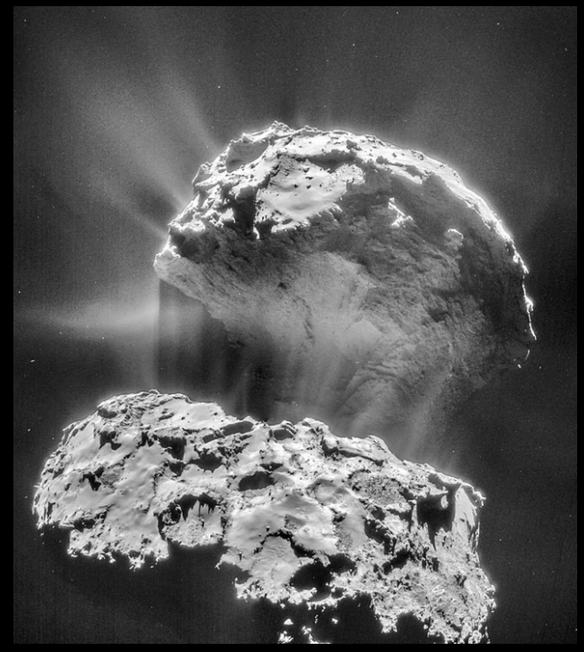
Where is the nitrogen in primordial bodies? Clues from the study of an ammonium salt

Nitrogen abundances seen in cometary comae are smaller than expected. These abundances are primarily determined by measuring the volatile gases ammonia ($NH_{3)}$ and hydrogen cyanide (HCN). One possibility is that there is a reservoir of nitrogen that is less volatile and requires higher temperatures to be observable.

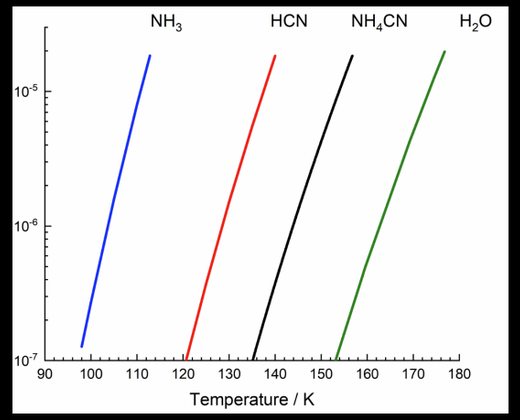
Ammonium salts are a prime suspect, based partly on evidence observed in the dust and surface ices of comet 67P/Churyumov-Gerasimenko. They can also have a substantial role in prebiotic chemistry. Yet, these species are difficult to detect remotely.

A team from Goddard has measured several properties of ammonium cyanide (NH_4CN) in the laboratory with higher accuracy than before, including its infrared absorption properties for use in quantifying its abundance in interstellar and planetary ices and the first detailed measurements of its sublimation behavior since 1882. All properties were measured at temperatures relevant to subliming cometary ices.

The new laboratory results confirm that NH_4CN will be retained in cometary ices at temperatures higher than NH_3 or HCN. The lab data also provide detailed information that can be used to better study ammonium salts in other environments.



Comet 67P/Churyumov-Gerasimenko with sublimating dust and gas as seen by the Rosetta spacecraft. Image credit: ESA.



Laboratory data from Goddard reveal the temperature sequence (from left to right) of the sublimation of cometary gases.

P. A. Gerakines, Y. Y. Yarnall, R. L. Hudson, 2024, Sublimation and infrared spectral properties of ammonium cyanide. Icarus 413, 116007. https://www.sciencedirect.com/science/article/pii/S0019103524000654