Influence of buffer gas pressure on the dynamics of active Brownian particle in RF discharge plasma

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An experiment was conducted to study the evolution of active Brownian systems [1]. A voltage with a frequency of 13.56 MHz was applied to an RF electrode with a parabolic shape cavity in argon, creating a RF discharge. Spherical plastic particles with partial molybdenum coating were injected into the near-electrode zone. The particles were charged by electron and ion fluxes and levitated above the center of the electrode. Upon illumination with a laser, a temperature gradient was formed on the particle surface, resulting in a radiometric force whose direction changed stochastically due to rotational diffusion. The particle motion was recorded using a high-frequency video camera. During the experiment, the buffer gas pressure in the discharge was varied (1 Pa, 10 Pa, and 30 Pa), influencing the regime of motion of the active particle. The overdamped, underdamped and crossover regimes of motion were obtained. The dependence of the mean first-passage time dynamic entropy [2] on the coarsening parameter, the value of the fractal dimension of the particle trajectories, and its localization area were obtained. The crossover region between ballistic and diffusion regimes of the MFPT function from the buffer gas pressure is investigated.

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