Paper ID: 95176
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student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Science, Instruments and Technologies (3B)

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ELECTROMAGNETIC NOISE ASSOCIATED WITH THE DYNAMICS OF CHARGED DUST PARTICLES IN MARTIAN PLASMA-DUST ENVIRONMENTS: IMPLICATIONS FOR SCIENCE AND INSTRUMENTATION

Abstract

Dust particles play a crucial role in planetary atmospheric processes, particularly in arid and extraterrestrial environments such as Mars. Their interactions with plasma and electric fields can lead to the generation of electromagnetic noise, influencing both natural atmospheric dynamics and the operation of spacecraft and landers. This study investigates the electromagnetic signals produced by charged dust particle interactions in a dense plasma-dust environment.

We explore various dust-charging mechanisms, including triboelectric effects, saltation, and ultraviolet radiation. The research is based on a combination of controlled laboratory experiments and arid terrestrial field studies. Laboratory experiments simulate Martian near-surface conditions using low-pressure CO environments and analyze dust charging and discharging processes. Field experiments, conducted in arid terrestrial regions, provide real-world observations of dust-induced electromagnetic activity.

The study employs the Electromagnetic Analyzer (EMA), a key sensor of the Dust Complex (DC) developed for the ExoMars mission, to detect and analyze electromagnetic signals generated by dust particle dynamics. Results indicate that dust particle collisions and electrostatic discharges contribute to detectable electromagnetic noise, with potential implications for planetary exploration and space instrumentation.

These findings enhance our understanding of dust-plasma interactions and provide critical insights for future missions studying planetary atmospheres, surface processes, and the mitigation of dust-related hazards in space exploration.