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Study of vortex flows of dust particles in a plasma KIL-BYOUNG CHAI, RYAN MARSHALL, PAUL BELLAN, Caltech — Vortex motion of dust particles in a plasma has been studied both theoretically and experimentally. In the theoretical study, the ion drag force acting on the dust particle is found to be non-conservative and to have a finite curl because the gradient of $|\mathbf{u}_i|$and the gradient of n_i are not parallel. The finite curl of the ion drag force acts as a source of vorticity; kinematic viscosity dissipates the generated vorticity. We confirm that vortex flows of micron size dust grains are observed where finite curls of the ion drag force are expected to exist in the Caltech ice dusty plasma experiment. The direction and velocity of the vortex flows are in good agreement with the values predicted by our model. We also found that vortex motion is only observed when the ion density exceeds a threshold value. Above the threshold value, the observed vorticity increases as the ion density increases as predicted by the theory. These observations support the conclusion that the vortex flows in the experiment result from the finite curl of the ion drag force (i.e., non-conservative force).

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