Search for meteoroid hypervelocity impacts on Earth-orbiting spacecraft

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Dust and meteoroid impacts pose a threat to both manned and un-manned space missions. Even collisions with very small particles can cause satellite anomalies by inducing sudden discharges. When a micrometeoroid hits a spacecraft, it induces an expanding plasma cloud, which can be recorded by electric field probes as brief, high-amplitude voltage spikes. This was first observed on Voyager 2, when it recorded dust grains when passing the G ring of Saturn. Recently more work has been performed on Wind/WAVES instruments orbiting the Sun at the Lagrangian point in the solar wind. The present project was recently initiated to study whether the electric field instruments on different Earth-orbiting satellites could be used to study the near-Earth dust/meteoroid/debris environment. Most of these satellites do not have conventional dust detectors. By employing the electric field method on existing magnetospheric missions such as Cluster with over a decade in orbit, it would offer a chance for systematic monitoring of the Earth's dust environment. In addition the results would provide us with knowledge about which instrumental parameters on-board existing and future Earth-orbiting missions could be used for dust detection and characterization as well as how this could be optimized.

We plan to study how the dust distribution vary inside and outside the Earth's magnetopause, what is the total interplanetary meteoroid mass flux, can the large abundance of interplanetary small-sized dust reach all the way to the altitude where e.g. navigation and Earth resource satellites orbit and how do the damaging effects from impacts depend on geomagnetic activity and properties of the surrounding plasma and neutrals. Efforts to measure the meteoroid number and mass flux have not lead to a full consensus; there are several orders-of-magnitude differences between the different methods. This method can contribute to a better global mass flux estimate. The mass flux is also an important parameter when describing the interaction between the various atmospheric layers. In addition to natural meteoroids and dust in space, debris from earlier space probes grows continuously in amount near Earth. The increasing number of hypervelocity impacts can result in spacecraft anomalies posing a threat against the space born security assets. The proposed project can provide the space community with information that could be used to reduce the risks with hypervelocity impacts.