Laboratory simulation of micrometeoroid ablation

Z. Sternovsky (1,2,3), M. DeLuca (1,2,3), E. Thomas (1,4), M. Horanyi (1,2,4), D. Janches (5), T. Munsat (1,4), J.M.C. Plane (6)
(1) IMPACT, University of Colorado, Boulder, CO 80303, (2) Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80303, (3) Department of Aerospace Engineering Sciences, University of Colorado, Boulder, CO 80309, (4) Physics Department, University of Colorado, Boulder, CO 80304, (5) Space Weather Laboratory, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, (6) School of Chemistry, University of Leeds, Leeds, UK. (Zoltan.Sternovsky@colorado.edu)

Introduction

In the Earth's atmosphere, layers of neutral metal atoms (Fe, Mg, Ca, K, Na) with densities peaking between 85 and 95 km are formed by the daily ablation of billions of incoming micrometeoroids. The metallic layers influence the nucleation of noctilucent clouds and impact stratospheric aerosols and O3 chemistry, for example. The dust accelerator facility operated at the University of Colorado is now expanded with a capability to investigate the ablation of micron-sized dust particles. Using a 3 MV Pelletron high voltage generator, the particles are accelerated to velocities relevant to those of micrometeoroids entering Earth's atmosphere (> 10 km/s). The particles are then introduced into a gas cell, where the pressure is maintained in the range of 0.05-0.5 Torr. Over a 30 cm distance within the cell the complete or partial ablation of the particles is achieved. The diagnostics of the ablation process includes photomultiplier tubes and sensitive electronics to detect the generated plasma. A row of collection plates connected to charge sensitive amplifiers is installed along the particles' flight path to collect electrons or ions with spatial resolution. There is an impact detector installed at the end of the path to detect the mass of the remaining particle, if any. The first few sets of measurements have been performed using iron dust particles and nitrogen and oxygen gases. The data analysis is intended to provide insight into the ongoing elemental processes and provide important parameters for modeling. For example, the measured total charge generated by particles that ablate completely in the system provides the ionization efficiency for the ablating elements; a parameter that is critical to the interpretation of meteor radar data. An numerical code is under development to provide the best fit of the data to existing ablation models.

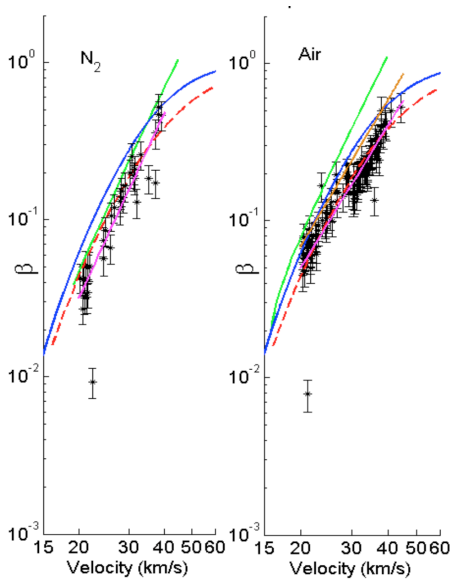

Figure. Ionization coefficient measurements from the experiment (black points) are compared to earlier measurement and the Jones model..

References

E. Thomas, M. Horanyi, D. Janches, T. Munsat, J. Simolka, Z. Sternovsky (2016), Measurements of the Ionization Coefficient of Simulated Iron Micrometeoroids, Geophys. Res. Lett., in revision.