SPECTROPHOTOMETRIC STUDY OF THE CHANGES ON JUPITER IN 2009-2011

V.G.Tejfel, V.D.Vdovichenko, G.A.Kirienko, G.A.Kharitonova. Fessenkov Astrophysical Institute, Almaty, Kazakhstan (tejf@hotmail.com)

Introduction. One of the most interesting and active regions on Jupiter is usually dark brown belt SEB, covering the latitudes of 7-17S and engulfing northern half of the Great Red Spot. In 2010, there was observed a process of the SEB fading and "disappearance" similar to what happened in 1989. The maximum stage of this process occurred in the middle of 2010, when the belt has become as light as the neighboring Tropical and Equatorial zones[1]. Analysis of the spectral observations of Jupiter in 2009-2011 revealed some of the features in the character of the latitudinal variations of the methane and ammonia absorption bands in the period of the SEB "disappearance"

Observations. Spectrophotometric observations of Jupiter were carried out on the 0.6-m telescope and diffraction spectrograph SGS with CCD-camera ST-7XE. The technique of observations and processing has been the standard for several years from 2004 [2]. Spectra were recorded in the orientation of the spectrograph slit along the central meridian of Jupiter and also the series of zonal spectra were obtained by scanning the disk from S-pole to N-pole. In the wavelength range 580-920 nm there were measured the profiles of the absorption bands of CH_4 690 nm, NH_3 + CH_4 670 nm, CH_4 725 nm, CH_4 + NH_3 780 nm and CH_4 887 nm.

Separation of ammonia absorption. The NH_3 absorption bands in the spectrum of Jupiter's are overlapped with CH_4, so to separate them an additional procedure is necessary. For combined band CH_4 + NH_3 780 nm there was calculated a ratio of the spectrum of Jupiter to Saturn. In Saturn's spectra the absorption of NH_3 is very weak and that ratio can extract Jovian ammonia band in an almost "pure" view. Fig.1 shows the profile of the combined bands on Jupiter and Saturn in the range of 770-815 nm. The NH_3 band center is located at 790 nm. In the wings of the methane band there may be found two sites at the wavelengths 780 and 803 nm, where the ammonia absorption is absent, and the absorption coefficients coincide with the absorption coefficient of CH_4 in 790 nm. If the spectrum of Jupiter had no band of ammonia, all changes in the intensity of the absorption band on the disk of the planet in three wavelengths (780, 790 and 803 nm) would have to be the same way. The observed differences near 790 nm should be related to the NH_3 absorption

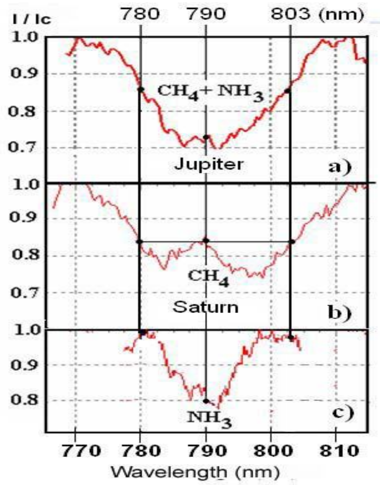

Fig.1 – The band CH_4+NH_3 787 nm in the spectra of Jupiter and Saturn and NH_3 band profile separated by Jupiter / Saturn ratio. Three vertical lines indicate the wavelengths where the pure CH_4 absorption coefficients have equal values.

Measurements and results. In Fig.2 there are shown the measured equivalent widths (W) and central depths (R) of the CH_4 absorption bands 619 nm and 725 nm for three seasons of Jupiter observations in 2009, 2010 and 2011. There may be followed some differences in absorption in SEB during its "disappearance", which lasted for almost the entire 2010. The behavior of these two absorption bands in SEB at this time was different. The W and R values for 619 nm band show almost similar latitudinal variations and reduced absorption within SEB in 2010. In 2009 and 2011 W and R significantly increased from the south side SEB to the north. The situation is similar in the SEB and the absorption band of 725 nm, but the graphics of W and R latitudinal changes for this band differ markedly, particularly for 2010 and 2011. Fig.3a shows the variations of the NH_3 645 nm absorption band equivalent width along the central meridian of Jupiter for three years (2009-2011). During of the SEB "disappearance" the NH_3 absorption in this region was less than in 2009 and 2011. An analysis of several hundreds spectra of Jupiter's central meridian also shows that, in contrast to the area in 790 nm, sections 780 and 803 nm varied equally .Consequently, all of the differences in the behavior of the absorption at 790 nm on the Jovian disk, calculated in relation to the areas 780 and 803 nm (Fig. 3b), can be attributed to variations in the optical path of the absorption of ammonia in relation to that of methane. In the band CH_4 887 nm relative absorption changes (Fig.3c) compared to the Equatorial zone in 2010 were smoother, but in SEB the absorption remained almost the same as in previous year. However, the absorption in the Northern and Southern Tropical zones in 2010 was higher than in other years.

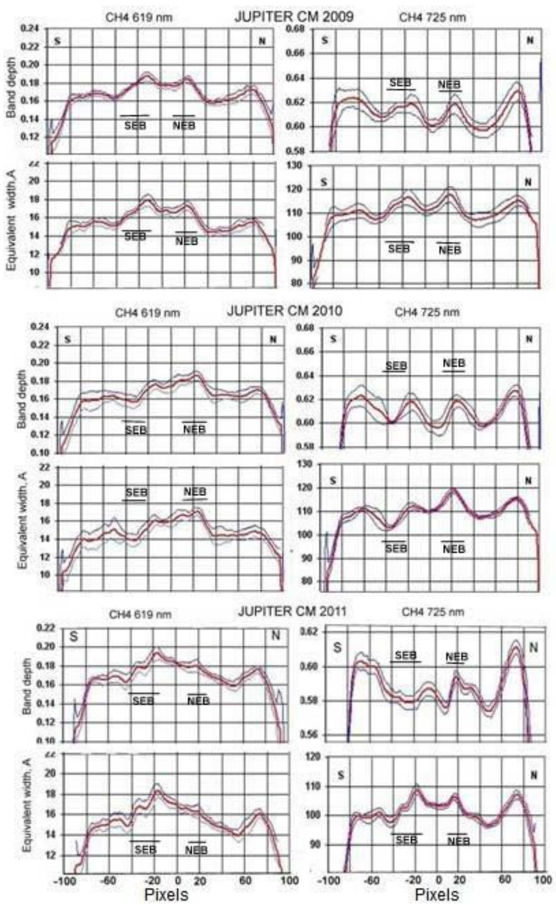

Fig.2 – Variations of the CH_4 619 nm and 725 nm absorption bands equivalent widths and central depths along Jupiter's central meridian in 2009, 2010 and 2011

Discussion. The formation of weak CH_4 absorption bands occurs mainly at multiple aerosol scattering in the cloud or haze layers. For moderate and strong bands significant contribution inputs by the absorption in the atmosphere above the clouds. This effect is particularly noticeable in the absorption band of 887 nm. The NH_3 absorption bands are formed only within the cloud layer at relative concentration of ammonia gas variable with height . Also, the formation of relatively weak band CH_4 619 nm occurs at larger effective optical depths than the band 725 nm. Perhaps the difference in the latitudinal variations of the W and R for CH_4 725 nm band is due to the fact that its central residual intensity corresponds to a higher effective level, while the wings of the band involved in the evaluation of its equivalent width correspond to large optical depths. Consequently, the observed differences in W and R for this band may indicate the existence of vertical inhomogeneity of the cloud cover at different latitudes.

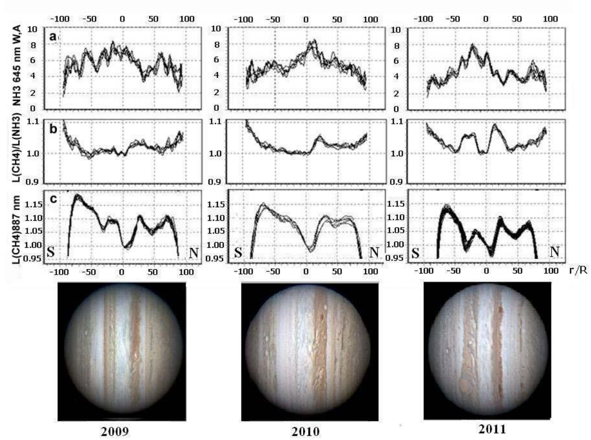

Fig.3 – Variations of the NH_3 645 nm absorption band equivalent width (a), relative and normalised to EZ ratio of the CH_4 and NH_3 optical paths (b) and relative variations of the absorption in the center of CH_4 887 nm band (c).

The observed particularity of the molecular absorption in SEB is likely to be associated with increased volume density of the aerosol component in 2010, which is consistent with the data [3] on the low brightness temperature SEB in 2010 at 4.8 mkm.

References.[1] Perez-Hoyos S., et al. (2012) *Icarus,217,* 256-271.[2] Tejfel V.G., et al. (2008) *LPI Contribution No. 1391,* 1530. [3] Fletcher L.N.,et al. (2011) *Icarus,213,*564-580

.