Artificial voids in nanodusty plasmas

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Artificial voids are an interesting and frequently studied phenomenon in dusty plasmas [1]. Such voids can be created by projectiles shot into the dust cloud or by electrostatic probes. We investigated artificial voids created in nanodusty plasmas at high electron depletion. The video [2] shows the change of the probe void around a floating electrostatic probe moving through the plasma. By variation of the probe voltage, the radius of the probe void can be changed. Figure 1 (Top), shows the U(I)-characteristics of an electrostatic probe at different positions in the plasma. This plasma consists of electrons, ions and dust particles (400 nm diameter) and was created using a reactive argon acetylene plasma. Snapshots of the nanodust cloud are shown in Figure 1 (Bottom) for six different probe voltages. From (a) to (c) the "natural" void and the artificial void coexist, for voltages near the local plasma potential the probe void closes. The collapse of the probe void leads to a destabilization of the whole dust cloud, strong dust streaming and the closure of the natural void are observed.

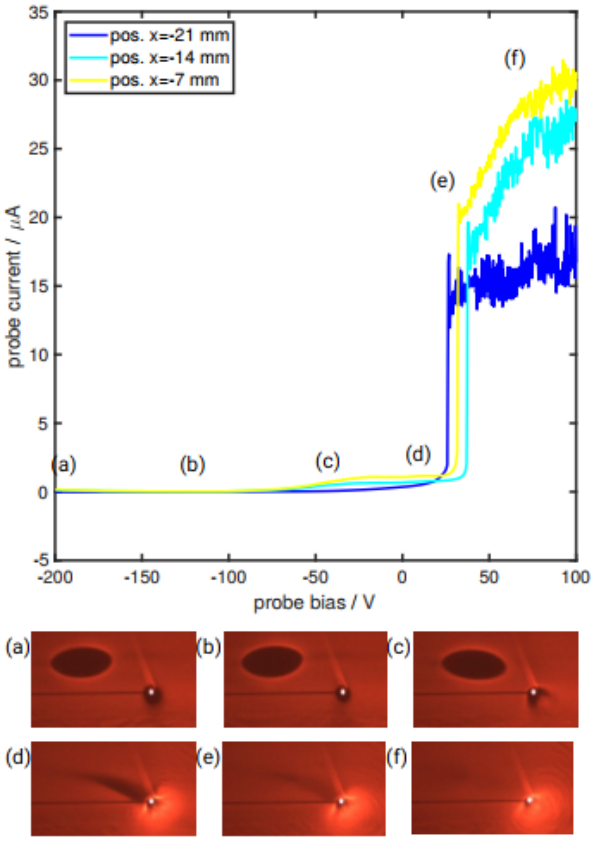

Figure 1: *Top: Langmuir probe characteristics in a nanodusty plasma. Bottom: Images of the nanodust cloud at the voltages marked on the characteristic.*

We present a simple force balance that explains the linear increase of the void radius for probe bias variations in the dust repelling regime (negative probe voltage in reference to the plasma potential). The ability to use force models to estimate the local plasma potential and the consequences for credible Langmuir probe measurements in nanodusty plasmas are discussed.

References

[1] O. Arp et al, PRE, 83:066404, 2011, https://journals.aps.org/pre/abstract/10.1103/PhysRevE.83.066404; M. Schwabe et al, NJP, 19(10), 2017, https://doi.org/10.1088/1367-2630/aa868c; M. Klindworth et al, RSI, 78(3), 2007 https://doi.org/10.1063/1.2714036 ; E. Thomas et al, PoP, 11(5), 2004, https://doi.org/10.1063/1.1688333

[2] Floating electrostatic probe moves through nanodusty plasma https://youtu.be/Nmz2nR8uTrE