Negative thermophoresis in the strong coupling regime

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Negative thermophoresis (a particle moving up the temperature gradient) is a somewhat counterintuitive phenomenon that has thus far eluded a simple thermostatistical description. We will show that a thermodynamic framework based on the formulation of a Hamiltonian of mean force has the descriptive ability to capture this interesting and elusive phenomenon in a straightforward fashion. We propose a mechanism that describes the advent of a thermophoretic force acting from cold to hot on systems that are strongly coupled to a nonisothermal heat bath [1]. When a system is strongly coupled to the heat bath, the system's eigenenergies become effectively temperature-dependent. This adjustment of the energy levels allows the system to take heat from the environment, and return it as work. This effect can make the temperature dependence of the effective energy profile nonmonotonic. As a result, particles may experience a force in either direction depending on the temperature.

[1] R. de Miguel and J. M. Rubi, Phys. Rev. Lett., 123, 200602 (2019)