火星探査機MAVENの観測データを使用した誘導磁気圏界面とイオン成分境界についての統計解析研究

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Statistical study of relation between the magnetic pileup boundary and ion composition boundary around Mars observed by MAVEN

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Direct interaction between the solar wind and the Martian upper atmosphere forms a characteristic transition region, so-called the magnetic pileup region, between the shocked solar wind (magnetosheath) and the Martian ionosphere. In this transition region, the solar wind is decelerated due to increasing mass loading by heavy ions, which are produced from the ionization of extended Martian neutral atmosphere. Since the interplanetary magnetic field (IMF) frozen-in the solar wind plasma, the solar wind deceleration make IMF to pile up and drape around the planet. After Mars Global Surveyor observations, the outer boundary of the magnetic pile up region is called as the magnetic pileup boundary (MPB). Previous observations by Phobos 2 and Mars Express, on one hand, showed existence of a boundary that separates the solar wind protons dominant region from the planetary heavy ions dominant one, which is referred to the ion composition boundary (ICB). However, due to the lack of continuous simultaneous measurements of the magnetic field and ion composition before Mars Atmosphere and Volatile EvolutioN (MAVEN), relation between MPB and ICB are far from understood.

In this study, we investigate relative locations of MPB and ICB, as well as their dependence on solar wind parameters by using MAVEN ion, electron, and magnetic field data. We conducted a statistical analysis for two periods from November 2014 to March 2015 and from June 2015 to October 2015, when MAVEN orbital configuration allows direct measurements of the solar wind near its apoapsis. We developed an automated algorithm to identify MPB and ICB. We identified MPB with criteria combining the time derivative of electron flux, strength of the high-frequency (>0.1Hz) magnetic field fluctuation, and plasma beta. As for ICB identification, we used the density ratio between the planetary heavy ions and the solar wind protons. Results show there is a north-south asymmetry in locations of MPB and ICB in MSO coordinates. Observations indicated that the southern crustal magnetic fields seem to play an important a role of the north-south asymmetry. Observations also indicate that locations of MPB and ICB depend on the solar wind dynamic pressure and the IMF direction. Based on the results, we will discuss relation between MPB and ICB, and formation processes of these boundaries.