Some Properties of Field Ion Emission from SiO₂ Grains

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Probably the most abundant dust in space constitutes silicates. When the dust grain is exposed to energetic electron or ion beams it can attain a large surface potential which is limited by field ion emission. It is generally expected that the field ion emission is controlled by the surface electric field, and pressure and composition of the ambient atmosphere.

In our study, we have used glass dust grains with diameter around one micron charged to several kilovolts. This charging creates the electric field in the range of $10^9$ V/m and observable field ion emission. A positive charge of the dust grain can be reached not only by ion bombardment but, under some circumstances, by electrons as well. Using this fact, we have compared the discharging characteristics of the glass grain charged to the same positive potential under electron and Ar ion bombardments. Contrary to the expectations, both profiles significantly differ (see Figure).

It is interesting to note that the profile of the field emission current that results from electron charging of the glass grain is similar to that observed from ion charging of conducting materials (carbon or gold) that were investigated earlier. The paper discusses in detail possible causes of the observed differences, i.e., a contribution of the ion implantation, effects of the ion bombardment on the electronic structure of the grain material, etc.

Figure: Emission currents from the glass dust grain charged by argon ions (black circles) and electrons prior to the ion bombardment (shadow squares) and after it (shadow triangles) as a function of the surface electric field.