A Whole New Way of Seeing the Moon

NASA's first-ever moon temperature-mapping effort, led by UCLA planetary scientist David Paige, has returned its first data—including the surprising finding that the moon harbors some of the coldest places in our solar system.

The moon, wrote author D.H. Lawrence, "is a white strange world, great, white, soft-seeming globe in the night sky." For as long as humans have looked to the sky, the moon has been an object of fascination. But even after six centuries of scientific observation, unmanned probes, and manned missions in the 1960s and '70s, in large measure the moon remains that "white strange world" about which much needs to be learned.

Of particular interest to lunar researchers are full-scale mapping of the moon's surface and learning fundamental information about the existence of water and other substances that would aid in human return for extended periods—all primary goals of the Lunar Reconnaissance Orbiter, an unmanned NASA mission launched June 18, 2009.

Onboard the Orbiter is the Diviner Lunar Radiometer Experiment, a UCLA-managed instrument that is making the first global survey ever conducted of the temperature on the lunar surface.

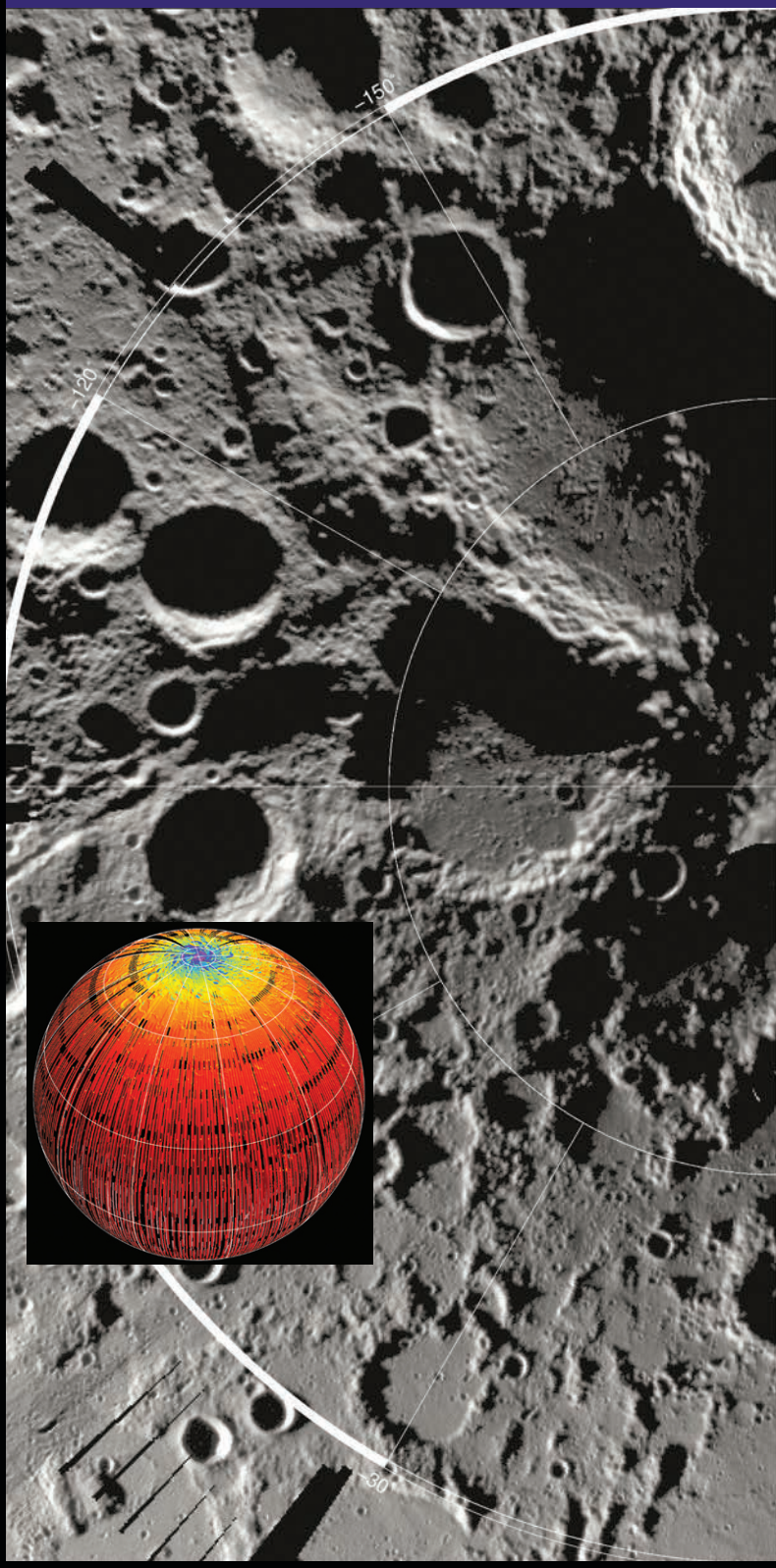
The Diviner team is led by David Paige, a UCLA professor of planetary science and principal investigator for the experiment. In addition to UCLA scientists, the Diviner team includes members from NASA, the United States Geological Survey, and six other universities.

Paige's team is exploring, among several issues, the temperatures on the surface of the moon that represent some of the most extreme in our solar system. On the moon, daytime temperatures can be hotter than boiling water while nights can be as cold as liquid oxygen, but precise temperatures in specific regions were unknown. In particular, the Diviner team is looking at temperatures in the moon's relatively unexplored polar regions, including extremely cold areas that do not receive direct sunlight.

"We are excited about this mission because fully mapping the temperature of the moon has never been done before," said Paige. "The more we learn about the moon helps refine the scientific problems we can pose and increases our understanding of the locations we can identify for lunar landing sites for robotic and human explorers."

Now circling 31 miles above the moon's surface, the Lunar Reconnaissance Orbiter is sending back a flood of data and images, including the Diviner's data on temperature measurements in the moon's polar regions.

"We knew we would find extreme temperatures," said Paige, "but we didn't know how extreme they would be."



Examining the areas inside craters that are permanently in shadow in the southern region of the moon, Paige's team has identified temperatures that are among the coldest in the solar system—colder than even the most distant bodies, such as Pluto, which is 40 times farther from the sun.

The Diviner recorded low daytime temperatures in the southern polar region that reached 397 degrees Fahrenheit below zero—only 62 degrees higher than the lowest temperature possible of absolute zero.

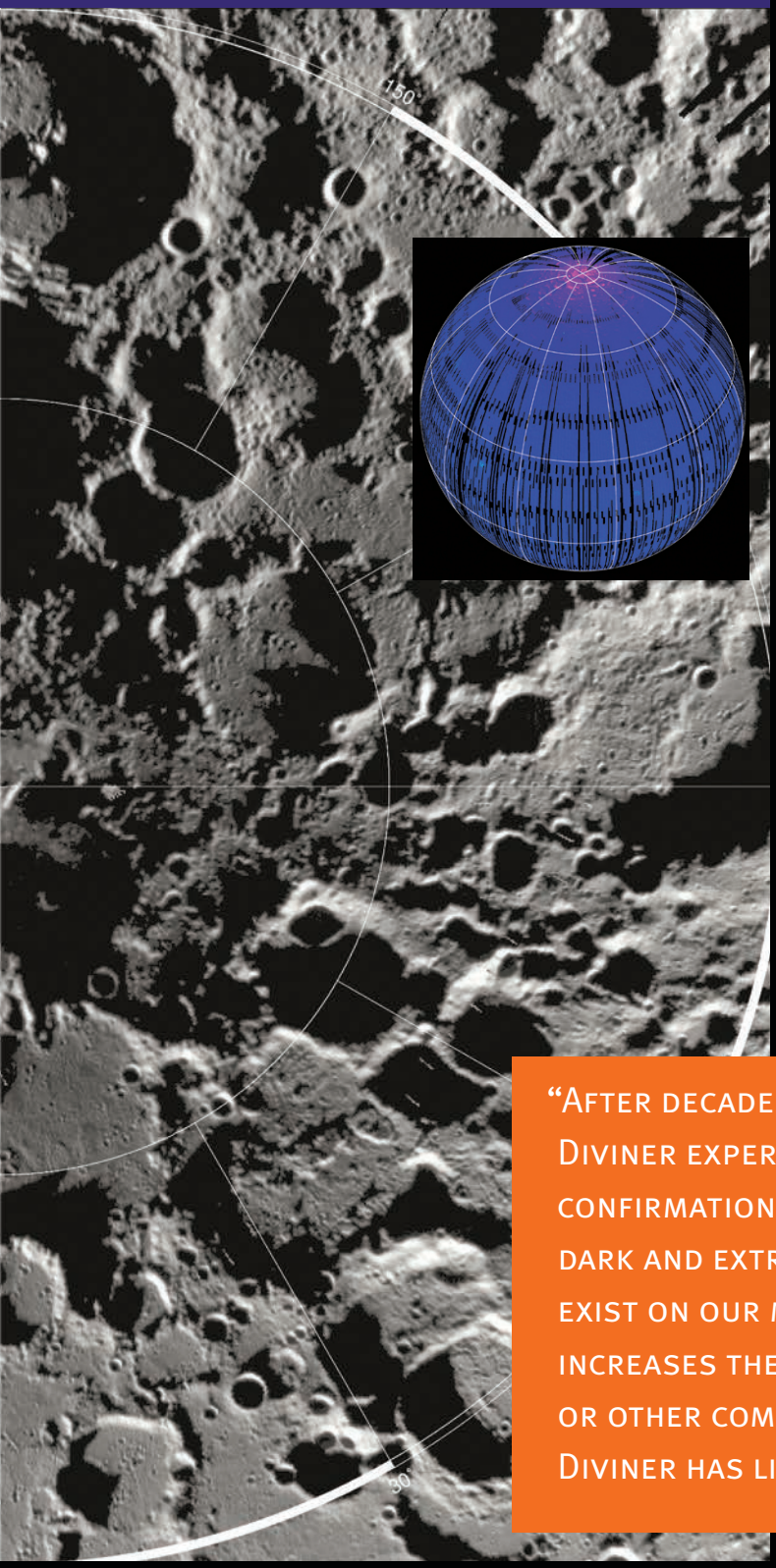
"After decades of speculation, the Diviner experiment has given us the first confirmation that strange, permanently dark and extremely cold places actually exist on our moon," said science team member Ashwin Vasavada of NASA's Jet Propulsion Laboratory. "Their presence greatly increases the likelihood that water or other compounds are frozen there. Diviner has lived up to its name."

Diviner also found extremes in temperature in other regions of the lunar surface that can vary by more than 600 degrees. While temperatures in the shadows near the south pole approach minus 400 degrees, the instrument found daytime temperatures near the lunar equator that reached 224 degrees above zero.

Identifying those ultra-cold areas on the Moon are important because they can trap volatile chemicals, such as water and methane, that could give astronauts resources to use for extended stays, and could also help scientists understand more about the origin of the solar system.

"It is safe to conclude that the temperatures in these super-cold regions are low enough to cold-trap water ice, as well as other more volatile compounds, for extended periods," Paige said. "These cold traps have been predicted theoretically for almost 50 years. Diviner is now providing detailed information regarding their spatial distribution and temperatures."

"Getting a look at the first global thermal maps of the lunar surface," said Paige, "is giving us a whole new way of seeing the moon."



Center: A high-resolution thermal map of the north polar region of the moon, taken by the Lunar Reconnaissance Orbiter. Insets: maps of lunar temperatures during the day (far left) and at night (above left).

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For findings from the Diviner Lunar Radiometer Experiment, visit www.moon.ucla.edu