Topic number: 7

On the levitation of the large dust in the magnetized, collisional plasma sheath

B. P. Pandey[*,1,2], A. Samarian[2], S. V. Vladimirov[2], Yu. Tyshetskiy[2]

[1]*Department of Physics, Macquarie University, Sydney, NSW 2109, Australia.*
[2]*School of Physics, University of Sydney, NSW 2006, Australia.*

[*] *bpandey@ics.mq.edu.au*

The dynamics of sheath is of great importance in a number of areas viz. plasma ion implantation, high-density computer chip development, diamond like film deposition, nuclear fusion etc. In plasma processing, where a target object is immersed in the plasma and pulsed repeatedly to a large negative voltage, a sheath is formed that expands in the ambient plasma. The plasma sheath characteristic is a sensitive function of the plasma parameters such as ion-neutral collision frequency and plasma drag forces. In the absence of collision and plasma drag, the grains of smaller size can be levitated inside the sheath. Often the balance between the gravitational and sheath electrostatic force on the grain is used to infer the charge on the grain. In the absence of gravity, the dust performs an inward spiralling motion inside the sheath before settling around a small region. In the presence of gravity, the dust travels much deeper inside the sheath as part of repulsive electrostatic force on the grain is offset by the attractive gravitational force.

The present study focuses on investigating the dust dynamics in a magnetized sheath in the presence of magnetized electrons and ions for varying plasma magnetization. We also investigate the effect of the changing plasma – neutral collision frequency on the dust dynamics. The drag forces acting on the dust due to both the electrons and ions are important. The electrostatic force becomes important closer to the wall and may modify the dust trajectory considerably. The dust charge is a function of the sheath potential as well as the dust radius. The dust charge implicitly depends on the plasma-neutral collision frequencies as well as on the plasma magnetization. More negative charge dust moves only a short distance inside the sheath before it is forced to turn back due to electrostatic repulsion which overcomes the bulk drag force. One can infer that if dust becomes sufficiently negative, it will not be able to penetrate the sheath at all. The plasma pressure and ambient magnetic field will determine the critical size of a dust that can be effectively employed for probing the sheath characteristics. We present a detailed study of the dependence of the dust motion on various parameters.