Pickup ions in the corotating interaction regions

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Shock waves are the most effective accelerator of space plasmas. In the heliosphere, one of such a shock structure appears at the boundaries of corotating interaction regions (CIRs), where a high-speed solar wind catches up a slow wind ahead. While the forward shock propagates with accelerating the slow wind plasma, the reverse shock is developed against the fast wind. Therefore, the plasma component is different between the forward and reverse shock, where asymmetric properties can be expected to be identified. It has been observationally known that CIR events generate suprathermal tails in the energy distribution, which are associated with acceleration at the boundary shocks. The intensity profile of these energetic particles often exhibits the asymmetry that the reverse shock more efficiently accelerates particles than the forward shock. Recently, Tsubouchi (2011) performed the hybrid simulation on a nonstationary evolution of CIR and showed that the reverse shock experiences the transition to a quasi-parallel geometry as a consequence of the solar wind adiabatic expansion. The quasi-parallel reverse shock can accelerate low-energy thermal particles in the suprathermal range (tens of keV) via well-known Fermi process. On the other hand, interplanetary pickup ions are considered to be another source of CIR energetic particles, which also accounts for the asymmetry between the forward and reverse shock. This is because the energy of pickup ions is larger in the fast solar wind than in the slow one. In the present study, we include the pickup ions in the simulation model of Tsubouchi (2011) to evaluate the energy partition into thermal solar wind and pickup ions during the CIR evolution.