

## Observation of Ammonia and Methanol in comet 67P with MIRO onboard Rosetta

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### Abstract

The Microwave Instrument on the Rosetta Orbiter (MIRO) [5] makes submillimeter- and millimeter-wavelength observations of the nucleus and coma of the target of the Rosetta mission: comet 67P/Churyumov-Gerasimenko. MIRO is probing both the continuum emission of the nucleus at 0.5 and 1.6 mm wavelength and the gaseous emission via high-resolution spectroscopic measurements of 8 molecular lines in the submillimeter range ( $\text{H}_2\text{O}$ ,  $\text{H}_2^{17}\text{O}$ ,  $\text{H}_2^{18}\text{O}$ ,  $\text{CO}$ ,  $\text{NH}_3$ , and three lines of  $\text{CH}_3\text{OH}$ ).

Since Rosetta arrived in the vicinity of comet 67P/Churyumov-Gerasimenko in July 2014, MIRO has been observing the coma almost continuously. Water emission at 556.9 GHz has been detected since early June 2014 [6] and the water outgassing of the comet and its spatial distribution has been regularly monitored and mapped [4, 6, 7].

MIRO is also observing the fundamental rotational transition  $J_K=(1_0 - 0_0)$  of ammonia at 572.5 GHz and three lines of methanol:  $J_K=(3_{-2} - 2_{-1}\text{E})$  at 568.6 GHz,  $(8_{+1} - 7_0\text{E})$  at 553.1 GHz and  $(12_{-1} - 11_{-1}\text{E})$  at 579.2 GHz. The ammonia line and the lowest energy  $(3_{-2} - 2_{-1}\text{E})$  methanol line have been detected in absorption against the nucleus of the comet (Fig.1,2) and in emission in the coma since August 2014, when Rosetta was at distances between  $\approx 10$  to  $\geq 100$  km from the nucleus.

We will present the results of one year of monitoring of the ammonia and methanol emissions. The measured  $\text{NH}_3$  and  $\text{CH}_3\text{OH}$  abundances relative to water in comet 67P/Churyumov-Gerasimenko will be compared to remote measurements made in several other comets [1, 2, 3].

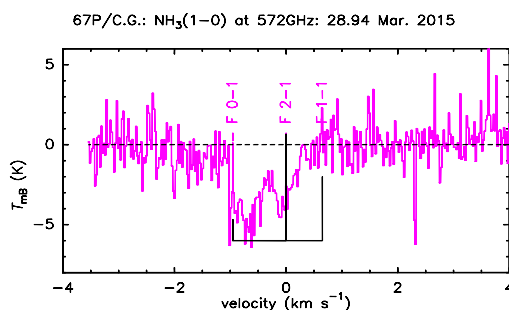


Figure 1: Ammonia detection in absorption against the nucleus of comet 67P on 28 March 2015 with MIRO.

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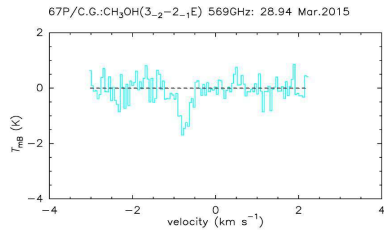


Figure 2: Methanol detection in absorption against the nucleus of comet 67P on 28 March 2015 with MIRO.

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