Geophysical Research Abstracts
Vol. 20, EGU2018-18395-1, 2018
EGU General Assembly 2018

Characterization of the White-Light F-Corona from STEREO/SECCHI Observations: Properties of the Circumsolar Dust Distribution

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The F-corona arises from sunlight scattered by the dust in orbit about the Sun. We have performed an analysis of the images taken by the STEREO-A/HI-1 instrument between December 2007 and March 2014 to (1) characterize the white-light F-corona, and (2) infer the orbital parameters of the surface of symmetry of the Zodiacal dust cloud. We found that both the inclination and ascending node are not constant in the field of view of HI-1 (4° to 24° elongation), but are functions of the elongation angle, i.e. the distance to the Sun. The values derived are slightly different from the parameters determined from the Helios mission. The elongation dependence reflects the gravitational influences of Jupiter, Venus and the Sun as well as of the Lorentz and Poynting-Robertson forces on the dust particle orbits, which implies that the dust is charged. The inferred center of symmetry is not at the Sun's center, but is offset by about 0.5 solar radii in the direction of the average position of Jupiter during the epoch studied. This average offset was estimated from both the observed difference in the latitudinal displacement of the surface of symmetry to both sides of the line of nodes and the radial brightness asymmetry. We also measured a slight difference in the inclination of the surface of symmetry north or south of the ecliptic. We suggest this may be due to remnant dust in the orbits of the Kreutz sun-grazing comets, which occur at an average rate of one every 2-3 days. We also found that the brightness of the F-corona is very dependent on the exact location of the STEREO-A S/C along its orbit (i.e. its position with respect to the surface of symmetry of the dust cloud). The geometric properties (e.g., flattening index) are found to be a function of elongation. Moreover, a per-orbit analysis showed that a secular variation of the intensity profile of the photometric axis of the F-corona of about 0.1% exists. The time progression of the variation was found to be in opposite sense to the absolute value of the angular distance between the mean longitude of Jupiter during the given orbit and the perpendicular to the line of nodes.

This study is part of a program we have begun to establish a baseline of the dust observations in preparation for the observations from the upcoming Parker Solar Probe (PSP) and Solar Orbiter (SolO) missions. As the dust particles evaporate we expect to see the F-coronal brightness correspondingly decrease. The detectability of the decrease will depend on the amount of dust evaporating, but a 10% change in the density is easily detectable. If a dust free zone surrounding the Sun exists, it will affect the F-coronal intensities observed by PSP and SolO by an observable amount.

We gratefully acknowledge the support of NASA.