Magnetic anomalies shield the Moon

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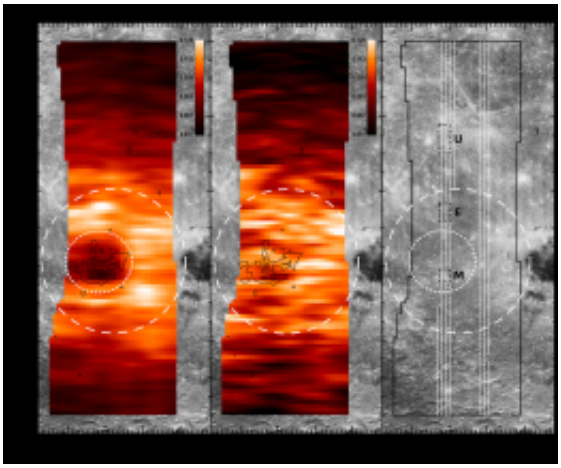

Figure 1: Spatial variation of the energetic neutral hydrogen flux over the magnetic anomaly close to the Gerasimovic crater. (a) High energy hydrogen flux with energy indicates a ~50% flux reduction inside the magnetic anomaly compared to the surrounding area. (b) Hydrogen flux with lower energy of 30-100 eV fills the magnetic anomaly. (c) The albedo (reflectivity) map of the Moon with the spacecraft trajectories (white lines).

Scientists have discovered a new type of solar wind interaction with airless bodies in our solar system. Magnetized regions called magnetic anomalies, mostly on the far side of the Moon, were found to strongly deflect the solar wind, shielding the Moon's surface. This will help understand the solar wind behaviour near the lunar surface and how water may be generated in its upper layer. Observational evidence for these findings were presented by Drs. Yoshifumi Futaana and Martin Wieser at the European Planetary Science Congress in Rome, on Friday

24th September.

Atmosphere-less bodies interact with the solar wind quite differently than the Earth: Their surfaces are exposed without any shielding by a dense atmosphere or magnetosphere. This causes them to be heavily weathered by meteoroids or the solar wind, forming a very rough and chaotic surface called regolith. Previously, the solar wind was thought to be completely absorbed by regolith. However, recent explorations of the Earth's moon by the Chang'E-1, Kaguya and Chandrayaan-1 spacecrafts have revealed that this interaction is not that simple.

A significant flux of high energy particles was found to originate from the lunar surface, most probably due to the solar wind directly reflected off the Moon's regolith. "These results may change dramatically the way we understood the solar wind-regolith interaction so far," says Dr. Futaana of the Swedish Institute of Space Physics. "Since the solar wind is one potential source of water on the Moon, we need to make better models of the lunar hydrogen circulation in order to understand how water molecules form in its upper layers. Also, it will be possible to remotely investigate the solar wind-surface interaction on other airless bodies, such as Mercury or the Martian moon Phobos, by imaging the energetic hydrogen atoms that are reflected back to space when the solar wind hits their surface," he adds.

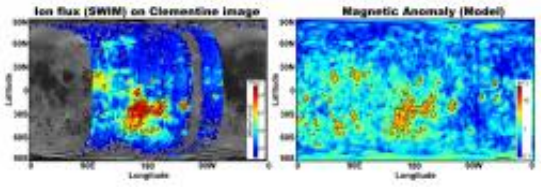

Figure 2: Comparison between the reflected proton flux and the magnetic anomaly distribution on the Moon. (Left) Proton flux distribution observed by the SWIM sensor mapped on the lunar map (generated by Clementine). The black line shows a contour of the lunar magnetic anomaly. (Right) Magnetic

anomaly distribution model based on Lunar Prospector data. The same contour as in the left panel is overlaid here.

The current investigation was carried out with the Sub-keV Atom Reflecting Analyzer instrument which was developed in a collaboration between Sweden, India, Switzerland and Japan and flown onboard the Indian Chandrayaan-1 spacecraft. Scientists have mapped for the first time the energetic hydrogen atoms coming from the Moon, and found that up to one fifth of the solar wind protons reaching the lunar surface are reflected back to space.

This may be a general feature of the atmosphere-less bodies, such as Mercury, meteorites and several moons of the giant planets. “In fact, during the close encounter of the European Mars Express spacecraft with Phobos in 2008, we detected signatures of reflected solar wind protons also from the surface of the Martian moon Phobos,” says Dr. Futaana.

However, when Chandrayaan-1 flew over a magnetic anomaly (magnetized region on the Moon surface), the scientists detected significantly less reflected hydrogen atoms meaning that the solar wind had not reached the lunar surface. In fact, the solar wind was found to be strongly deflected by an aggregation of magnetic anomalies in the southern hemisphere of the lunar far side. “We detected a strong flux of deflected solar wind protons. This clearly indicates that magnetic anomalies can shield the lunar surface from the incoming solar wind, in the same way as the magnetospheres of several planets in our solar system,” says Dr. Futaana.

“It all depends on how strong the solar wind ‘blows’. When the solar wind pressure is low, this ‘mini-magnetosphere’ expands causing stronger

shielding," adds Dr. Wieser, also of the Swedish Institute of Space Physics.

More information: -- Backscattered solar wind protons by Phobos, Futaana, Y., S. Barabash, M. Holmström, A. Fedorov, H. Nilsson, R. Lundin, E. Dubinin, and M. Fränz, *J. Geophys. Res.*, doi:10.1029/2010JA015486 , in Press.
-- First observation of a mini-magnetosphere above a lunar magnetic anomaly using energetic neutral atoms, Martin Wieser, Stas Barabash, Yoshifumi Futaana, Mats Holmström, Anil Bhardwaj, R. Sridharan, M. B. Dhanya, Audrey Schaufelberger, Peter Wurz, and Kazushi Asamura, *Geophys. Res. Lett.* VOL. 37, L05103, 2010 doi:10.1029/2009GL041721

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