DETECTION OF PARENT MOLECULES IN THE IR SPECTRUM OF P/HALLEY WITH THE IKS-VEGA SPECTROMETER

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The two spectroscopic channels of the IKS experiment on board the VEGA probes were designed for the detection of emission bands of parent molecules and/or cometary dust, in the the 2.5-5μm range and the 6-12μ range respectively. On VEGA 1, the experiment worked successfully, and cometary spectra were recorded at distances D from the comet nucleus ranging from about 250,000 to 40,000 km. The field of view was 1° and the spectral resolving power was about 50. On VEGA 2, no result could be obtained due to a failure of the cryogenic system.

The strong internal background signal caused by the (uncooled) instrument had to be eliminated. As it was not possible to use a sky chopper, the signal was only modulated by the rotation of the CVF wheel. In order to remove the background, we used the difference between the current spectrum and a reference spectrum with a very small cometary signal taken at the beginning of the sequence (D$\sim$200,000 km). A good test of the reliability of a cometary feature is its evolution with distance D: the signal of a parent molecule, as well as the cometary dust, with a density distribution in r^{-2}, is in first order expected to vary as D^{-1}.

In the 2.5-5μm channel, strong emission features, which follow the expected D^{-1} variation, are attributed to parent molecules: H_2O, CO_2, and CH-bearing molecules, at 2.7, 4.3 and 3.3-3.4μm, respectively. Other weaker features also follow the D^{-1} law and are tentatively attributed to parent molecules: H_2CO at 3.6μm, CO at 4.6 and 4.7μm, and possibly OCS at 4.8μm and a CN-bearing molecule at 4.4μm. In addition, there is an emission feature at 2.8μm which does not follow the D^{-1} law but is stronger at the beginning of the sequence when the observed coma diameter is larger: it might be attributed to the daughter product OH. Finally, there is an absorption feature at 2.9μm which could be attributed to H_2O ice.

In the 6-12μm region, the cometary signal is dominated by the emission of dust, which is characterized by a blackbody emission at about 350K, with a strong and broad emission due to silicates between 8 and 12μm. This broad emission shows two distinct peaks at 9 and 11.2μm, which, as suggested by Bregman, can be well interpreted by the presence of olivine. The emission announced at 7.5μm in the preliminary reduction of the IKS data (Combes *et al.*, 1986) is now known to be of instrumental origin. The final IKS spectrum between 6 and 12μm is in very good agreement with the other spectra recorded from the KAO (Campins *et al.*, 1986; Bregman *et al.*, 1987) and from the ground (Bouchet *et al.*, 1987).

The derived production rates of H_2O and CO_2 are 10^{30} and $2x10^{28}$ respectively. Other production rates are indicated in Table 1. The 3.3-3.4μm feature is attributed to hydrocarbons in both the saturated (3.4μm) and unsaturated (3.3μm, alkenes and/or aromatics) forms. The fact that we see no associated features beyond 6μm can be simply interpreted if we assume the hydrocarbons are in the form of gaseous molecules, excited by resonant fluorescence as in the case of H_2O and CO_2. With this assumption, we derive a total number of carbon atoms of about 30 percent of H_2O.

REFERENCES

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TABLE I

Molecule	H_2O	CO_2	Hydro-carbons	H_2CO	CO	OCS	CN-Mol
Wavelength(μm)	2.7	4.3	3.3-3.4	3.6	4.6-4.7	4.8	4.4
Production Rate (s^{-1})	10^{30}	$2x10^{28}$	$2x10^{29*}$	$5x10^{28}$	$5x10^{28}$	$5x10^{27}$	?

*Total number of carbons.

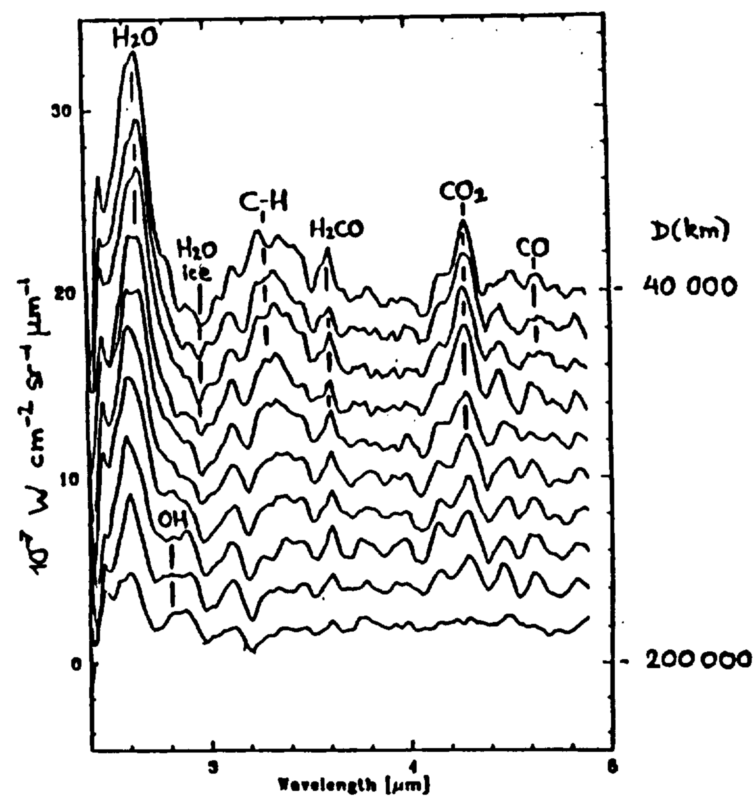

Figure 1 - Evolution of the cometary signal as a function of nucleus distance, as the spacecraft approaches the nucleus. Top: D=40,000 km; bottom: D=200,000 km.

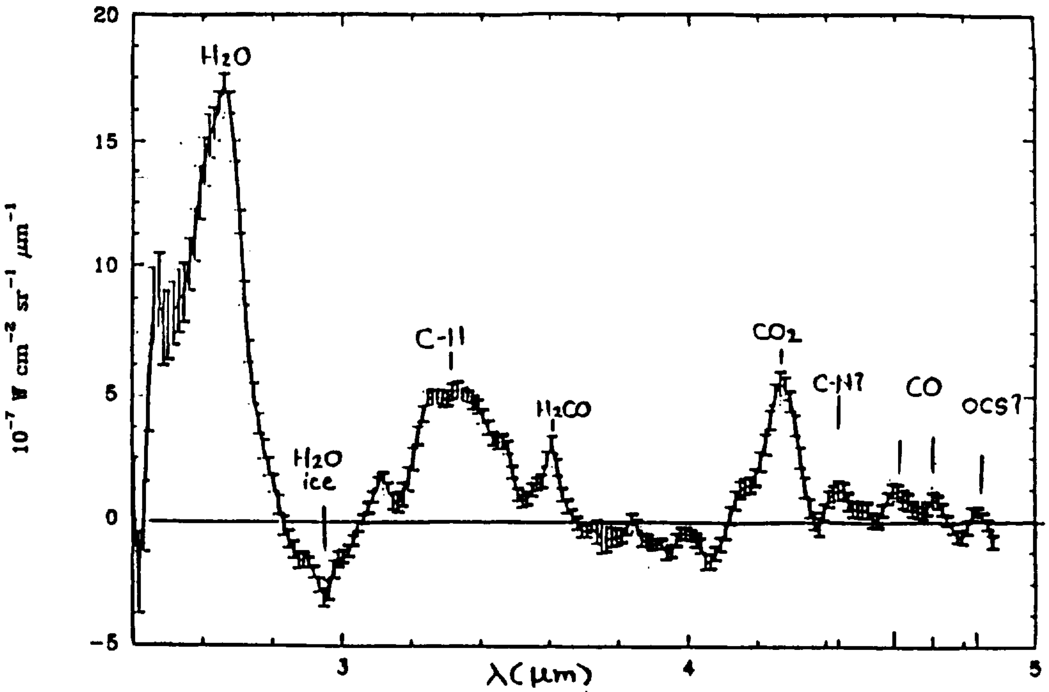

Figure 2 - Extraction of the 1/D part of the cometary signal between 2.5 and 5μm. Signatures of secondary cometary products are eliminated in this procedure. The emissions are interpreted as the signatures of parent molecules. The vertical scale corresponds to a distance to the nucleus D=40,000 km.

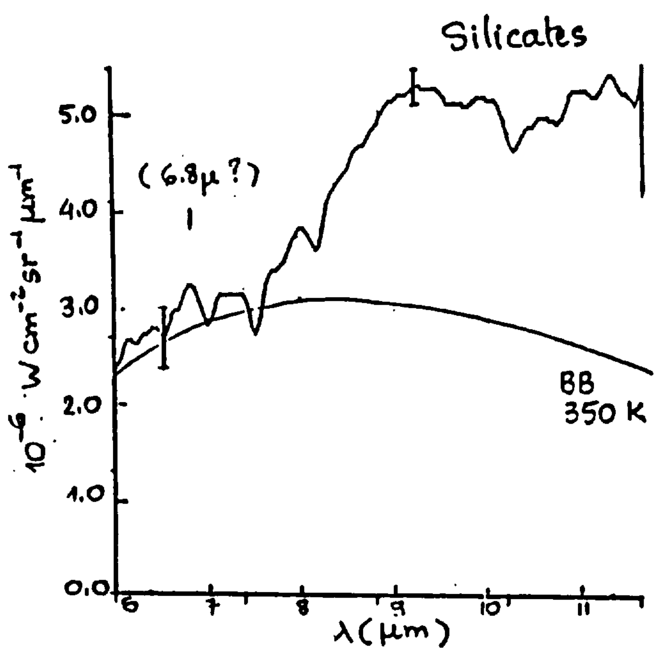

Figure 3 - The spectrum of the central coma (diameter of 700 km) between 6 and 12μm. The broad emission between 8 and 12 μm is the silicate signature. The distance to the nucleus is 40,000 km.