

Deuterium on Venus: Observations from Earth B. L. Lutz
C. de Bergh
B. Bézard
T. Owen
D. Crisp
J.-P. Maillard

The amount of deuterium relative to hydrogen in the atmosphere of Venus is a fundamental constraint on models for the evolution of its atmosphere. For example, a large enrichment of deuterium, compared to the protosolar value, would support arguments of a wet Venus in its early history, although its present-day atmosphere is water-deficient by 4 to 5 orders of magnitude. The deuterium-to-hydrogen ratio has been a controversial topic, with *in situ* observations by the Pioneer Venus Orbiter, suggesting a hundredfold enhancement of the deuterium-to-hydrogen ratio compared to that ratio on Earth. Yet ultraviolet spectra recorded by the International Ultraviolet Explorer provided an upper limit significantly less.

In view of the importance of the deuterium-to-hydrogen ratio in understanding the evolutionary scenario of planetary atmospheres and its relationship to understanding the evolution of our own on Earth, we undertook a series of observations designed to resolve the previous observational conflicts. We observed the dark side of Venus in the 2.3 μm spectral region in search of both H_2O and HDO , which would provide us with the D/H ratio in Venus' atmosphere. We identified a large number of molecular lines in the region, belonging to both molecules, and, using synthetic spectral techniques, obtained mixing ratios of 34 ± 10 ppm and 1.3 ± 0.2 ppm for H_2O and HDO , respectively. These mixing ratios yield a D/H ratio for Venus of $\text{D/H} = 1.9 \pm 0.6 \times 10^{-2}$ and 120 ± 40 , times the telluric ratio. Although the detailed interpretation is difficult, our observations confirm the Pioneer Venus Orbiter results and establishes that indeed Venus had a period in its early history in which it was very wet -- perhaps not unlike the early wet period that seems to have also been present on Mars -- and that, in contrast to Earth, lost much of its water over geologic time.