ORIGINAL PAPER

The Kinetic of Dust with Different Sizes in a Magnetized Collisional Plasma Sheath

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Abstract The characteristics of dust are investigated in a magnetized plasma sheath with taking into account the gravitational force and collisions between dust and neutral. The model is based on using fluid method and solving the basic equations of fluid method numerically. As the Lorentz, gravitational and collisional forces depend on the dust radius, the numerical calculations are done for different values of dust radius. It enables us to study the effects of dust size on dust dynamics in a magnetized plasma sheath.

Introduction

The problem of the dusty plasma has been extensively studied in many articles during the past several years because of the frequent occurrence of dust particles in space and laboratories [1, 2]. Dust grains often accumulate near the plasma boundary and cause contamination to substrates and wafers. Thus, it is important to understand the dust characteristics under the action of various forces in order to control dust transport. Here we present studies on dust particle dynamics in a sheath region.

"Sheath" is a thin positive space charge layer extending over several electron Debye length which shields the neutral bulk plasma from the wall having negative potential. A good understanding of sheath dynamic is necessary in a number of contexts, including the simulation of ion beam formation and including the plasma source ion implantation (PSII) process—a promising technique for surface modification.

Because of the sizes, charges and mass densities of dust, in compare with the negative ions, the effects of dust particles on plasma sheath are different from ions effects [3]. Among the models developed to study the dusty plasma sheath [4–6], we use the fluid model since the dust grains are collectively treated as fluid. Assuming that the plasma sheath is under the effect of an external magnetic field, we consider the electromagnetic, gravitational and neutral collisional force on dust particles. Considering these forces, we study the dust dynamics for dust particles having different radiuses. Changing the radius of dust makes the mentioned forces change. In next section, we mention the essential equation in fluid method and then we solve these equations numerically for different values of dust radius.

Model

Following some correlative works [7–10], we consider that the plasma sheath is in constant external magnetic field which embedded in x–z plane and makes θ angle with x-direction. The x-direction is taken as the depth direction from plasma edge to the wall. Also we consider the sheath region at the boundary of one-dimensional stationary dusty plasma whose constituent are isothermal electrons, fluid ions and cold charged dust grains.

We assume the variable parameters which characterize the sheath dynamics change only in depth direction. At the sheath edge $x = 0$, the electrostatic potential is taken to be zero.

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