Dust charge distribution in a plasma afterglow

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Discharging of dust particles in an argon plasma afterglow has been investigated. The study has been carried out using different approaches. First, we have obtained the dust charge distribution function (DCDF) by solving numerically the master equation [1, 2] describing dust discharging as a one-step stochastic process. Second, the DCDF has been calculated as a Gaussian distribution with mean dust charge and variance, which are functions of time [1]. The charge distributions obtained using these two approaches have been found to be very similar. Additionally, results of our calculations have been compared with available experimental data on dust charge distribution in a plasma afterglow [3, 4]. They have been found to be in a good qualitative agreement if the dust discharging model accounts for the emission of electrons in the collisions of argon atoms in excited states with dust particles. The study has been carried out taking into account for multistep ionization and excitation and deexcitation of argon atoms and for the transition from ambipolar to free diffusion in the plasma afterglow. The cases of fast transition and slow transition have been considered, nearly in the same way as in [3]. It has been found that the variance decreases with time in the beginning of afterglow because of decreasing the average dust charge. However, the variance may increase with time in the late afterglow when the ion flux to a dust particle or the secondary emission flux dominate over the electron flux to a dust grain. Different neutral gas pressures and dust radii have been considered. It has been analyzed how the time-dependencies for the mean dust charge, the dust charging time and the variance of the dust charge depend on gas pressure and dust radius. In particular, it has been found that at late afterglow times, the absolute value of mean dust charge may increase with decreasing dust size because of larger charging time.

[1] Shotorban B 2011 *Phys. Rev. E* **83**, 066403

[2] Matsoukas T, Russell M and Smith M 1996 *J. Vac. Sci. Technol. A* **14**, 624

[3] Couëdel L, Samarian A A, Mikikian M and Boufendi L 2008 *Phys. Plasmas* **15,** 063705

[4] Couëdel L, Samarian A A, Mikikian M and Boufendi L 2008 *EPL* **84,** 35002