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Linear and Nonlinear Dust Acoustic Waves, Shocks and Stationary Structures in a dc-Glow-Discharge Dusty Plasma[1]

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In 1990, Rao, Shukla, and Yu (Planet. Space Sci. 38, 543) predicted the existence of the dust acoustic (DA) wave, a low-frequency ($\sim$ few Hz), compressional dust density wave that propagates through a dusty plasma at a phase speed $\sim$ several cm/s. The DA wave was first observed by Chu et. al., (J. Phys. D: Appl. Phys. 27, 296, 1994) in an rf-produced dusty plasma, and by Barkan et. al., (Barkan et. al. Phys. Plasmas 2, 2161, 1995) who obtained video images of the DA wave trains using light scattering from a dust suspension confined in an anodic glow discharge plasma formed within a Q machine plasma. The dispersion relation for DAWs was measured by Thompson et. al., (Phys. Plasmas 4, 2331, 1997) in a dc glow discharge dusty plasma by modulating the discharge current at a set frequency. DAWs have been investigated by many groups both in weakly-coupled and strongly-coupled dusty plasmas (E. Thomas, Jr., Contrib. Plasma Phys. 49, 316, 2009). In most experiments where DA waves are present, the wave amplitude is relatively high, indicating that they are nonlinear. In this talk, results of our recent experiments on DAWs will be presented. The following experiments, performed in a dc glow-discharge dusty plasma will be described: (1) Observations of spontaneously excited nonlinear, cylindrical DAWs, which exhibit confluence of waves propagating at different speeds. (2) Investigations of self-steepening DAWs that develop into DA shocks with thicknesses comparable to the interparticle separation (Heinrich et. al., Phys. Rev. Lett. 103, 115001, 2009). (3) Measurements of the linear growth rates of DAWs excited in merging dust clouds. (4) The formation of stationary, stable dust density structures appearing as non-propagating DAWs (Heinrich et. al., Phys. Rev. E, in press, 2011). This work was performed in collaboration with S. H. Kim, J. R. Heinrich, and J. K. Meyer.

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