Electron heat-flux instabilities in the solar wind

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Abstract: The solar wind is a magnetized plasma outflow, mainly composed of electrons and protons, emanating from the sun and streaming through the interplanetary space. In-situ measurements of the electron velocity distributions reveal not only a bulk quasi-thermal (core) component, at lower energies, but also suprathermal populations enhancing the high-energy tails of the distributions. There is an ubiquitous suprathermal halo component, and a magnetic-field-aligned beam, usually called the strahl and enhanced in the fast winds. This peculiar suprathermal formation carries an important amount of heat-flux in the solar wind. However, the observations show that the heat-flux carried by the solar wind is suppressed below the values provided by collisional models. The significance of particle-particle collisions decreases with increasing the heliocentric distance, and beyond 0.5 AU, when electrons and ions are practically collisionless, other self-consistent mechanisms should be at work. Wave-particle interactions through kinetic instabilities have been proposed as a mechanism responsible for shaping the electron distribution, reducing the suprathermal skewness, and hence regulating the heat transport. In this talk we will describe the full spectrum of heat-flux instabilities prescribed by the linear kinetic theory and, using particle-in-cell (PIC) simulations, we will discuss their role in the scattering of strahl electrons and in the regulation of the heat-flux in the solar wind.

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References: R. A. López et al., ApJL 900, L25 (2020), A. Micera et al., ApJL 903, L23 (2020).

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