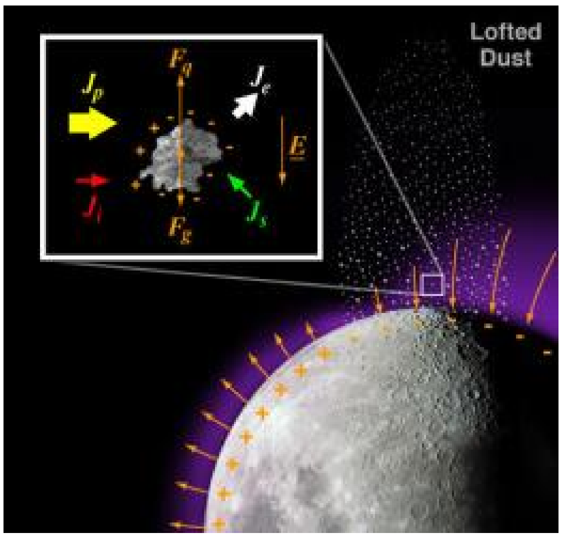
Mystery of the Lunar Ionosphere

November 15 2011, By Dr. Tony Phillips



Dust grains floating above the lunar surface are ionized by solar UV radiation.

How can a world without air have an ionosphere? Somehow the Moon has done it.

Lunar researchers have been struggling with the mystery for years, and they may have finally found a solution.

But first, what is an ionosphere?

Every terrestrial planet with an atmosphere has one. High above the planet's rocky surface where the atmosphere meets the vacuum of space, ultraviolet rays from the sun break apart atoms of air. This creates a layer of ionized gas--an "ionosphere."

Here on Earth, the ionosphere has a big impact on communications and navigation. For instance, it reflects radio waves, allowing shortwave radio operators to bounce transmissions over the horizon for long-range communications. The ionosphere also bends and scatters signals from GPS satellites, sometimes causing your GPS tracker to mis-read your position.

The first convincing evidence for an ionosphere around the Moon came in the 1970s from the Soviet probes Luna 19 and 22. Circling the Moon at close range, the orbiters sensed a layer of charged material extending a few tens of km above the lunar surface containing as many as 1000 electrons per cubic centimeter—a thousand times more than any theory could explain. Radio astronomers also found hints of the lunar ionosphere when distant radio sources passed behind the Moon’s limb.

The idea of an "airless Moon" having an ionosphere didn't make much sense, but the evidence seemed compelling.

As a matter of fact, the Moon isn't quite as airless as most people think. Small amounts of gas created by radioactive decay seep out of the lunar interior; meteoroids and the solar wind also blast atoms off the Moon's surface. The resulting shroud of gas is so thin, however, that many researchers refuse to call it an atmosphere, preferring instead the term "exosphere." The density of the lunar exosphere is about a hundred million billion times less than that of air on Earth—not enough to support an ionosphere as dense as the ones the Luna probes sensed.

For 40 years, the Moon's ionosphere remained a mystery until Tim Stubbs of the Goddard Space Flight Center published a possible solution earlier this year. The answer, he proposes, is moondust.

Stubbs--a 30-something scientist who wasn't even born when the Moon's ionosphere was discovered—read the accounts of Apollo 15 astronauts who reported seeing a strange glow over the Moon's horizon. Many researchers believe the astronauts were seeing moondust. The Moon is an extremely dusty place, naturally surrounded by a swarm of dust grains--think PigPen in Charlie Brown. When these floating grains catch the light of the rising or setting sun, they create a glow along the horizon.

Stubbs and colleagues realized that floating dust could provide the answer. UV rays from the sun hit the grains and ionize them. According to their calculations, this process produces enough charge (positive grains surrounded by negative electrons) to create the observed ionosphere.

An ionosphere made of dust instead of gas is new to planetary science. No one knows how it will behave at different times of night and day or at different phases of the solar cycle, or how it might affect future radio communications and navigation on the Moon. NASA's ARTEMIS probes (orbiting the Moon now) and the LADEE spacecraft (scheduled to launch in 2013 specifically for the purpose of studying the lunar exosphere) may yet reveal its habits.

Updates may be expected in less than 40 years.

More information: The original research reported in this story was published in the October 2011 edition of *Planetary and Space Science*: Stubbs, T.J., D.A. Glenar, W.M. Farrell, R.R. Vondrak, M.R. Collier, J.S. Halekas, and D.T. Delory (2011), On the role of dust in the lunar ionosphere, Planetary and Space Science, 59, 1659-1664, doi: 10.1016/j.pss.2011.05.011

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