

# The first Herschel/HIFI spectral survey: methanol between 452 and 500 GHz

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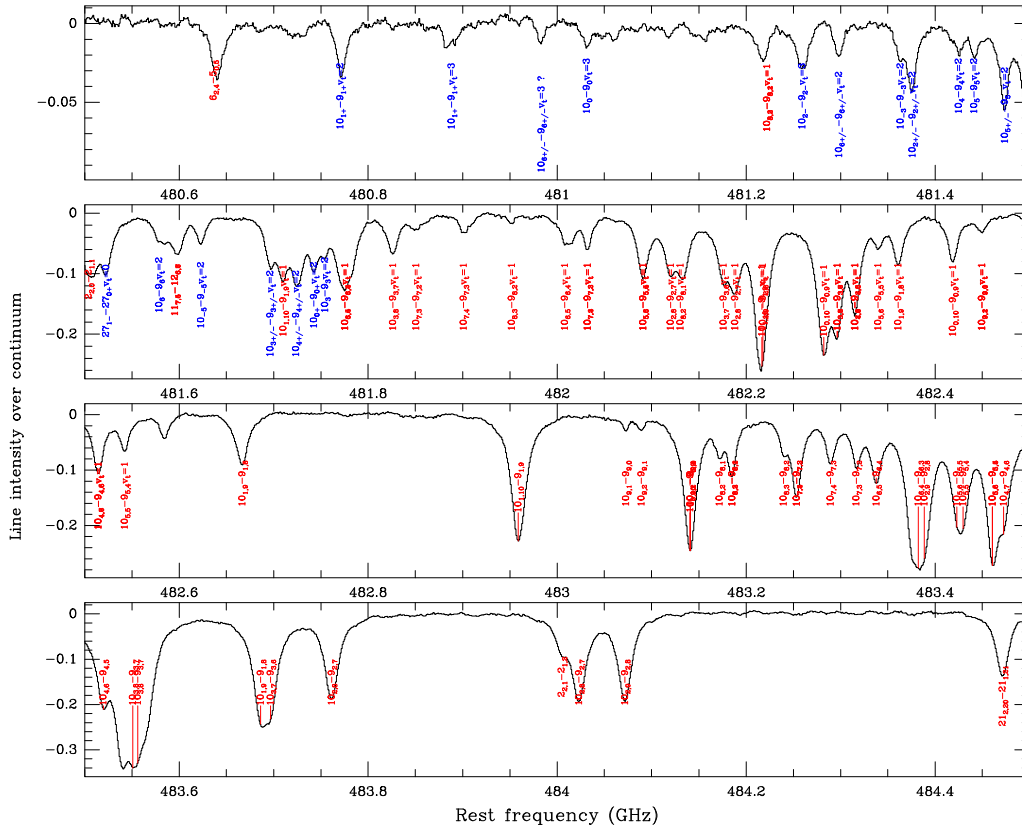
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## Abstract.

We present the first submm spectral survey measured by the Heterodyne Instrument for the Far-Infrared (HIFI), to be flown onboard the Herschel Space Observatory in 2007. The survey was obtained during one of the pre-flight qualification campaigns on the so-called *Development Model* (DM) of the instrument. Methanol (CH<sub>3</sub>OH) was observed through a 1 m long gas cell fed by a chopped hot/cold load at ambient and LN<sub>2</sub> temperatures respectively (Teyssier et al. 2004). The survey extends from 452 to 500 GHz and was conducted using the DM of the Band1 SIS receiver of HIFI, which offered Double-Sideband (DSB) system noise temperatures of order 150 K. The survey makes use of 23 independent Local Oscillator (LO) settings, each of which yields an instantaneous IF bandwidth of 4 GHz, sampled by a 1 MHz resolution AOS. Frequency steps varied between 1.5 and 1.6 GHz, allowing a redundancy of order 2-3. The Single-sideband (SSB) reconstruction has been performed using the Maximum-Entropy-Method (MEM) described in Comito & Schilke (2002). 200 lines are detected over the whole deconvolved survey, showing that the method works well even at the edge of the surveyed band where the redundancy is lower.

The deconvolved spectrum has relatively few ghost features (28 out of a total of 200 lines), and their intensity is of the order of 1% of the continuum level. The identified lines are a mixture of the ground torsional state  $v_t=0$  (102 lines), and of first to third excited torsional states (respectively 48, 17 and 3-4 lines). 30 of the lines were first labelled as unidentified as we found no corresponding frequencies in either the JPL or the CDMS spectral databases. However, these lines could be identified using recent laboratory measurements obtained at the JPL by J. Pearson and collaborators, using FM modulated spectra. They correspond mostly to lines from the torsional state  $v_t=2$ , and feature 3 (+1 doubtful)  $v_t=3$  cases. These are the first reported detections in this excited torsional state with a heterodyne instrument. This work shows the high potential of spectral surveys with the HIFI instrument, and the power of the reconstruction method, even for species or areas with very crowded spectra. For the record, the whole survey needed about 2 h of measurement time, suggesting that larger pre-flight surveys could probably be achieved in short times once the system is fully operational.

**Keywords.** molecular data, surveys, submillimeter, instrumentation: detectors, methods: data analysis



**Figure 1.** Extract of the HIFI methanol survey SSB spectrum between 480.5 and 484.5 GHz, showing a particularly crowded area. Identified lines are indicated in red with their transition names. Formerly unidentified lines are labelled in blue. Note that the line intensity scale is updated for each frequency chunk.

## References

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