A dynamical model of the heliosphere with adaptive mesh refinement

*Tomoaki Matsumoto[1], Daikou Shiota[2], Ryuho Kataoka[3], Hiroko Miyahara[4], Shoko Miyake[5]

1. Hosei University, 2. NICT, 3. National Institute of Polar Research, 4. Musashino Art University, 5. National Institute of Technology, Ibaraki College

A change in the heliospheric environment plays an important role in the modulation of the galactic cosmic rays (GCRs). The magnetic field structure and the speed of the solar wind affect the GCRs transport in the heliosphere. In the previous studies, the simple Parker spiral models have been utilized for calculating the modulation of GCRs.

We have here developed a dynamical model of the heliosphere based on MHD simulations. This model is a framework for simulating the heliospheric environment that the planets are inhabiting. The model was constructed as a part of Project Gm7. We utilized the adaptive mesh refinement (AMR) code, SFUMATO, to obtain local high-resolution around the heliospheric current sheet (HCS) because the GCRs are transported efficiently in the HCS.

Recently we modified the heliospheric model several points. First, we extended the computational domain of a distance of 14 au from the Sun up to a distance of 100 au. The extension of the computational domain allows us to reproduce highly tightly winding spirals of the HCS. The AMR captures the tightly winding spirals with a relatively low numerical diffusion. Second, we improved the robustness of the numerical method. We modified the numerical scheme by solving the advection of the internal energy besides the total energy in the conservation forms of MHD equations. This modification ensures the positivity of the internal energy even for very high speed and low beta plasmas.

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