An MHD Simulation on the Structure and Dynamics of Heliosphere

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The flow of supersonic solar wind plasma with a spiral interplanetary magnetic field (IMF) is continuously blowing off in the interplanetary space. The fundamental structure of heliosphere is determined by interaction between the solar wind plasma and a local interstellar medium (LISM). This process may be also influenced by interplanetary magnetic field and interstellar magnetic field.

At about 100 AU distance from the sun, the solar wind is slowed down from supersonic to subsonic through the Termination Shock(TS). At the outer side of this process, Bow Shock(BS) is formed in the interstellar space due to the flow of LISM. In the region between two shocks, Heliopause(HP) is formed as a boundary of LISM and the solar wind plasma.

It was reported that Voygager 1 crossed TS, but there is no specific conclusion. Moreover the mission to observe the global heliosphere has not achieved. So the global heliosheric strcuture and its physical processes are not clarfied.

There are some researches for the simulation of the global heliosphere. Linde et al., (1998) got the result which nose of HP is projected. Tanaka and Washimi considered of current sheet and got the result which surface of HP is formed V-shape.

In this study we have carried out the three-dimentional global magnethydrodynamics(MHD) simulation to investigate the structure of heliosphere. We solved MHD and Maxwell's equations as an initial-boundary value problem using the Modified Leap-Frog method which is one of the high precision numerical methods.

We used parameters from Linde et al. (1998), for simulation that density n=0.0078 /cm∗∗3, velocity v=450 km/s, temparature T=30000 K, strength of magnetic field B=0.15 nT as the solar wind parameter and density n=0.0078 /cm∗∗3, velocity v=26 km/s, temparature T=7500 K, strength of magnetic feild B=0.2 nT as the LISM parameter. This time we did not considerd of IMF.

We have obtained the fundamental structure of heliosphere which is composed of the BS, HP, and TS. Their average positions from the sun are 125 AU, 205 AU, 310 AU respectively.

The figuration of TS was Bullet Shape in static state. Mach Disc ,Reflected Shock, and Slip Line were formed in the heliotail. There is fluctuation on HP in xy plane at about t=38 years from the begin of simulation. It developed to wave structure. We conceived Kelvin-Helmholtz instability as the trigger of this fluctuation. So we substituted value of simulation result to conditional expression of Kelvin-Helmholtz instability. Since it was satisfied, we concluded that posibility which the trigger of the fluctuation comes from K-H instability is high.