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On the role of radial expansion and Coulomb collisions in shaping the electron velocity distribution function: comparison between kinetic simulations and observations.

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By means of fully kinetic simulations we show that the combined effect of particle's binary collisions and spherical expansion naturally leads to the generation of two populations in the electron velocity distribution function (eVDF): a collision-dominated cold and dense population almost isotropic in velocity space and a tenuous field-aligned and anti-sunward drifting population. The main characteristics for the two populations observed in the simulations (relative widths , drift velocities, temperature anisotropies and radial gradients) appear to be in excellent agreement with those observed in the core and strahl populations of the solar wind electrons and result to be correlated to the ratio between the collisional time and the solar wind expansion time. Even though collisions are able to shape the eVDF, the heat flux observed in the simulations can be conveniently described by a collisionless model where a fraction of the electron thermal energy is advected at the solar wind speed. The fact that a model which takes into account only Coulomb collisions, spherical expansion, and the self-consistent electric field is able to reproduce a large number of the properties observed in the solar wind, without the need of additional heating, implies that (1), in order to identify the role of the interactions of the electrons with waves, structures, and turbulence, higher resolution measurements of the electron properties are necessary in the next generation of probes which will explore the heliosphere, and (2) any reasonable kinetic model of the solar wind expansion has to include collisions to conveniently describe the electron velocity distribution function evolution in the solar wind.