6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Dust-charge fluctuation – a revisit

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Dust particles are almost ubiquitous in all kinds of plasmas – ranging from space and astrophysical plasmas to fusion-grade plasmas. With dusty plasma effects, comes the effect of dust-charge fluctuation, which is equally ubiquitous whenever there are dusty plasmas. Recent dusty plasma simulations[1] have indeed demonstrated that dust-charge fluctuation is a very natural effect that accompany the dust-charging process. Earlier theoretical works[2, 3] show how dust-charge fluctuation affects ion-acoustic and dust-acoustic plasma wave regimes, which is also demonstrated through simulations[1]. This talk aims to take a slightly different look at this basic plasma phenomenon based on the possibility of driven dust-charge fluctuation. There were some earlier works in this regard[4, 5] but the topic has largely been unexplored. This talk will be based on some recent theoretical and simulation work that we have been doing. Toward this, we have developed a PIC code with hybrid Monte Carlo collision scheme[1, 4] and also a Flux Corrected Transport (FCT)-based Navier-Stokes solver and we hope to present some recent results.

A similar problem is encountered when a charge accumulation travels across a plasma which can excite nonlinear wave. A typical example of this problem can be found in low earth orbit (LEO) region where nonlinear waves are found to be excited by moving space debris[6]. Although, physics-wise this is fundamentally similar to the driven dust-charge problem, the latter is self-excitation of charge accumulation (or deficiency) resulting out of dust-charge fluctuation driven externally. In this talk, we also try to draw a parallel between these two.

References

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