Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PPS003-P23 Room: Convention Hall Time: May 24 17:15-18:45

Full-Particle simulation of the solar wind interaction with lunar crustal magnetic anomalies

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The moon has localized crustal magnetic anomalies and it is suggested that characteristic plasma phenomena are caused by the direct solar wind interaction with them. This is a topic taken up by Apollo and Lunar Prospector observations and proposed as one of the important research subjects of the Kaguya mission. Weak shock structures and ion reflections observed around the anomalies have been actively studied based on the results of data analyses and numerical experiments. In the study of plasma phenomena around the anomalies, where the characteristic scale length becomes close to the ion scale, we should pay attention to the validity of the MHD approximation. Additionally, a peculiar lunar plasma environment (a thin ionosphere and the reflection/absorption of the ground) makes it difficult to identify the dominant physical process.
The previous simulation studies have discussed mainly the parameter dependence of the macrostructure of the mini magnetosphere around the anomalies by using (Hall) MHD and particle codes. The effects of the ion kinetics on the shock wave structures have also been discussed by using electromagnetic hybrid (particle ion/fluid electron) code. However, the details of the microphysics and wave-particle interactions occurring in the electron scale remain unsolved. Indeed, Lunar Prospector observations suggested the enhancement of ULF waves in association with the energization of 10-100 eV electrons.
In the present study we conduct 1D and 2D full-particle simulations so as to discuss wave-particle interactions in the electron-ion scale observed in the solar wind interaction with lunar crustal magnetic anomalies. We assume initial settings of the simulations based on the observations around the magnetic anomalies, and we compare the simulation results with the signature of wave -particle interactions around the anomalies observed by the Kaguya spacecraft. In this presentation, we also report the validity of the developed code by comparing with the previous works.

Keywords: moon, anomaly, interaction, simulation