LABORATORY INVESTIGATION OF ELECTRIC CHARGING OF DUST PARTICLES BY ELECTRONS, IONS AND UV RADIATION

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There exists many cosmic environments where electric charging of dust particles occurs by electrons, ions and UV radiation (e.g. review of Whipple 1981). In case of interstellar dust particles the value of their electric charge can have, for instance, very important consequences for their destruction rate in SNR's shock-waves and can globally influence the overall life cycle of dust particles in galaxies (see e.g. Seab, 1987). There are many phenomena in case of dust particles within the solar system which can be explained by their electric charging with consequent interactions with electromagnetic fields and/or electrostatic fragmentations (see e.g. Morfill and Grün, 1979; Sekanina and Farrell, 1980; Fechtig et al., 1979; Grün et al., 1984; Mendis et al., 1984). Theoretical calculations of charging are often based on unreliable data extrapolated from the results of measurements with plane surfaces (parameters of secondary electron emission, photoemission, capture probalilities of electrons and ions etc.). The experimental laboratory work on the simulation of charging processes and the study of physical phenomena related to them (e.g. electrostatic fragmentation) promise the possibility to improve our knowledge in this field of research. For charging of particles at MPIK we used a vacuum chamber in which particles fall through an electron or ion beam of energies up to 10 kev. Some of the particles attaining the proper charge-to-mass ratio were then suspended in an electrodynamic quadrupole. After isolation of a single particle the charge-to-mass ratio of the particle could be determined from the oscillation frequency of the particle and amplitude and frequency of alternating voltage applied to the quadrupole electrode. The charge itself was possible to determine by means of the charge induced on the metallic cylinder placed below quadrupole, through which the particle is forced to pass after completion of a charging process. In a similar suspension system Vedder (1963,1978) charged particles for subsequent acceleration. The aim of these experiments was, however, to attain maximum charge of dust particles and the charging processes were not explicitly studied. To simulate the cosmic charging processes requires finding out the influence of strong electric field inside quadrupole which can result in induced charge of the particles and in strongly modified energy distributions of electron and ion beams. Furthermore to be determined is the influence of the rest gas because electrons and ions produced by collisional ionization of rest gas can result in significant effects. For measurements at MPIK we used particles of size 1 to 100μm from glass, carbon, aluminium, iron, MgO and very loosely bound conglomerates of aluminium oxide particles. The main aim of initial measurements was to reach high values of charge-to-mass ratio and to study the dependence of maximum attainable charge-to-mass ratio on ion energy and applied voltage (see Svestka et al., 1987). In the course of time the experimental set-up has been improved by e.g. installation of a two dimensional opto-electronic damping system for damping of particle motions at low vacuum pressures, better control of electron and ion beams as well as optical and vacuum system, better characterization of dust particles etc. Measurements of the dependences of maximum attainable charge-to-mass ratio and charge itself on the energy of ion and electron beams at different vacuum pressures and applied voltages have been performed. Further secondary electron emission from particles has been studied by determination of the equilibrium surface potentials of particles at different vacuum pressures and then by solving the set of equations describing respective equilibrium states. At present the similar apparatus for charging of dust particles is under construction at Prague Observatory with the aim to study at the beginning the parameters of the photoemission to UV radiation. Study of photoemission from aluminium, glass and aluminium oxide particles of size 1 to $10\mu m$ under illumination by UV radiation of wavelengths 200 to 300 nm has already begun and preliminary results have been obtained. Results of measurements from both set-ups are presented and possible consequences discussed.

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