Suprathermal electrons in the solar corona and transition region

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Suprathermal tails are a common feature observed in solar wind electron velocity distributions (VDFs), and can be expected in the solar corona as well. Resonant interaction with whistler waves is one mechanism capable of producing suprathermal tails out of an initially Maxwellian VDF. This mechanism is presented here for the quiet solar corona, without any flare activity, in a closed magnetic loop (Vocks et al., 2008). The electron-whistler interaction is described by quasilinear theory. The kinetic model is based on a numerical solution of the Boltzmann-Vlasov equation for electrons, considering Coulomb collisions and wave-electron interaction. The waves enter the simulation box with a given power-law spectrum, that evolves inside the box due to wave propagation and absorption. The temporal change of the initially Maxwellian VDF is calculated until a final steady state is reached (Vocks et al., 2012). The results show that a population of suprathermal electrons develops, that can be approximated by a power-law in the energy range of 4 - 10 keV. The power-law index is in agreement with the solar wind kappa distribution observations. For lower energies, the electrons are quickly thermalized, and the efficiency of the acceleration mechanism decreases for higher energies.

These numerical studies show that the quiet solar corona is capable of producing suprathermal electron VDFs, with similar characteristics as observed in the solar wind. In the second part of this presentation, the propagation of suprathermal electrons from the loop through the steep temperature gradient of the transition region towards the chromosphere is studied. The coronal boundary condition of the simulation box is the electron VDF found at a loop footpoint in the previous simulation, while initial and chromospheric boundary conditions are Maxwellian VDFs with densities and temperatures based on a background fluid model. The model results (Vocks et al., 2016) show the presence of strong suprathermal tails in transition region electron VDFs, starting at energies of a few 10 eV. Above electron energies of 600 eV, electrons can traverse the transition region essentially collision-free. The presence of strong suprathermal tails in transition region electron VDFs shows that the assumption of local thermodynamic equilibrium is questionable there, with significant implications on EUV line formation and ionization dynamics.

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