



Isotopic Ratios in Titan's Atmosphere from Cassini CIRS

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Isotopic ratios in planetary atmospheres are valuable sources of information regarding the formation and evolution of the body. Their present-day values may also be ambiguous, reflecting the sum total of many processes that can alter the ratio from primordial: physical and chemical processes in the nebula, during primary or secondary atmospheric formation, and subsequently. For this reason, deducing a unique past history for a given isotopic ratio is rarely straightforward.

Since Cassini's entry to Kronian orbit in 2004 the spacecraft has made more than 50 close flybys of Titan, during which the Composite Infrared Spectrometer (CIRS) instrument has been active in mapping the thermal emissions from stratospheric gases. The large improvement in spectral resolution and sensitivity over Voyager IRIS, combined with the ability to make repeated long-path limb observations to increase signal-to-noise, has proved CIRS to be a powerful tool for measuring isotopic variants of stratospheric gases.

These measurements provide an ideal complement to those of the Huygens probe mass spectrometer (GCMS). Whereas GCMS provided a single, high-precision value for the isotopic ratios in the most abundant species (e.g. D/H in H₂), CIRS instead provides multiple, lower-precision measurements of the same isotopic ratios in different gases. So far, CIRS has published values for four ratios (D/H, ¹²C/¹³C, ¹⁴N/¹⁵N, ¹⁸O/¹⁶O) in six gases (CH₄, C₂H₂, C₂H₆, HCN, HC₃N, CO₂), totalling ten different molecular ratios in all (six ¹³C variants, two deuterated gases, and one of each ¹⁸O and ¹⁵N). Divergence of the values between species (e.g. D/H is different in H₂ and CH₄; ¹⁴N/¹⁵N is different in HCN than in N₂) can then be used to constrain models of fractionation.

In this paper we summarize the molecular isotopic measurements by CIRS to date, and their current interpretations; we also outline which other ratios will potentially be detected by CIRS during the Cassini extended mission.