Development of ultraslim magnetometers to discover the mechanism of the solar wind heating

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It has been thought that the solar wind is cooled down along radial directions of the Heliosphere, however, Richardson and Paulerena [1995] showed by the Voyager 2 that the observed temperatures ($T=\sim T_0 \cdot R^{-1/2}$)of the solar wind are higher than those of the adiabatic model ($T=T0 \cdot R^{-4/3}$). This suggests an acceleration process of the solar wind particles, although, its mechanism has not been understood. One of the possible acceleration mechanisms is the dissipation of plasma turbulences in the solar wind. The spectrum of the plasma turbulence in the solar wind have been investigated at the interplanetary space by the Helios 1 [Roberts+1987] and the Ulysses [Goldstein+1995], and at the near-Earth orbit by Cluster [Sahraoui+2007;2010]. In their observations the kinks at the wavenumber k corresponding to the inertia lengths of ion and electron were found in the relation between thepower of turbulences E and the wavenumber k ($\log_{10}(E)\sim kA+E_0$). These kinks possibly indicate the energy transfer from the plasma turbulence to the particles by the wave-particle interactions, however, the mechanism (e.g., the wave mode) has not been understood yet.
Since the one spacecraft observation cannot distinguish between temporal and spatial variations, the wave vector has not been estimated in the interplanetary space. Then the dispersion relation could not be obtained to determine the wave mode. In order to find the wavenumber by deploying four magnetometers at edges of the large thin film solar cell (~50m each) of the Solar Sail (Trojan asteroid exploration mission), we are developing an ultra-slim and light magnetometer integrated with signal processing circuits of low power and noises. One of the problems for installing our magnetometers is that the signal process circuits are too large and heavy to deploying into the solar cell. Therefore we developed the 5mm-chip (ASIC; Application Specific Integrated Circuit) for the analog parts of our signal process circuits to achieve both weight saving and downsizing. In our presentation, we will show the simulation results and the performance evaluations of the developed circuits of ASIC.

Keywords: fluxgate magnetometer, plasma turbulence, solar wind, wavenumber analysis

