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Limiting Charged Particle Flux Spectrum at the Heliopause and Beyond

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Ongoing Voyager 1 and 2 measurements show proton and heavier ion flux spectra unfolding upwards at MeV energies and in time with presumably decreasing distance to the heliopause interface of the heliosheath and local interstellar medium (LISM) plasma environments. Despite large spatial separation between the two spacecraft, the respective flux measurements are converging to a common spectrum consistent with a source beyond both spacecraft. This trend may conceivably reverse in response to increasing solar modulation of the new sunspot cycle but otherwise it must approach some limiting form of the plasma and energetic particle spectra near and beyond the heliopause. If an outer heliosheath region is bounded outwards by a postulated heliospheric bow shock, there could be an intermediate spectrum of shock-accelerated particles, but otherwise the limiting spectrum is that of the LISM. As reported earlier, a simple power-law extrapolation from known LISM plasma distributions at eV energies to the relatively unmodulated fluxes of galactic protons at GeV energies yields the "universal" stochastic cascade spectrum of Fisk and Gloeckler. Although the heliopause interface of the inner heliosheath and LISM plasma flow environments is usually visualized as laminar with little flow across the interface, boundary instabilities and charge exchange processes at a more chaotic and realistic boundary could enable interpenetrating flows. The limiting heliosheath spectrum now being approached by measurements from both spacecraft is suggested to be the LISM spectrum. Lack of significant and sustained spectral changes in response to increasing solar modulation within the supersonic heliosphere, and continuity of the unfolded spectral form for future measurements across the heliopause, would support direct LISM and/or outer heliosheath origins for the suprathermal ions of the inner heliosheath. This could further require modification of source and transport models for the so-called "anomalous component" ions at higher MeV energies. Unlimited extension of the presently observed suprathermal ion spectrum into the neutral gas environment beyond the heliopause, e.g. within the hydrogen wall region, would also impact energy and directional distributions of energetic neutral atoms now being measured from Earth orbit by the Interstellar Boundary Explorer (IBEX) mission.