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Electron physics and global processes in the heliosphere

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Electron scales in the heliosphere are orders of magnitude smaller than global heliospheric scales, both in space and in time [1]. This notwithstanding, electron physics is fundamental in shaping global heliospheric processes.
The fundamental non-locality of electron physics in the heliosphere is highlighted by a number of recent works and observations.
The recently observed sunward deficit in the electron distribution is considered a signature of the interplanetary potential that traps electrons over global scales. The interplanetary potential traps the electrons that leave the Sun with kinetic energy below a cut-off value: these are the electrons that return towards the Sun. The electrons giving rise to the deficit are the ones with energy above the cut-off, which do not return [2,3]. The sunward deficit can create the conditions for an electron-scale microinstability, the whistler heat flux instability [4], which contributes to further modify the electron velocity distribution.
Another example of the fundamental role of electron physics in global heliospheric dynamics is given by heat flux regulation by electron scale microinstabilities. That kinetic instabilities should contribute to heat-flux regulation has been demonstrated decades ago with Ulysses observations [5]. Recent Parker Solar Probe and Solar Orbiter observations, e.g. [6], together with first-principle Particle-In-Cell simulations, e.g. [7], have shown a directly link between electron microinstabilities and scatter of strahl electrons, which results in reduction of the heat flux. Interestingly, also here global and electron-scale processes are related non-trivially: it has been demonstrated via semi-implicit expanding box Particle-In-Cell simulations [8] that plasma expansion can trigger electron-scale instabilities, which in turn contribute to heat flux regulation [9, 10].
In this talk, we will illustrate the above-mentioned links between electron scale and global heliospheric dynamics with the support of Particle In Cell simulations, both "standard" and Expanding Box.

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