The Giant Planets as seen by ISO

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Abstract

The study of the giant planets's atmospheres -thermal structure, chemical composition, abundance ratios - has greatly benefited from spectroscopic observations with ISO. New discoveries have been achieved in the following areas: (1) determination of the D/H ratio; (2) discovery of new molecules; (3) retrieval of the stratospheric thermal structure; (4) determination of vertical distributions of several species.

The determination of D/H, which has important cosmological and cosmogonical implications, has been achieved through the first detection of HD rotational lines: R(2) on Jupiter with SWS-FP (Encrenaz et al., 1996; Lellouch et al., 1996), R(1) on Saturn with LWS-FP (Griffin et al., 1996); R(2) on Neptune with SWS-grating (Feuchtgruber et al., 1997a). The results are presented by Lellouch et al. at this workshop.

The detection of new species includes: H_2O in the stratospheres of all giant planets; CO_2 in the stratospheres of Jupiter, Saturn and Neptune; CH_3C_2H in the stratospheres of Jupiter and Saturn; C_4H_2 in the stratosphere of Saturn; H_2O in the deep troposphere of Saturn. The Saturn detections (apart from stratospheric H_2O) have been announced by de Graauw et al. (1997). Other results concerning the stratospheric H_2O and CO_2 have been announced by Feuchtgruber et al. (1997b) and Lellouch et al. (1997); they will be presented by Lellouch et al. at this workshop. All these detections have been achieved with SWS in the grating mode.

Information upon the thermal structure of the giant planets is retrieved from the emission bands of methane at 3.3μm (ν_3 band) and 7.7 μm (ν_4 band) (both observed with SWS-grating) which probe pressure levels around a μbar and a mbar respectively. In particular, in the case of Jupiter, a temperature of about 800 K, higher than previously expected from Voyager, has been inferred at a pressure level of 0.16 μbar (Encrenaz et al., 1996); this new result is in agreement with the recent measurements from Galileo. The 7.7 μm CH_4 band has been used to constrain the temperature distributions in the lower stratospheres of Jupiter (Encrenaz et al., 1996) and Saturn (de Graauw et al., 1997).

In the case of Saturn, the vertical distributions of NH_3 and PH_3 (Davis et al., 1996) and CH_4 (Davis et al., 1997) have been retrieved from the LWS in the grating mode. On Neptune, the stratospheric abundances of CH_4, C_2H_2, C_2H_6 and CH_3D have been retrieved by Bézard et al. (1997) in the 7-14 μm range, using SWS-grating; these result lead to a new determination of D/H, in agreement with the HD measurement. On Uranus, only the C_2H_2 band is visible in this spectral range; from its analysis, an eddy mixing coefficient of about 2 10^4 cm^2s^{-1} is inferred at the homopause (Encrenaz et al., 1997); this confirms the very low diffusion in Uranus' stratosphere as compared to the other giant planets.

Other spectroscopic data have also been obtained using PHT-S on Uranus and Neptune, and using CAM-CVF on Jupiter. In particular, the CAM images of Jupiter, coupled with SWS-grating observations at various points of the Jovian disk, will be used for studying the spatial variations of the Jovian atmospheric structure, in view of a better understanding of the planet's global dynamics (see the poster presentation by Encrenaz et al. at this workshop).

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