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Observations of Neptune and Uranus with Herschel

E. Lellouch (1), P. Hartogh (2), H. Feuchtgruber (3), C. Jarchow (2), R. Moreno (1), B. Swinyard (4), T. de Graauw (5), T. Cavalié (2), G. Orton (6), B. Vandenbussche (7) and the HssO team
(1) Observatoire de Paris, France (emmanuel.lellouch@obspm.fr) (2) MPS, Lindau, Germany (3) MPE, Garching, Germany (4) RAL, Oxfordshire, UK (5) SRON, Groningen, NL, (6) JPL/Caltech, Pasadena, USA (7) KU Leuven, Belgium

Abstract

In the framework of the Key Program "Water and related chemistry in the Solar System" [1], Neptune and Uranus are scheduled to be observed by the three *Herschel* instruments. The observations consist of (i) full range spectra by SPIRE and PACS, covering respectively the 200-670 and 52-220 µm range (ii) dedicated line scans with PACS (iii) observations of the water 1_{10}-1_{01} line at 557 GHz by HIFI. For both planets, the aims are (i) to determine the abundance of water and possibly its vertical distribution, with the ultimate goal of establishing the input flux of water and its origin (ii) to measure the D/H ratio in both planets, using the HD R(0) and R(1) lines at 56 and 112 µm (iii) to measure the abundance and profile of methane in their stratospheres, using CH_4 rotational lines over 80-160 µm (iv) to determine the vertical profile of CO in Neptune's stratosphere, and confirm/infirm a non-uniform vertical distribution that would result from a dual internal/external origin, as previously claimed [2,3] (v) to search for additional species, such as phosphine, in Neptune and Uranus.

Full range and dedicated CH_4 line scan observations of Neptune with PACS have been obtained early in the mission (Oct. 30-31) and their preliminary analysis has been reported (Lellouch et al. 2010, see Fig. 1). Lines due to CH_4, HD, CO and H_2O are detected as expected, but no new molecule was found. These observations allow, in particular, a precise determination of the CH_4 stratospheric abundance to be obtained ((1.5+/-0.2) x 10^{-3}). This is ~10 times greater than allowed by the saturation cold trap at 56 K. The most probably origin of this elevated abundance is that CH_4 leaks from the hot southern region (62-66 K at the tropopause, Orton et al. 2007). Preliminary values of the D/H abundance and of the H_2O and CO vertical distributions were also inferred (Lellouch et al. 2010). However, these findings will be doubtless refined and superseded when dedicated PACS line scans scheduled for late May 2010 are analyzed, and when high S/N SPIRE spectra are recorded. These data will be combined with a deep HIFI observation of the water 557 GHz obtained on May 16, 2010

Similar observation plans hold for Uranus. A full range PACS spectrum, taken on November 25, 2009, reveals only features due to HD and H_2O, consistent with much lower CH_4 and CO abundances in Uranus than in Neptune.

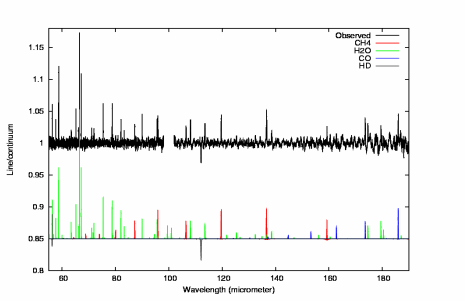

Figure 1: An overview of Neptune's spectrum at 55-190 µm, as seen by PACS. The color-coded curves below are synthetic spectra showing the contribution of CH_4, H_2O, CO and HD (from Lellouch et al. 2010)

References

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