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Properties of polar plumes from white-light observations with the SOHO/LASCO-C2 coronagraph

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The polar regions of the solar corona exhibit, mostly during solar minima, faint ray-like structures which apparently outline the polar magnetic field lines. In order to understand the spatio-temporal characteristics of these plumes, we analyzed a sequence of continuous observations obtained with the SOHO/LASCO-C2 coronagraph over a period of 3 days with a time resolution of less than 10 minutes (400 images). We generated sinograms where the intensity of the plumes is plotted as a function of their angular positions (x-axis) and as a function of time (y-axis). Application of the Hough transform allowed to unambigously defines the trajectories of individual plumes, i.e., sinusoidal curves resulting from their solid-body rotation. However the paths are "dotted", indicating that the plumes are enduring structures that are only transiently lit. This on-off behavior takes place on time scales as short as 2 hours. Tracking individual plumes and stacking their radial profiles allowed to characterize the flow in the plumes and we found typical velocities ranging from 250 to 600 km/sec (median value of 400 km/sec). Our analysis shows that plumes appear as the projection of a fractal distribution of electrons onto the plane of the sky. The physical parameters of the fractal distribution have been obtained from numerical simulations of coronal images. In particular, we found a fractal dimension of 2.9 for the initial electronic distribution.

Reference

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