Efficient mechanism of the pickup ion acceleration

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Pickup ions (PUIs) are considered to be the dominant source of anomalous cosmic rays (ACRs). ACRs are generated at the heliospheric termination shock (TS), where the diffusive shock acceleration (DSA) must account for the mechanism. The particle energy required for DSA should already be energetic enough, typically on the order of hundreds of kiloelectronvolts for ACRs. However, TS alone may be insufficient to provide PUIs with such energies, because the primary PUI energy (10 keV at most) is still too low for DSA. Therefore, additional preacceleration within the heliosphere is necessary for PUIs before encountering with TS.

We have already performed hybrid simulations on the PUI dynamics at corotating interaction regions (CIRs), and reported the following results on the behavior of energetic PUIs; (1) adiabatic acceleration due to the magnetic mirror effect at the CIR boundary shocks, and (2) back-and-forth motion between a pair of CIRs. A combination of these processes efficiently generates suprathermal particles on the order of 100 keV. This mechanism well accounts for the preacceleration mechanism for ACRs.

Recently, Wu et al. (2014) presumed from the observations by the STEREO-B spacecraft that a U-shaped magnetic field topology connecting the reverse shock of the first CIR and forward shock of the second CIR results in the acceleration and trapping of energetic particles in the region between CIRs. Our results partly confirm these features. In order to compare with observations more accurately, we perform the simulations with embedding the sector boundary, or current sheet, in the magnetic field configuration, and further evaluate acceleration efficiency of PUIs.