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## **Tianwen-1 Observations of Martian Oxygen Ion Plumes** Xiao Ma<sup>1</sup>, Anmin Tian<sup>1</sup>, Ruilong Guo<sup>1</sup>, Shichen Bai<sup>1</sup>, Lihui Chai<sup>2</sup>, Linggao Kong<sup>3</sup>, Wenya Li<sup>4</sup>, Binbin Tang<sup>4</sup>,

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#### **1. Introduction**

Unlike Earth, Mars lacks a global, intrinsic dipole magnetic field. The ionized particles in the Martian ionosphere are exposed to the solar wind (SW) and can escape into interplanetary space directly. Both observations and simulations found that there are two main channels for ion escape: tail-ward escape and plume-like escape along the upstream solar wind electric field  $E_{sw}$  (Fang et al., 2008; Dubinin et al., 2011; Dong et al., 2015).

#### Motivations

- How do they gain energy? (energization)
- Where are they from? (source region)

In this study, we use China's first Mars mission, **Tianwen-1**, to measure oxygen ion plumes and quantify their  $\bigcirc$ energization and source region IMF Vsw locations with the MAVEN spacecraft.

#### **2.** A plume case



- Both Tianwen-1 and MAVEN observed plumes in the sheath and SW
- Tianwen-1 observed higher energy oxygen plumes than MAVEN
- The theoretical energies and observed plume energies are consistent



Plume

#### **3. Statistical results**





- Plumes are observed in **+E** hemisphere in the MSE frame (**MSE frame:**  $X_{MSF}$ : Mars to the Sun,  $Z_{MSF}$ : along the upstream  $E_{sw}$ ,  $Y_{MSE}$ : complete the right-hand coordinates)
- Tianwen-1 observed plume events at higher altitudes (>~3  $R_{M}$ , the apoapsis of MAVEN)





Theoretical energy

- $W_{theory} = q_i E_{SW} \left( Z_{MSE\_plume} 0.5 R_M \right)$
- The theoretical plume energy and observed plume energy are linear correlated
- The solar wind electric field acceleration is the main energization mechanism

#### 6. Summary

- Tianwen-1 MINPA instrument has ability to measure the Martian oxygen plume escape at higher altitudes than the MAVEN spacecraft.
- Using in-situ measurements, we find that plume energy can be quantified by the  $E_{sw}$  and  $Z_{MSF}$  – motional electric field acceleration mechanism.
- Based on a B & E empirical data model and the backward tracing method, we find plume ions mostly originate from 30-60° MSE latitude regions on the dayside.







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