R010-07
Zoom meeting B ：11/3 AM2 (10:45-12:30)
11:00〜11:15

Simulation study on the deformation of magnetic field in interplanetary CMEs

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Coronal mass ejections (CMEs) are the largest eruption in the solar system. CMEs carry huge plasmas in the solar corona of 10ˆ11 to 10ˆ13 kg into interplanetary space at velocities of a few hundred - thousand km/s. CMEs can affect a variety of space weather conditions when they collide with the magnetosphere of the earth. In particular, the magnetic field of CMEs is a serious factor of space weather disturbance, because the southward component of the magnetic field in CMEs could cause the geomagnetic field storm. In this study, we focus on the interaction between interplanetary CME (ICME) and the background solar wind, especially the deformation of ICME magnetic field structure due to the CME-solar wind interaction.

We performed three series of MHD simulations of ICME propagation in the inner heliosphere using SUSANOO-CME (Shiota & Kataoka, 2016) with the aim of elucidating the basic mechanisms of the deformation. In order to explore the basic processes, we adopted the following two assumptions: First, the velocity and magnetic field of the background solar wind were assumed to be isotropic to avoid the effect of the complicated anisotropy of the solar wind; Second, a CME with spheromak-type internal magnetic field is launched from a same position of the inner boundary of the computational domain. In Series 1, a CME with different magnetic field orientations was launched into the background solar wind with no magnetic field. The major axis of the internal spheromak field is assumed to be along the solar equator and facing west or east. Here, we used four different cases in which the toroidal and poloidal components of the spheromak magnetic field are inverted, respectively. In Series 2, an identical CME (the same as one of Series 1) was launched into the background solar wind with different magnetic field strengths. In Series 3, the same CME with different initial velocities was launched into the solar wind of standard magnetic field strength.

As the results of Series 1, it was found that the magnetic flux at the front part of the spheromak is compressed in the direction of motion and expands laterally due to the interaction with the solar wind in the early stage just after the CME injection. As the result of Series 2, we found that the magnetic flux of the CME rotates and the major axis of the spheromak tends to tilt in the radial direction. The stronger the solar wind magnetic field, the faster the rotation speed. This rotation of ICMEs may be caused by the tilting instability of spheromak. Finally, in Series 3 we measured the tilt angle in terms of the orientation of spheromak torus on the equatorial plane and investigated the dependency of the tilting on the CME speed. The result was consistent with the model of the tilting instability. These calculations imply that not only the hydrodynamic interaction with the solar wind but also the magnetohydrodynamic interaction has a significant impact on the magnetic field deformation of ICMEs. Based on the simulations, we will also discuss the prediction of the magnetic field of ICME.