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Constraints on Charged-Particle Acceleration in the Heliosphere

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A number of different mechanisms have been proposed for accelerating the various energetic charged particle species observed *in situ* in the heliosphere, including anomalous cosmic rays, co-rotating particle increases, superthermal tails, and SEPs. Mechanisms being advocated include diffusive shock acceleration, compression acceleration, stochastic or 2nd-order Fermi acceleration, transit-time damping and reconnection events. Because of the absence of collisions,the acceleration must be caused by the ambient electric field, which at the scales of interest, can be written in terms of the fluid velocity U, magnetic field B and the speed of light c as $E = -U \times B/c$. Therefore, consideration of the observed SPATIAL AND TEMPORAL scales and the ambient fluid velocities in any given region, such as the heliosphere or inner heliosphere, constrains the attainable particle energies. For example, in the solar wind, a proposed mechanism must be faster than the adiabatic cooling in the expanding solar wind. The observed charge states of ACR require the mechanism at the termination shock or heliosheath to accelerate particles to hundreds of MeV in less than a few years. These observations place significant constraints on acceleration mechanisms.