CONTROL ID: 2255393

TITLE: Herschel/HIFI Legacy Survey of HF and H2O in the Galaxy: Probing Diffuse Molecular Cloud Chemistry

ABSTRACT BODY:

Abstract Body: We combine Herschel observations of a total of 13 sources to construct the most uniform survey of HF and H2O in our Galactic disk. Both molecules are detected in absorption along all sight lines. The high spectral resolution of the Heterodyne Instrument for the Far-Infrared (HIFI) allows us to compare the HF and H2O distributions in 47 diffuse cloud components sampling the disk. We find that the HF and H2O velocity distributions follow each other almost perfectly and we establish that HF and H2O probe the same gas-phase volume. Our observations corroborate theoretical predictions that HF is a sensitive tracer of H2 in diffuse clouds, down to molecular fractions of only a few percent. We use HF as a surrogate tracer of H2 to study the variations of H2O column density -relative to HF- within the Galactic disk diffuse gas. We find that the N(H2O)-to-N(HF) ratio shows a narrow distribution with a median value of 1.51. Our results therefore add weight to the previous suggestion that H2O can also be used as tracer of H2- within a factor of 2.5- in the diffuse ISM- in the absence of HF or CH observations. We show that the measured variation of about a factor 2.5 around the median is driven by true local variations in the H2O column density throughout the disk. The latter variability allows us to test our theoretical understanding of the chemistry of oxygen-bearing molecules in the diffuse gas. We will show that both gas-phase and grain-surface chemistry are required to reproduce our H2O observations. While most chemical pathways involve gas phase reactions alone in the diffuse ISM, we will demonstrate that our survey confirms that grain surface chemistry can play a significant role in the production of some molecular species, such as gas phase H2O, in this low-density environment.

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