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Sensitivity of solar off-limb line profiles to electron density stratification: the contribution of polar plumes

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Observations recorded in the polar coronal holes show very broad line profiles emitted by heavy species. Understanding the origin(s) of this broadening is fundamental to address the source(s) of heating and acceleration of the coronal plasma. Generally, these broad profiles are interpreted in terms of ion-cyclotron waves. Here we investigate the effect of the electron density stratification on the line-of-sight integrated radiance profiles of different atomic species (H I, O VI and Mg X) formed in solar coronal holes. The large scale coronal magnetic field is obtained from an analytical 2-D model providing a good representation of the corona at the solar cycle minimum. We use the mass-flux conservation to determine the outflow speed of the solar wind plasma. We do not consider any anisotropy in the kinetic temperature of the coronal species.
We find that at distances greater than 1 $R_\odot$ from the solar surface the widths of the emitted lines by heavy species (namely O VI and Mg X) are very sensitive to the details of the adopted electron density stratification. However, H I Ly-α, which is a pure radiative line, is less affected. The calculated total radiances of Ly-α and the O vi doublet depend to a lesser degree on the density stratification and are comparable to the observed ones for most of the considered density models. The widths of the observed profiles of Ly-α and Mg X are well reproduced by most of the electron density stratifications considered, whereas only a few stratifications give satisfying results for the O vi doublet. The densities deduced from SOHO data result in O vi profiles whose widths and intensity ratio are relatively close to the values observed by UVCS although only isotropic velocity distributions are employed. This result suggests that the need for a strong anisotropy of the velocity distribution is not so clear as previous investigations of UVCS data suggested.
The contribution of polar plumes is also taken into account. We consider the same magnetic field model for both plumes and inter-plumes areas, but different velocity and density stratifications. We show that the narrow components observed by UVCS can be the contribution of denser plumes or concentration of polar plumes along the line of sight. We obtain constraints on the dynamics and on the outflows in the polar plume structures.