Role of variable charges in space dusty plasmas

A.V. Ivlev (1), V.N. Tsytovich (2), U. de Angelis (3), and G.E. Morfill (1)

(1) Max Planck Institute for Extraterrestrial Physics, Garching, Germany, (2) General Physics Institute, Moscow, Russia, (3) University of Naples "Federico II", Italy

Charges of grains in dusty plasmas are not constant, but fluctuate in time around some equilibrium value which, in turn, is some function of spatial coordinates. Therefore, the mutual collisions of grains as well as the ion-grain collisions do not conserve the particle energy. An appropriate way to investigate evolution of such systems is to employ the kinetic approach. We studied the role of variable charges theoretically and using numerical simulations. For the theoretical analysis we used the Fokker-Planck approach, for the numerical analysis the molecular dynamics simulations were employed. We obtained that the mean particle energy grows in time when the neutral friction is below a certain threshold. The energy of dust grains and ions changes as $\sim (t_{cr} - t)^{-a}$, exhibiting the explosion-like growth, with t_{cr} being critical time scale and a =1-2 is the growth exponent. We discuss applications of these results to space plasma environments where inhomogeneous and/or fluctuating charge distributions are often present. For instance, the discovered instability could operate in protoplanetary disks and affect the kinetics of the planet formation, or it could develop in interstellar clouds and cause ion acceleration, etc.