Observation of O+ Characteristics During the Terrestrial Alfvén Wing State Induced by the April 2023 Coronal Mass Ejection

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Abstract

We report Magnetospheric Multiscale observations of oxygen ions (O+) during a coronal mass ejection in April 2023 when the solar wind was sub-Alfvénic and Alfvén wings formed. For the first time, O+ characteristics are studied at the contact region between the unshocked solar wind and the magnetosphere. The O+ ions show energies between 100s eV and _˜30 keV. The possible sources are the ring current, the warm plasma cloak, and the ionosphere. The O+ ions exhibit bi-directional streaming along newly-formed closed field lines (CFLs), and dominantly anti-parallel on earlier-formed CFLs. Escaping O+ ions in the unshocked solar wind are observed. During the recovery phase, the O+ pitch-angle distribution associated with flux tubes shows dispersion, indicating potential loss to the solar wind. Our results show escaping as well as trapped O+ ions in the region where a magnetic cloud, an Alfvén wing, and magnetospheric field lines are mixed.

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