EGU22-1895, updated on 15 Aug 2022
https://doi.org/10.5194/egusphere-egu22-1895
EGU General Assembly 2022

Towards a realistic evaluation of transport coefficients in non-equilibrium plasmas from space

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While space plasmas are largely considered to be nearly collisionless, at relatively low heliocentric distances, that is, below 1 AU, particle-particle collisions still play an important role in the transport of matter, momentum, and energy. A way to quantify these processes macroscopically, e.g., in fluid models, is within classical transport theory, where fluxes and their sources are linearly related by transport coefficients. In the solar wind context, of particular interest are the observed velocity distributions of plasma particles with Kappa-distributed suprathermal tails, conditioned not only by binary collisisions, but also by their interaction with plasma waves and turbulence. We present first derivations of the main transport coefficients based on regularised Kappa distributions (RKDs), which, unlike standard Kappa distributions (SKDs), enable a macroscopic description of non-equilibrium plasmas without mathematical divergences or physical inconsistencies. All transport coefficients are finite, well defined for all values of $\kappa > 0$, and markedly enhanced in the presence of suprathermal electrons. The results indicate that for low values of κ, that is, below the SKD poles, the transport coefficients can be many orders of magnitudes higher than the corresponding Maxwellian limits, which can lead to significant underestimations if suprathermal electrons are ignored. Moreover, we show the importance of an adequate Kappa modeling of suprathermal populations by contrasting our results to other modified interpretations that underestimate the effects of suprathermals.