Experimental investigation of the conditions for torsion formation in a pair of vertically aligned particles in a gas-discharge plasma

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The torsional motion of a pair of dust particles in a radio-frequency discharge plasma was investigated. Nonreciprocal interparticle interactions mediated by an ion wake were considered as a mechanism sustaining the motion. The directed ion flow in the discharge sheath produced a region of enhanced positive ion density downstream of a negatively charged particle. The influence of this region on a neighbouring particle rendered the effective interparticle interaction nonreciprocal [1].

The aim of this study was to investigate the three-dimensional dynamics of the particle pair as the gas pressure and discharge power were varied, and to identify the conditions for the transition to torsional motion. In the experiment, synchronised photographs of the two particles were acquired using two cameras at different gas pressures and discharge powers. The images from each camera were processed separately to determine the particle positions. Images acquired at the same instant were then matched, and the three-dimensional particle coordinates were reconstructed. The resulting sequences of reconstructed positions were used to obtain the three-dimensional particle trajectories. The discharge parameters at which the particle pair underwent a transition to torsional motion were identified. Analysis of the three-dimensional trajectories enabled the spatial dynamics of the pair to be characterised.

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