ACCELERATION OF 3HE AND HEAVY IONS AT INTERPLANETARY SHOCKS

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We have surveyed the 0.5-2.0 MeV nucleon-1 elemental abundances of 56 interplanetary shocks (IP) observed by the Ultra Low Energy Isotope Spectrometer (ULEIS) on board the Advanced Composition Explorer (ACE) from October 1997 through November 2000. Our survey shows the first ever measurement (25 cases) of 3He ions being accelerated in interplanetary space. Our results are: (1) The 3He/4He ratios at the 25 shocks lie between the range 0.0014-0.24; the ratios were enhanced between factors of ~3-600 over the solar wind value. (2) The occurrence probability of the 3He-rich shocks increases with rising solar activity, as measured in terms of the occurrence rates of sunspots and X-ray flares. (3) The 3He enrichments are accompanied by significant enhancements in the abundances of Ne-Fe. (4) The heavy ion abundances at the shocks are markedly different when compared with reference populations like the solar wind, SEPs, and CIRs. The 3He and heavy ion enhancements at IP shocks cannot be attributed to rigidity dependent acceleration of solar wind ions and are better explained if the shocks accelerate ions from multiple sources, one being remnant impulsive solar flare material, as suggested by Mason et al. (1999). Our results also indicate that the contribution of impulsive flares to the seed population for IP shocks varies from event to event, and that the interplanetary medium is being replenished with impulsive material more frequently during periods of increased solar activity. We discuss the implications of these new results for current ideas regarding the origin and acceleration of energetic particles at interplanetary shocks.