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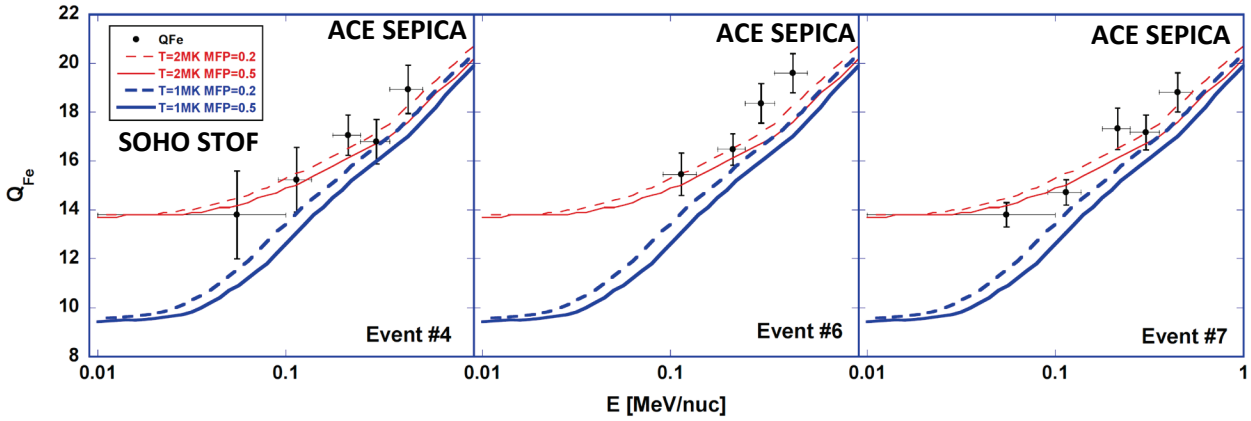
Impulsive Events with High Charge State Fe at Low Energies: Occasional High Temperature Source Material!



Mean Fe charge states for three impulsive energetic particle events as a function of energy together with model curves, including acceleration, stripping, and adiabatic cooling for source temperatures of 1 MK (blue) and 2 MK (red), and transport mean free paths λ = 0.5 AU (solid) and λ =0.2 AU (dashed) (Kartavykh et al., ApJ, 671, 947, 2007). Typical coronal temperatures as derived from ionic charge states in the solar wind are about 1 MK (ACE News #146).

Earlier studies have shown that impulsive Solar Energetic Particle (SEP) events emit Fe ions with Q_{Fe} <14 at the lowest energies (E ≤ 0.1 MeV nuc^{-1}) that are consistent with typical corona source material (ACE News #107, DiFabio et al., *ApJ*, **687**, 623, 2008). However, the occasional observation of Fe with Q_{Fe} >16 in solar wind associated with active regions (ACE News #52, Lepri et al., *JGR*, **106**, 29231, 2001) led to a search for acceleration of high charge state Fe in all SEP events observed with ACE SEPICA.

A total of nine SEP events with Q_{Fe} ≥ 14 across the entire SEPICA energy range (0.08 - 0.54 MeV/nuc) were identified (Guo et al., *ApJ*, **785**, 26, 2014). Five of these events were CME related events with acceleration of high charge state material, in some cases mixed with the acceleration of a separate component of more normal coronal material. Four of these events are impulsive events with the clear signature of ion velocity dispersion. In comparison with a model that involves acceleration out of a source at equilibrium temperature, further stripping during the acceleration, and adiabatic cooling during transport to 1 AU (shown for three events in the Figure above), all four events are consistent with a source temperature T > 2 MK (Kartavykh et al., *ApJ*, 671, 947, 2007) and thus the presence of hot solar material in these impulsive events.

Contributed by Zhangbo Guo, Eberhard Möbius, and Mark Popecki, University of New Hampshire, and Berndt Klecker, Max-Planck-Institut für exterrestrische Physik. See http://www.srl.caltech.edu/ACE/ACENews_Archives.html for an archive of earlier ACE News items. Address questions or comments to eberhard.moebius@unh.edu.