SOUTH-NORTH HEMISPHERIC ASYMMETRY OF THE ALBEDO AND MOLECULAR ABSORPTION ON SATURN . V.G.Tejfel, A.M.Karimov, G.A.Kharitonova
Fessenkov Astrophysical Institute, Alnaty, Kazakhstan (tejf@mail.ru)

Introduction. All observations of Saturn, made over the past decade indicate that there is significant seasonal changes in the planet's atmosphere. These changes are detected for a number of measuring optical characteristics in a continuous spectrum, and in the molecular absorption bands. Unfortunately, 30-years orbital period of Saturn is too long to realize fully uniform regular observations during though two Saturnian years. Even just taking photos of planets over the past three decades has undergone a radical transformation with the advent of digital image receivers. The same CCD-matrix significantly changed the method of photometry and spectrophotometry. This technique permitted to observe Saturn from rhe 1995 equinox annually up to 2014, i.e. during more than half of its orbital period [1].

Observations at last ewuinox . At Saturn's 2008-2009 apparition both hemispheres of the planet were in equal conditions of sunlit and visibility. A previous equinox took place in 1995 and that time we observed a considerable asymmetry between southern (S) and northern (N) hemispheres in latitudinal variations of methane absorption: in the S-hemisphere, all the CH_4 bands were weaker than in the N-hemisphere [2]

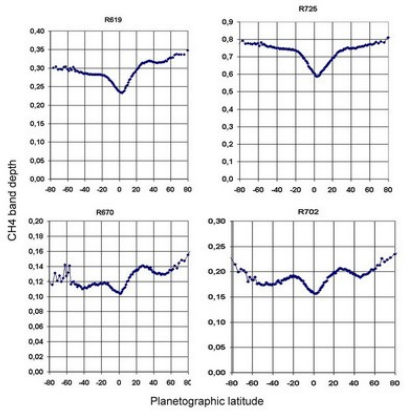

Fig.1 – Latitudinal variations of the CH4 absorption bands depths on Saturn st the equinox-2009.

During the last equinox-2009 more than 600 zonal CCD-spectra of Saturn were recorded and most of them were processed to get the latitudinal distribution of the methane absorption in both hemispheres of yje planet. Maun results as aversged data are shown on Figure 1 for four CH4 bands. Latitudinal CH_4 absorption differences at 1995 and 2009 equinoxes are significant and show in both cases more or less expressed S–N asymmetry. In 1995 sharply expressed asymmetry of the methane absorption in southern and Northern hemispheres has been noted . For all bands the stronger absorption was observed at the temperate latitudes of Northern hemisphere. Minimum absorption is characteristic for an equatorial belt and it remained during all periods of Saturn's observations.

At the temperate latitudes of Southern hemisphere the absorption was much less, than in Northern. It was possible to expect that the opposite picture must take a place at equinox 2009, that is to say the lowered absorption should be in Northern hemisphere and raised in the Southern one. However the observed results were very different from expected (Figures 1-2). Actually in 2009 the equivalent widths and depths of the CH_4 725 nm absorption band have near equal values at temperate latitudes of both hemispheres. The minimum absorption was observed in the equatorial belt. Thus, though the overall picture of latitudinal variations of absorption differs from observed in 1995., but there was not opposite character of asymmetry. It may be interesning snd should be noted that in both 1995 and 2009 the albed0 of Northern hemisphere of Saturn was noticeably lower than pf Southern hemisphere.

Asymmetry and the band intensity. The latitudinal variationa are not similar for the CH4 absorption bands with different intensity as, for instance, 629 and 725 nm bands (Figures 2 and 3). The absorption bands CH_4 619 nm, 702 nm, 675 nm and others are some weaker in Southern hemisphere .

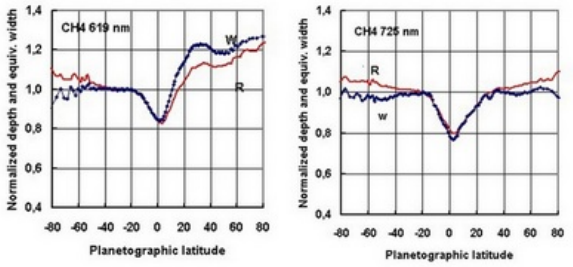

Fig.2- Normalized to -40 deg latitude equivalent widths (W) and depths (R) of the CH4 619 and 725 nm absorption bands

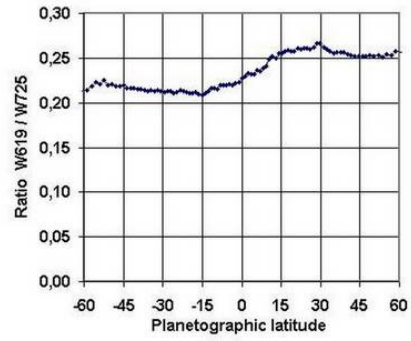

Fig.3 – Latitudinal changes of the CH4 619 and 725 nm bands equivakent widths ratio

There is a definite pattern in the observed asymmetry of absorption: the weaker absorption band, the more different from unit the ratio of its intensity (equivalent widths or depths) in the temperate latitudes of the northern and southern hemispheres. (Figure 4). This may be due to differences in the degree of vertical heterogeneity of the ammonia cloud layer. The reason for the albedo differences in the continuous spectrum must be another

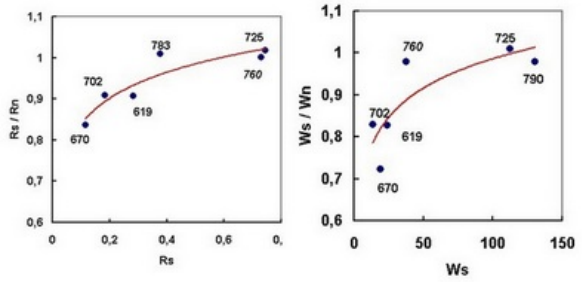

Fig.4- Ratio Soith/North for different CH4 bands , averaged in the latitudes 40-60 deg .Telluric O2 760 nm band ishown for comparison.

Seasonal changes of r asymmetry. Figure 5 shows the methane absorption latjyusinal variations for 1995 and 2009 equinoxes.The main reason for the observed asymmetry of the hemispheres and the of its difference in the periods of the equinoxes in 1995 and 2009 almost certainly connected with the significant eccentricity of the orbit of Saturn. It is very interesting and important that the maximum inclination of the northern and southern hemispheres to the direction of e planet from the Sun. The equinox in 1995 was preceded
northern hemisphere tilted toward the Sun. Equinox in 2009 was preceded by the minimum distance of the planet from the Sun and tipped to him the southernSun coincide with the extremes of the distance of the by the maximum distance of Saturn from the Sun and hemisphere. Such inequality insolation regimes for Saturn's hemispheres, continuing for at least ten years, should be reflected on the state of the atmosphere of Saturn, despite its considerable inertia. The studies of seasonal changes on Saturn were continued also between the last equinoxes [3]. Seasonal effecys sre observed also in another characteristics of the state of Saturn's atmosphere (for instance [4,5]).

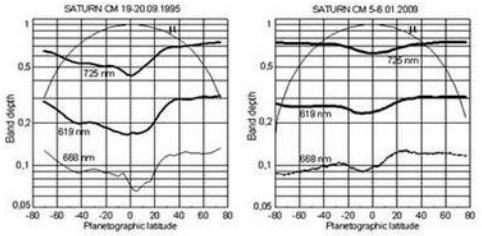

Fig.5– Latitidinal variations pf thr chr absorption bands depths on Satirn in 1995 and 2009.

The cloud altitude differences. In the absence of obscuring the equatorial belt and at the temperate latitudes and estimate some differences in the density and height of the cloud cover. Estimates of the effective optical depths of absorption band formation indicate some differences in a rate of vertical heterogeneity of the cloud layer: in the S-hemisphere it is greater than in the N-hemisphere. Similar differences were observed in the latitudinal variations of the brightness. An upper limit of the altitude difference between the cloud tops at equatorial and temperate latitudes is estimated as 16-17 km from the measurements of both CH_4 absorption bands 619 and 725 nm. These estumates are comparable with Apt and Singer [6] measurements at 1980 Saturn's equinox.

Conclusion: More detailed description of this work is planned to be published in "Solar System Research".

References: [1] Tejfel V.G., et al..(2013) Astron.& Astroph. Transactions, v. 28, 121-134. [2] Tejfel V.G. (1997) Solar Syst.Res., v.31,.198-206. [3] Tejfel V.G..,et al.(2010) LPSC, Abstr.1250 [4] Sinclair J.A. et al. (2013) Icarus, v.s 225 257–271[5] Fletcher L.N. et al.(2015) Icarus, v. 250131-153, [6] Apt J.,Singer R.B .(1982) Icarus, v.52, 581-585.