Discovery of CO_2 Ice on the Surface of the Uranian Satellite Ariel

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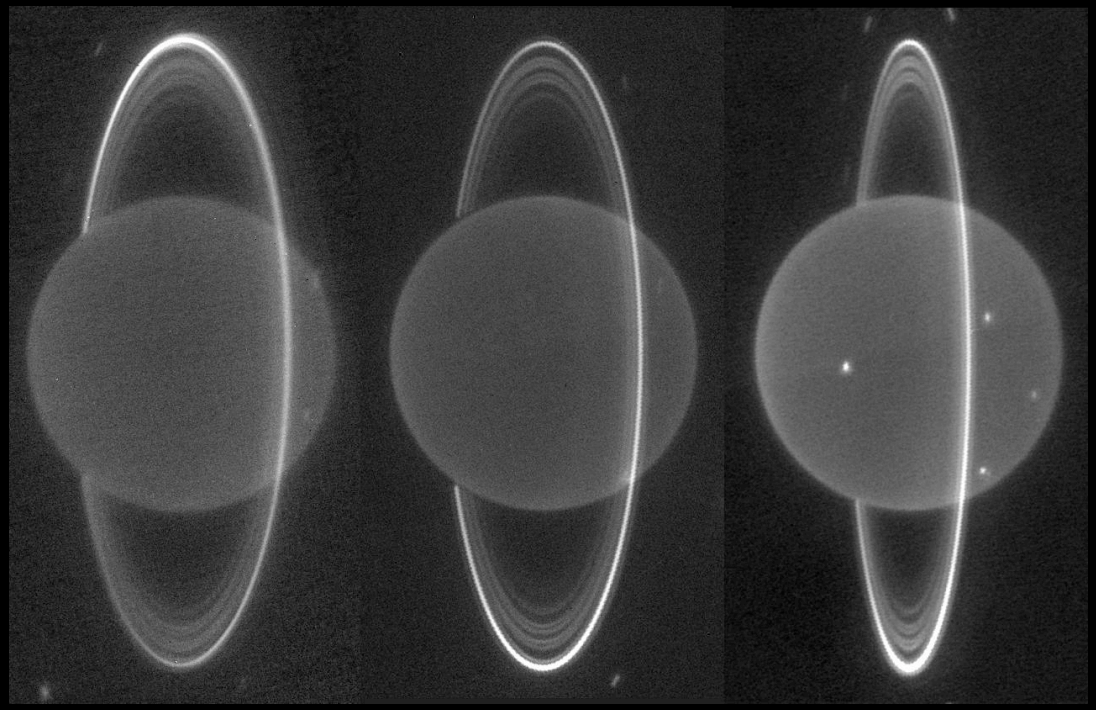
Grundy et al. 2003, Icarus, 162, 222.

During the past 2 decades of infrared spectroscopy searching for longitudinal variability on the Uranian satellites has been hampered by the nearly pole-on orientation of the Uranus system. But the Uranian equinox is finally approaching, enabling longitudinally-resolved observations.



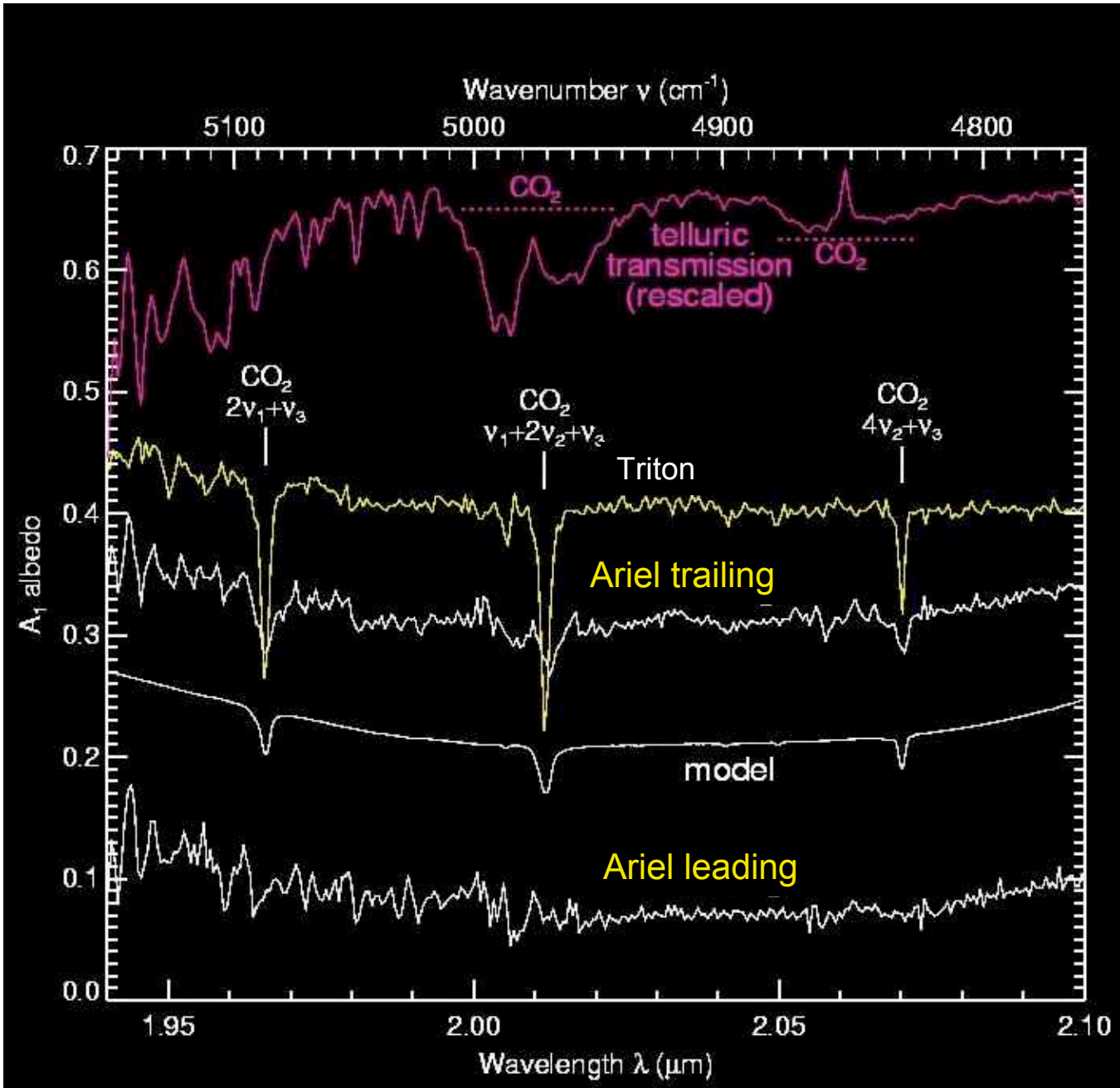
2002 2003 2004

Keck images at K' (2.2 μm)

Uranus approaching equinox. Figure from Heidi Hammel.

IRTF/SpeX observations during July 2002 have revealed for the first time differences between the leading and trailing hemispheres of the satellite Ariel: the trailing hemisphere spectrum shows 3 narrow CO_2 ice absorption bands near 2 microns (see next figure).

This discovery of CO_2 ice on one hemisphere of Ariel is its first detection in the Uranian system and is the first new species to be discovered on a Uranian satellite since water ice was detected some 2 decades ago. Its presence also raises many questions, such as: Why is it only on the trailing hemisphere? Why is it not seen on any of the other Uranian satellites? Where did it come from and how stable is it?



IRTF/SpeX spectra of Ariel's leading and trailing hemispheres, offset up and down, respectively. For comparison, a spectrum of Neptune's satellite Triton is included (also offset vertically), as well as a model spectrum based on a mixture of water ice and dark dust, with a patch of CO_2 ice covering 8 percent of the surface area. The pink curve shows extinction by the Earth's atmosphere, which also contains CO_2, but in the gas phase.

Preliminary models show that 8 percent or more of Ariel's trailing hemisphere must have CO_2 ice on it. The CO_2 ice could be confined to the northern hemisphere not mapped by the Voyager spacecraft in 1986, but it could equally well be distributed all over the trailing hemisphere.

Compared with water ice, CO_2 ice is much more easily sputtered by radiation from the Uranian magnetosphere. This radiation should predominantly impinge on Ariel's trailing hemisphere, where the CO_2 ice was found. Why the CO_2 is there, and not on the leading hemisphere where radiation doses are milder, remains a mystery which future observations and models will seek to resolve.