

## Dust ion acoustic solitary structures at the acoustic speed in presence of nonthermally distributed electrons and positrons

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The Sagdeev pseudo-potential technique and the analytic theory developed by Das *et al.* [1] have been used to investigate the dust ion acoustic solitary structures at the acoustic speed in a collisionless unmagnetized dusty plasma consisting of negatively charged static dust grains, adiabatic warm ions, Cairns [2] distributed nonthermal electrons and positrons. Several authors investigated small or arbitrary amplitude dust ion acoustic solitary structures in different electron-positron-ion-dust plasma systems. But in all those works dust ion acoustic solitary structures have been considered at the supersonic speed only, i.e., for  $U > C_D$ , where  $U$  is the velocity of the wave frame and  $C_D$  is the linearized velocity of the dust ion acoustic wave for long wave length plane wave perturbation. In the present paper, we have studied the dust ion acoustic solitary structures at the acoustic speed i.e., for  $U = C_D$  with the help of the existence domains and the phase portraits of the dynamical system describing the nonlinear behaviour of the dust ion acoustic waves in the same plasma system considered by Paul *et al.* [3]. At the acoustic speed, the system supports both positive and negative potential solitary waves, but does not support the coexistence of solitary waves of opposite polarities. The system also supports negative potential double layer at the acoustic speed, but does not support positive potential double layer. Although the system supports positive potential supersoliton at the supersonic speed, but there does not exist supersoliton of any polarity at the acoustic speed. For the first time, we have introduced the phase portrait analysis of the dynamical system corresponding to the solitary structures at the acoustic speed. Phase portraits of the dynamical system corresponding to different dust ion acoustic solitary structures indicate the difference between the solitary structures at the acoustic speed ( $U = C_D \Leftrightarrow M = M_C$ ) and the solitary structures at the supersonic speed ( $U > C_D \Leftrightarrow M > M_C$ ).

### References:

- [1] A. Das, A. Bandyopadhyay, and K. P. Das, *J. Plasma Phys.* **78**, 565 (2012).
- [2] R. A. Cairns, A. A. Mamun, R. Bingham, R. O. Dendy, R. Boström, P. K. Shukla, and C. M. C. Nairn, *Geophys. Res. Lett.* **22**, 2709 (1995).
- [3] A. Paul, A. Bandyopadhyay, and K. P. Das, *Phys. Plasmas* **24**, 013707 (2017).