Anisotropic Particles under Thermal Fields: How Non-Equilibrium Coupling Effects Alter Transport Properties

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Particle anisotropy can confer striking thermophysical properties to fluids and materials. For example (among other factors), the structure and dynamics of polymers depend crucially on the chain length, and the isotropic-nematic phase transition in liquid crystals is determined by the aspect ratio of the particles. We demonstrate that temperature gradients can be used to manipulate materials comprised of anisotropic particles with three examples. (1) Anisotropic colloids, where an inhomogeneous mass distribution can bias rotational diffusion, altering the Soret coefficient of the colloidal suspension [1]. (2) Molecular mixtures, in which components can be separated based on their internal mass distribution, introducing a new contribution to the isotopic Soret effect. (3) Liquid and supercritical acetonitrile (a polar fluid), where a temperature gradient can induce an electrostatic field, leading to a decrease in thermal conductivity [2]. These results suggest a variety of potential applications: from using temperature gradients as sensing probes, to thermophoretic transport, to waste heat recovery.

References

[1] O. R. Gittus, J. D. Olarte-Plata and F. Bresme, Eur. Phys. J. E, 42, 90 (2019)

[2] O. R. Gittus, P. Albella and F. Bresme, J. Chem. Phys., accepted, (2020)