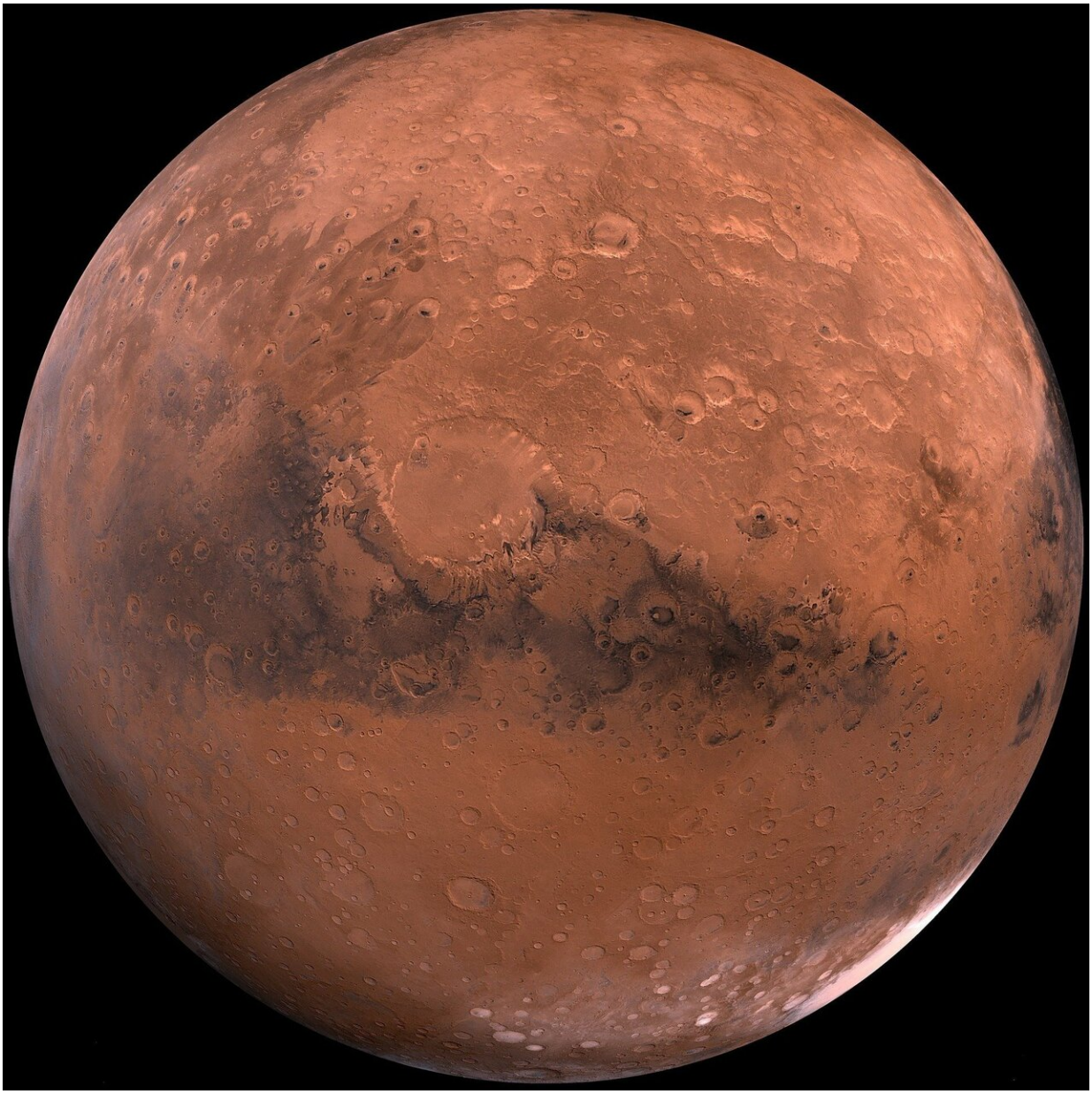
The dynamic battle between Mars's atmosphere and solar wind

March 7 2025, by Annelie Klint Nilsson



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Qi Zhang, a doctoral student at the Swedish Institute of Space Physics and Umeå University, explores in her doctoral thesis the interaction between Mars and the stream of charged particles from the sun, the solar wind. Her research provides new insights for understanding how the atmosphere of Mars has evolved over time.

Unlike Earth, Mars lacks a global magnetic field and interacts with the solar wind directly. Over billions of years, this interaction has stripped much of the Martian atmosphere, transforming the planet from a warm, wet world into the cold, arid landscape we see today.

Qi Zhang's research introduces a groundbreaking approach to studying this process, focusing on the escape of heavy ions from Mars.

By combining data from Mars satellites with advanced computer models, the study unveils how solar activity—such as solar radiation, solar dynamic pressure and interplanetary magnetic field—affects the atmospheric escape rate.

"My method allows us to estimate how much of Mars's atmosphere is being lost to space under different conditions and understand the forces driving this process. This is crucial for piecing together the planet's history and predicting its future," says Qi Zhang.

One of Qi Zhang's key discoveries is the concept of a degenerate induced magnetosphere—a state in which extreme solar wind conditions trigger a unique interaction feature and a surge in atmospheric escape. These findings have broader implications for planetary science, including the study of exoplanets and their interactions with stellar

winds.

Qi Zhang's studies not only deepen our understanding of Mars but also have practical implications for future exploration.

Her research is based on computer models and observations from scientific instruments, as part of IRF's Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3), onboard the ESA spacecraft Mars Express and NASA's spacecraft MAVEN, both of which orbit around Mars.

More information: Modeling the effects of solar conditions on the interaction of the solar wind with Mars. umu.diva-portal.org/smash/record.jsf?pid=diva2%3A1934828&dswid=7870

Provided by Umea University

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