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Acceleration of Helium at Interplanetary Discontinuities: ACE STEREO Observations and Simulations

H. Kucharek(1), E. Moebius(1), F. Allegrini(2), M. Desai(2), B. Klecker(3), M. Popecki(1), C. Farrugia(1), A. B. Galvin(1), P. Bochsler(4), K. Simunac(1), R. Karrer(4), A. Optiz(4)

(1) University of New Hampshire, 39 College Road, Durham, NH 03824, United States, (2) Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78228, United States, (3) Max-Planck-Institut f. Extraterrestrische Physik, Giessenbach Strasse 1, 85740 Garching, Germany, (4) Universitaet Bern, Sidlerstrasse 5, Bern, 3012, Switzerland

ACE/SEPICA measurements in the energy range of 250-800keV/n showed that, on average, energetic He+ is, after H+ and He2+, the third most abundant energetic ion species in the heliosphere. As a major source of energetic He+ interplanetary pickup ions have been identified that are either preferentially injected or accelerated at Corotating Interaction Regions (CIRs), Transient Interaction Regions (TIRs), and interplanetary traveling shocks. ACE/ULEIS and ACE/SEPICA measurements showed that very often 3He2+ and He+ are also accelerated simultaneously at CME-driven IP shocks. Considering that these two species originate from different sources, this may indicate that the injection, or the acceleration efficiency of the accelerator for different source population may be similar. A survey of individual IP shocks shows that ions are routinely accelerated from multiple seed populations such as multiple SEP events, CIRs, pick-up ions, etc., via systematic rigidity-dependent acceleration processes where ions with higher rigidity or M/Q ratios are accelerated less efficiently than those with lower M/Q ratios. However, 3He2+ does not fit into this scheme. STEREO/PLASTIC extends the energy range into injection region of the source. Data in the energy range from 0.2-80keV/Q show clear evidence of abundant He+ at interplanetary discontinuities. At this stage of the low solar activity, we shall emphasize

CIRs and TIRs. A series of corotating streams have been investigated and the energetic He+/He2+ ratio has been determined. Observations alone cannot differentiate easily between injection and acceleration. We therefore addressed this problem also with test particle simulations as well as multi-dimensional hybrid simulations. In numerical simulations this can be done because there is control over species and distribution functions.