Soret-driven convection in colloidal suspensions

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Convection in colloidal suspensions of solid particles is characterized by the interplay between thermophoresis, sedimentation and Brownian diffusion. Their coupled effects is represented by a dimensionless parameterβ and experiments by Chang et al. (2008) have shown that for a given set of experimental parameters, β a function of the particle radius r_p with the function $\beta(r_p)$ having the shape of an inverted parabola with two roots in the range $5nm \leq r_p \leq 125nm$. We investigate both the linear and nonlinear convection in a suspension of solid particles using a particulate medium in a Rayleigh-Bénard geometry set-up. The analysis focuses on the particle dominated convection regime for which the onset is steady and to disturbances having infinitely long wavelength. For $0 < \beta \ll 1$, which corresponds to particle size near the two roots of $\beta(r)$, we retrieve the instability threshold conditions for the binary mixture model. For $\beta = O(1)$, we show that, unlike the binary mixture model, the conditions for instability onset can be mapped to corresponding experimental parameters. A nonlinear evolution equation is derived and its predictions compared to those of a similar equation for the binary mixture case.