Testing the Solar Probe Cup, An Instrument Designed to Touch the Sun

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Abstract: Solar Probe Plus will be the first, fastest, and closest mission to the Sun, providing the first direct sampling of the sub-Alfvénic corona. The Solar Probe Cup (SPC) is a unique re-imagining of the traditional Faraday Cup design and materials for immersion in this high temperature environment. Sending an instrument of this type into a never-seen particle environment requires extensive characterization prior to launch to establish sufficient measurement accuracy and instrument response. To reach this end, a slew of tests are created for allowing SPC to see ranges of appropriate ions and electrons, as well as a facility that reproduces solar photon spectra and fluxes for this mission. Having already tested the SPC at flight like temperatures with no significant modification of the noise floor, we recently completed a round of particle testing to see if the deviations in Faraday Cup design fundamentally change the operation of the instrument. Results and implications from these tests will be presented, as well as performance comparisons to cousin instruments such as those on the WIND spacecraft.

What is SPC?

The Solar Probe Cup (SPC) and the Solar Probe ANalyzers (SPAN) form the plasma instruments in the Solar Wind Electrons Alphas and Protons suite on Solar Probe Plus (SPP). The spatial resolution of these instruments operating together is illustrated in the model below:

To the Edge of the Corona

SPC is a Faraday Cup

A Faraday cup operates by:
1. Using a voltage biased, variable-value modulating grid which selectively prevents or permits portions of the plasma population with E/q greater than the modulating bias voltage.
2. Collecting the charged particles on rear collector plates, obtaining a current, often in picoamperes.

The Solar Wind Facility (SWF) exposes SPC to a range of ion and electron distribution energies. Abbreviations are as above. Error bars are centered about points of measurement, with solid lines as Gaussian fits. Using x = (Vb-V0)/dV scales signal in all energy windows to a normalized value, allowing for direct comparison between energy windows of different amplitude as well as between model & experimental results.

Where Are We Now?

To the Edge of the Corona

SPC measures a cold ion population over a range of energies. (July 2014) Abbreviations are as above. Error bars are centered about points of measurement, with solid lines as Gaussian fits. Using x = (Vb-V0)/dV scales signal in all energy windows to a normalized value, allowing for direct comparison between energy windows of different amplitude as well as between model & experimental results.

Comparison to Past Faraday Cups

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