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OH Fluorescence and Prompt Emission in comet 103P/Hartley 2 observed by EPOXI mission and expected results for comet 67P/Churyumov-Gerasimenko observed by Rosetta/OSIRIS WAC camera

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Abstract

The OH radical, observed in cometary comae, is the direct dissociation product of water. Given the strong $A^2\Sigma - X^2\Pi\ (0,0)$ emission band in the near-UV at 308.5 nm due to resonance fluorescence, the OH radical has been used, for years, as a tracer of the water parent molecule. Specifically, the OH fluorescence band provides an immediate tool to monitor the water production rate and its variations with the comet's heliocentric distance, rotational period and possible activity changes.

Photolysis of water in cometary comae gives rise, with a non negligible branching ratio, to OH fragments in the first electronically excited state (OH*). This state is very unstable, with a lifetime of about 10^{-6} s (Becker and Haaks, 1973), therefore OH* molecules promptly decay to the ground state. This process, generally referred to as prompt emission (PE), is responsible for an emission band in the near-UV ranging approximatelly from 306 to 325 nm. Original studies and tentative detections of OH PE have been put forth by Bertaux (1986), Budzien and Feldman (1991), Bonev et al. (2004), A'Hearn et al. (2007) using ground and space observations. Both from the above mentioned works together with our analysis, this process is expected to be prominent at short distances from the nucleus, where there is high density of water molecules, requiring the need of spacecraft observations to reach the necessary resolution.

The hyperactive Jupiter family comet 103P/Hartley 2 has been visited by EPOXI spacecraft on 4 November 2010 at a minimum distance of 694 km, when it was at 1.064 AU from the Sun (A'Hearn et al. 2011). We present the analysis of photometric observations in OH filter acquired by MRI camera onboard EPOXI used to investigate the spatial distribution of OH in the coma of Hartley 2. The data revealed a radial OH structure within 35 km from the nucleus, appearing to be coming directly from the nucleus, in the region of the central waist. A theoretical computation evidencing a strong possibility that this OH structure could be partially associated with OH PE has been performed. This is strongly supported by the agreement of the OH spatial distribution with the water spatial distribution derived from HRI IR spectrometer observations (A'Hearn et al. 2011).

Given the results on comet Hartley 2, we present our expectations and preliminary analysis of OH fluorescence and prompt emission mechanisms in the coma of 67P/Churyumov-Gerasimenko, target of the Rosetta mission. The OSIRIS WAC camera on board Rosetta is equipped with 7 narrowband filters centered on molecular emission bands, including the OH gas filter. This will enable us to investigate OH fluorescence and PE at increasing resolution as Rosetta will approach the comet. This analysis, supported by accompanying observations acquired by OSIRIS WAC camera in the forbidden OI band at 630 nm, will help in further constrain the water photochemistry and the fluorescence and PE processes occurring in the cometary comae.

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