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Electrohydrodynamic interactions in Quincke rotation: from pair dynamics to collective motion DEBASISH DAS, DAVID SAINTILLAN, University of Illinois, Urbana-Champaign — Weakly conducting dielectric particles suspended in a dielectric liquid can undergo spontaneous sustained rotation when placed in a sufficiently strong dc electric field. This phenomenon of Quincke rotation has interesting implications for the rheology of these suspensions whose effective viscosity can be reduced by application of an external field. While previous models based on the rotation of isolated particles have provided accurate estimates for this viscosity reduction in dilute suspensions discrepancies have been reported in more concentrated systems where particle-particle interactions are likely significant. Motivated by this observation we extend the classic description of Quincke rotation based on the Taylor-Melcher leaky dielectric model to account for pair electrohydrodynamic interactions between identical spheres using method of reflections. We also consider the case of spherical particles undergoing Quincke rotation next to a planar electrode, where hydrodynamic interactions with the no-slip boundary lead to a self-propelled velocity. The interactions between such Quincke rollers are analyzed, and a transition to collective motion is predicted in sufficiently dense collections of many rollers, in agreement with recent experiments.

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