Inertial and inertialess 3D-dynamics of an active Brownian particle in plasma

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Active Brownian motion in a viscous medium is generally considered inertialess and highly overdamped. However, inertial effects can significantly alter particle dynamics when the medium's viscosity is reduced or rotational diffusion is enhanced, whether through active mechanisms or external actions. These phenomena can be realized in experiments with light-absorbing particles in weakly ionized plasma [1], potentially facilitating the observation of a transition from overdamped to underdamped motion. Such experimental approaches offer significant potential for fundamental studies of active matter, allowing for the control of dissipation over a wider range than is possible in active systems within liquids [2]. This study experimentally investigated the three-dimensional dynamics of an inhomogeneously light-absorbing particle levitating in a glow discharge, considering various laser intensities and surrounding medium viscosities. Motion regimes were determined by analyzing particle trajectories and oscillation spectra under different environmental and irradiation conditions. Calculations were performed for mean squared displacements (MSD) and average kinetic energies. The research was funded by the Russian Science Foundation (project No. 24-22-00130).

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