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Exploring Magnetic Reconnection at Mars With MAVEN: A Unique Natural Laboratory of Multi-Ion and Collisional Plasmas

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Thanks to accumulated data of comprehensive plasma and field measurements at Mars by MAVEN, a growing number of papers have reported observational signatures associated with magnetic reconnection in the Martian plasma environment. The recent results collectively indicate that magnetic reconnection occurs in a wide variety of plasma regions around Mars: in the magnetotail, above strong crustal magnetic fields, at magnetospheric boundaries, and in the ionosphere. Here we explore two frontiers of Martian reconnection research: (i) reconnection and aurora and (ii) collisional reconnection.

(i) Based on recent auroral observations, it is proposed that the discrete aurora at Mars is driven by reconnection between the draped IMF and crustal fields. This hypothesis provides a testable prediction of the location and condition of reconnection occurrence. We investigate ion flow patterns above strong crustal fields in comparison to the predicted location of X-lines. We analyze velocity distribution functions of multiple ion species in detail.

(ii) MAVEN's orbit is designed to explore the collisional ionosphere of Mars below the exobase around the periapsis. We upgrade Harada et al. (2020)'s algorithm to identify low-altitude current sheets and reconnection jets within them. From the identified current sheets and ion jet events, we investigate ion-neutral friction effects on reconnection outflows as proposed by Cravens et al. (2020).