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Polar enhancement of lunar water ions observed by Kaguya: Implications for surface-exosphere coupling

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Water on the Moon is crucial for understanding its origin and evolution and is also of interest for future human exploration. Recent observations show that water ice and hydroxyl are mainly concentrated in permanently shadowed regions near the lunar poles, and these species have also been detected in the lunar exosphere. However, how exospheric water is distributed and how it is coupled to the surface remain poorly constrained.

Using the Ion Mass Analyzer onboard the Kaguya spacecraft, we report the detection of water ions originating from the lunar exosphere. We identify statistically significant low-energy water ions and characterize their latitudinal distribution, showing that their flux is enhanced in the polar regions compared with lower latitudes, consistent with previous remote-sensing observations of lunar water. From the observed flux, we estimate near-surface exospheric water density, comparable to previous in-situ measurements.

These results demonstrate that the spatial distribution of surface water is reflected in the exospheric ion population, indicating a dynamically coupled surface–exosphere system. Ion measurements therefore provide a powerful tool for investigating the release, transport, and loss of water on airless bodies.