A DOUBLE HEMISPHRECIAL PROBE (DHP) FOR IMPROVING SPACE PLASMA MEASUREMENTS.

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Langmuir probes have been the most frequently used in-situ instruments for measuring the plasma density, temperature, and spacecraft (SC) potential. However, there are still challenges in the interpretation of Langmuir probe measurements in many scenarios. Due to the interaction of the ambient plasma with the SC and the onboard probe itself, the local plasma conditions are often created around the probe to affect its measurements and consequently introduce errors in the derived plasma characteristics. These local plasma conditions are often anisotropic and/or inhomogeneous, making the measurement and data interpretation of current single Langmuir probes difficult.

Directional probes are able to characterize these anisotropic and/or inhomogeneous conditions. Split Langmuir Probes and Segmented Langmuir Probes have been developed mainly to characterize the plasma flow in Earth's ionosphere. We advance this technology with a Double Hemispherical Probe (DHP) to improve space plasma measurements in the much broader scenarios: i) low-density plasmas; ii) high surface-emission environments; iii) flowing plasmas; and iv) dust-rich plasma environments.

i) Low-density plasmas create large Debye sheaths around the SC that may engulf the Langmuir probe mounted at the end of a boom, causing mischaracterization of the ambient plasma.

ii) High-surface-emission environments are either due to energetic plasmas that cause secondary electron emission, or due to intense UV radiation generating photoemission from the SC or probe itself. These emitted electrons can contaminate the probe measurements.

iii) Flowing plasmas are by definition not isotropic and therefore cause fundamental issues in interpreting the I-V curves. Ions in space are generally far from isotropic w.r.t the SC and thus the probe.

iv) Dust-rich plasma environments will cause dust particles to impact on the probe and SC, generating localized plasma clouds around the probe.

Similar to the split Langmuir probes, the DHP consists of two hemispheres electrically insulated from each other. These two hemispheres are swept with the same voltages simultaneously, yielding two current-voltage (I-V) curves. The addition of the each hemisphere's I-V curve yields the I-V curve that is same to the one of a single spherical probe (SSP) of same radius. The difference currents between the two hemispheres can identify and characterize the anisotropic/inhomogeneous plasma conditions created around the probe, which will be then removed or minimized on the interpretation of their I-V curves. This paper describes the basic concept and design of the DHP sensor, as well as its initial results tested in the laboratory plasma environments.