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ORIGINAL ARTICLE

Dynamical behaviors of size graded dust grains levitated in robust sheath in inhomogeneous plasmas

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Abstract Our interest is to study the sheath formation in an inhomogeneous plasma coexisting with an interaction of weak ionization. Pseudopotential analysis has been employed to derive the coherent structures of sheath in plasma. It has shown that the ionization affects the growth of sheath in plasma and nature depends fully on plasma constituents as well. After getting a robust sheath, dynamical behaviors of a levitated dust grain into the robust sheath has been studied which, in fact, leads to find the variation of dust potential, dust sizes along with the net force generated on grains. Results are obtained numerical for some typical plasma parameters. It has demonstrated that the plasma constituent effects the clustering of dust grains in different region within the sheath as a result of which dust agglomeration forms nebulons: patches of dust cloud-like structures with changing fleece.

Keywords Nonlinear waves · Sheath in plasmas · Dust clouds

1 Introduction

Studies on nonlinear plasma-acoustic waves, since its concept derived in plasmas by Washimi and Taniuti (1966) and Sagdeev (1966), have spurred many researchers for finding the heuristic properties on plasma acoustic modes and formed a solid platform for experiments and space plasmas. As far the observations concerned, Sagdeev equation displays many inherent features, out of which, findings of sheath formation establishes an uneven competition between theory and experiments as well as satellite observations (Reimann 1981a, 1981b; Havnes *et al.* 1987; Raadu 1989; Nitter and Havnes 1992; Wu et al. 1996). The energy falls through the sheath and regulates both the physical and chemical processes which have been studied earlier in discharge phenomena (Child 1911; Langmuir 1913; Langmuir and Bodgett 1923; Chen 1984) and yields regular applications in industrial plasmas. Many more investigations have been worked out enormously in ideal unmagnetized and magnetized plasmas and receiving day by day much more growing interest in experiments (Reimann 1981a, 1981b) for industrial application as well as support the astrophysical problems (Havnes *et al.* 1987; Nitter and Havnes 1992). Latter, Baishya and Das (2003) studied the sheath formation in magnetized plasma in relation to astrophysical problems along with the dynamical behaviors of a levitated dust grain into the sheath and could be of a growing interest in space physics. Dust grains form different behaviors in dust atmospheres of interstellar space, over Moons' surfaces and other regions of spaces. Again Tian and Gao (2005), Gao and Tian (2006a, 2006b) have studied its evidences in impure dusty plasmas showing the formation of nebulons commonly found in Milky way, Saturn's ring, and pollute the astroplasmas by the clustering of dust grains. Edward (2001) studied the dust dynamics rigorously in various plasma constituents and have shown the role of dust in modifying the sheath, double layers and expects further study, what exactly we are looking forward as for new findings in the formation of nebulons. Very recently Das and Chakraborty (2011a, 2011b) find the reality on the formation of sheath over the Moon surface and thereafter formation of nebulons by the dust grains levitated from Earth's Moon surface. However, all most all the studies made earlier were limited to an ideal homogeneous plasmas, and, in contrast,

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