Empirical solar wind fluid models constrained by Parker Solar Probe, Solar orbiter and Helios measurements

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Abstract

Classifying solar wind observations by HELIOS in several populations sorted by bulk speed, has revealed constant and slight accelerations of the wind as it expands away from the Sun in the 0.3 – 1 AU radial range. The faster the wind is, the smaller is this acceleration. Recent measurements from Parker Solar Probe (PSP), which have been added closer to the Sun, show that the HELIOS populations can nicely be extrapolated back to the Sun. For instance the well established bulk speed/proton temperature (u, Tp) correlation, togheter with the acceleration of the slowest winds, are clearly visible in the PSP data. Even more recent Solar Orbiter data confirm this tendency

Based on the previous classifications, we present results of empirical Parker-like models for which the solar wind undergoes a double expansion: isothermal in the corona, then polytropic after the sonic point, with polytropic indices corresponding to the observed temperature gradients. Such models are useful because they allow to establish a differentiated energy balance for the heating of the wind and for the acceleration separately.