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Latitudinal asymmetry of the ammonia absorption on Saturn

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Introduction

The ammonia absorption band centered at 647 nm is clearly seen on spectrograms of Jupiter. At lower temperature in Saturn's atmosphere the ammonia must be freezed and its absorption bands seem laying on a limit of detection as they were lost inside of methane absorption bands strengthened in comparison with Jovian ones.. Nevertheless, the spectral observations [1-3] detected certainly a weak band of absorption of the ammonia centered at 647 nm in the spectrum of Saturn, though there were no detailed data about its behavior at different latitudes. There are evidences that in equatorial area of Saturn NH3 absorption lines near at wavelength 5 mkm are weaker than at the temperate latitudes of the southern hemisphere [4,5] turned to the Sun during observation, carried out on infra-red telescope NASA.

Observations

Zonal spectrophotometry of Saturn have been executed on 0.6-meter telescope by means of diffraction spectrometer SGS (dispersion 4.3 A/pixel). with CCD-camera ST-7XE During our researches of latitudinal variations of molecular absorption bands on Saturn's disk of in 2007-2009 we have noted a little bit unusual change of absorption in a band conditionally designated as CH4 670 nm Its depth R =1 - I/Ic (where I - intensity within a band, and Ic - intensity in continuous spectrum) varied with latitude similarly to the depths of other weak bands centered at 702 nanometers and 619 nanometers (Figure.1). However the equivalent width of 670 nm band in northern hemisphere increases more sharp, than for other bands (Figure 2). It was reasonable to assume that the 670 nm band consists actually of two closed bands: the short-wave part of a band in the wavelengths 630-655 nm centered at 647 nm belongs to ammonia, and a long-wave part in an interval of 650-680 nm with the maximal absorption at 687 nm related to methane. Certainly, such division is some conditional because the band of methane absorption is partially Fig.1. Latitudinal variations of the central depths of the absorption bands on Saturn in 2008-2009 seasonblended with ammonia in the short-wave wing.

According to laboratory measurements the band of absorption NH3 of 647 nanometers consists of set of rotary lines which are not resolved completely on the received spectrograms. The laboratory spectrum [6] shows that band have a range 638-656 nanometers so this part of spectrum is responsible for observable additional absorption. Research of a structure of all combined band NH3+CH4 has shown that the ratio N/S (NH3) is less than ratio N/S (CH4), specifying on the additional strengthening of absorption caused by ammonia in northern hemisphere (Figures 3 and 4).

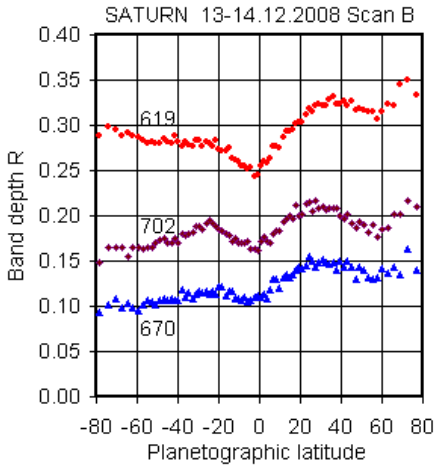

Fig.1. Latitudinal variations of the central depths of the absorption bands on Saturn in 2008-2009 season

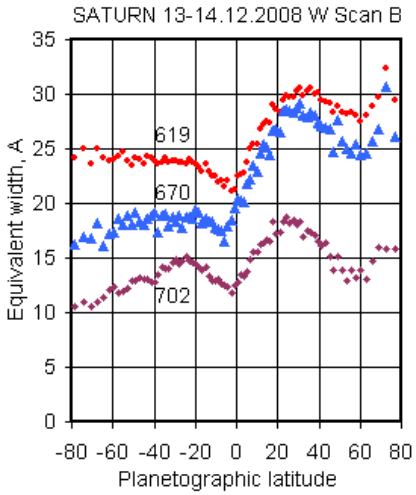

Fig.2 Latitudinal variations of the absorption bands equivalent widths on Saturn in 2008-2009

Analysis

If ammonia absorption did not increase in northern hemisphere, the equivalent width of a band would increase by the same manner as other bands. It may be seen that in the shortwave (ammonia) part of the band absorption in northern hemisphere more than southern approximately for 60 percent whereas absorption of methane (longwave part) increases only for 25-30 percent. For depth of a band this additional growth is not observed because that depth was calculated for wavelength of 667 nanometers, i.e. for a maximum of absorption of methane outside of the ammonia band.

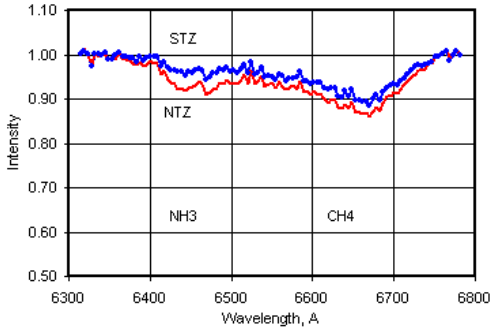

Fig.3 Profiles of the NH3+CH4 absorption band on southern and northern temperate latitudes

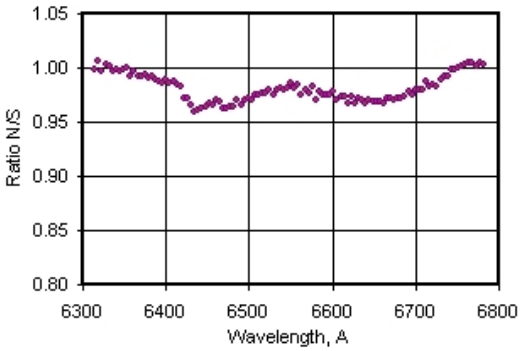

Fig.4. The ratio of N to S profiles of the absorption band NH3+CH4

The described feature - distinction of ammonia absorption in two hemispheres of Saturn - is noted apparently for the first time. Some measurements of longitudinal and latitudinal variations of ammonia lines were carried out earlier [7,8] but they were made not when both hemispheres were equally accessible to view.

Discussion

The reason of latitudinal dependences of intensity of bands of molecular absorption for methane and ammonia, generally speaking, may be not similar.

Methane is not condensed in the atmosphere of Saturn, therefore relative concentration ÑÍ4 and its high-altitude distribution should not depend essentially on latitude and a longitude. Observable variations of absorption of methane are connected with variations of the cloud layers structure (height, volume density, the particles sizes). The upper cloud cover of Saturn consists of crystals of the frozen ammonia so the parity between concentration of solid and gaseous NH3 should be defined by a temperature regime corresponding latitudinal belts of a planet. Therefore for the further interpretation of observable features it is necessary to have data about latitudinal variations of thermal infra-red radiation obtained during the same period.

References

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