Numerical simulations of dust charging in magnetized plasmas

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Dust grains immersed in plasma are charged by plasma and other currents, and will usually acquire net negative charge. Charged dust grains will interact with each other via screened Coulomb potentials and under certain conditions can exhibit collective phenomena [1]. Both the dynamic and structural properties of dusty plasmas strongly depend on the dust charge and also on plasma screening.

Under certain conditions the charging of dust grains becomes asymmetric. An example is a grain in flowing plasma, when a wake will form downstream of the grain. The resulting wakefields can play an important role in the non-reciprocal interaction between the grains, and can align grains in the direction of the flow [2, 3]. Another reason for symmetry breaking is the magnetic field that restricts the plasma dynamics. While dust charging and wake formation in unmagnetized plasmas has been subject to many studies, charging in weakly and strongly magnetized plasmas is still not well understood.

This work presents results from numerical particle-in-cell (PIC) simulations of charging of a single dust grain in weakly and strongly magnetized plasmas. Both stationary and flowing plasma conditions are considered. Structural properties of the wake and the effects of the magnetized wake on the dust grain interactions are investigated. It is demonstrated that the wake size and strength can be significantly affected by the presence of the magnetic field.

References