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Protons and alpha particles in the solar wind

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We investigate energetic consequences of ion kinetic instabilitities in the solar wind connected with beam and core protons and alpha particles drifting with respect to each other. We compare theoretical predictions, simulations and observation results. For theoretical prediction we assume drifting bi-Maxwellian ion populations and we calculate theoretical quasilinear heating rates (*Hellinger et al.*, 2013b). The nonlinear evolution of beam-core protons, and alpha particles in the expanding solar wind we investigate using hybrid expanding box system (*Hellinger and Travnicek*, 2013). The expansion leads to many different kinetic instabilities. In the simulation the beam protons and alpha particles are decelerated with respect to the core protons and all the populations are cooled in the parallel direction and heated in the perpendicular one in agreement with theoretical expectations. On the macroscopic level the kinetic instabilities cause large departures of the system evolution from the double adiabatic prediction and lead to a perpendicular heating and parallel cooling rates. The simulated heating rates are comparable to the heating rates estimated from the Helios observations (*Hellinger et al.*, 2013a); furthermore, the differential velocity between core and beam protons observed by Ulysses exhibits apparent bounds which are compatible with the theoretical constaints imposed by the linear theory for the magnetosonic instability driven by beam-core differential velocity (*Matteini et al.*, 2013).

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