A statistical study of slow-mode shocks observed by MMS in the dayside magnetopause

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Petschek's reconnection theory [1964] provides a means for faster reconnection by creating X-line geometry with two pairs of slow-mode shocks. Earth's magnetosphere acts as a natural laboratory to investigate the presence and role of these slow-mode shocks. Considerable amount of studies have reported the presence of the slow-mode shocks in the magnetotail [e.g. Feldman et al., 1987; Saito et al., 1995; Eriksson et al., 2004] but only a few have reported the slow-shocks in the magnetopause [Walthour et al., 1994; Sonnerup et al., 2016]. The slow-shocks are observed in the magnetosheath side and/or magnetosphere side of the magnetopause. These studies suggest that strong pressure anisotropy and presence of cold ions could play an important role in determining the structure of the slow-mode shocks in the magnetopause. These studies also report the presence of rotational discontinuity and theoretical studies have also indicated that the magnetopause consists of multiple MHD discontinuities [e.g., Hau and Wang, 2016]. The solar wind conditions as well as the local conditions in the magnetosphere can affect the structure of the magnetopause. One of the reasons of the small number of the slow-shock events reported for the magnetopause is the lack of the high time resolution data to separate multiple discontinuities before MMS. Thus, an exhaustive study with many events is needed to understand the underlying physics of the slow-shocks in the magnetopause.

Here we present a statistical study of slow-mode shocks in the dayside magnetopause crossings observed by MMS (Magnetospheric Multiscale). For this study, we used the data from FGM and FPI instruments onboard the MMS satellites. Fast survey data were analyzed from 1^{st} Sept, 2015 to 31^{st} Jan, 2017. For event selection, we checked the southward IMF magnetopause crossings with jet ($|V_{gsm}|$is greater than equal to 200 km/s). We ensured the presence of the magnetosheath side in our events by using Plasma Beta greater than 1 and M_A less than 1 conditions. The events obtained by using this criterion were then checked by using burst mode data and incomplete magnetopause crossings were removed to get a set of 71 full crossings from the magnetosheath to the magnetosphere. Ranking-Hugoniot analysis was applied on these crossings after determining two separate deHoffmann-Teller frames for each side. Out of these 71 crossings, 23 magnetopause crossings were identified as the slow-mode shocks. Among the 23 events, 13 events contained slow-shock on the magnetosheath side whereas 10 contained slow-shock on magnetosphere side. We will report on the relation of these slow-mode shocks with solar wind conditions and the local parameters as well as on their relative location to other discontinuities in the magnetopause.