle interaction [1]. More generally, the existence of a state function is conditioned by the absence of wall-induced torques and the type of interaction between the active particles [1]. We are interested in how these results change when using a different model for describing the interaction with the solvent, such as the Multi-particle-collision dynamics technique [2], which includes hydrodynamic interactions between the self-propelled particles. Even for spherical particles, hydrodynamic torques can arise and make an equation of state less likely to exist.

[1] A.P. Solon et al., Nature Physics 11, 673–678 (2015)

[2] G.Gompper et al., Advances in Polymer science 221 p. 1 (2009)