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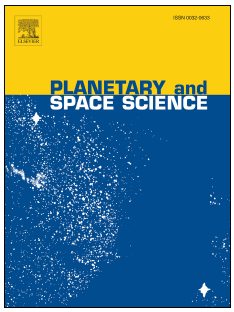

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Laboratory modeling of dust impact detection by the Cassini spacecraft

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Abstract

The paper presents laboratory investigations of the response of a scaled down model of the Cassini spacecraft to impacts of submicron iron grains accelerated to velocities 5-25 km/s. The aim of the study is to help in a detailed analysis and interpretation of signals provided by the RPWS (Radio Wave Plasma Science) instrument that were attributed to dust impacts onto RPWS antennas or spacecraft body. The paper describes the experimental set-up, discusses its limitations, and presents the first results. Both monopole and dipole antenna configurations are investigated. We demonstrate that the amplitude and polarity of the impulse signals recorded by antenna amplifiers depend on the voltages applied onto the antennas or the spacecraft body and briefly introduce the mechanism leading to the signal generation. The experimental results support the recent suggestion by Ye et al. (2016) that antennas operated in a dipole mode are greatly insensitive to dust impacts on the spacecraft body. The pre-peak phenomenon, commonly observed in space, is also reproduced in the measurements and explained as the induced charge on the antenna from the impact plasma cloud that is becoming non-neutral due to the escape of the faster electrons.

Keywords: dust impacts, monopole and dipole antennas, plasma–surface interaction
PACS: 96.50.Dj, 98.38.Cp, 52.27.Lw, 52.40.Hf

1. Introduction

Voltage spikes associated with the impact of high velocity dust particles on a spacecraft have been observed by electric field sensors on several space missions. Voyager and Cassini observed such spikes in conjunction with passage through the rings of Saturn (Gurnett et al., 1983; Wang et al., 2006) and