INFLUENCE OF SOLAR ACTIVITY ON THE BRIGHTNESS FACTOR OF PHOTOMETRIC ACTIVITY OF JUPITER'S HEMISPHERES. A. P. Vidmachenko[1], [1]Main Astronomical Observatory of National Academy of Sciences of Ukraine, Str. Ak. Zabolotnogo, 27, Kyiv, 03680, vida@mao.kiev.ua.

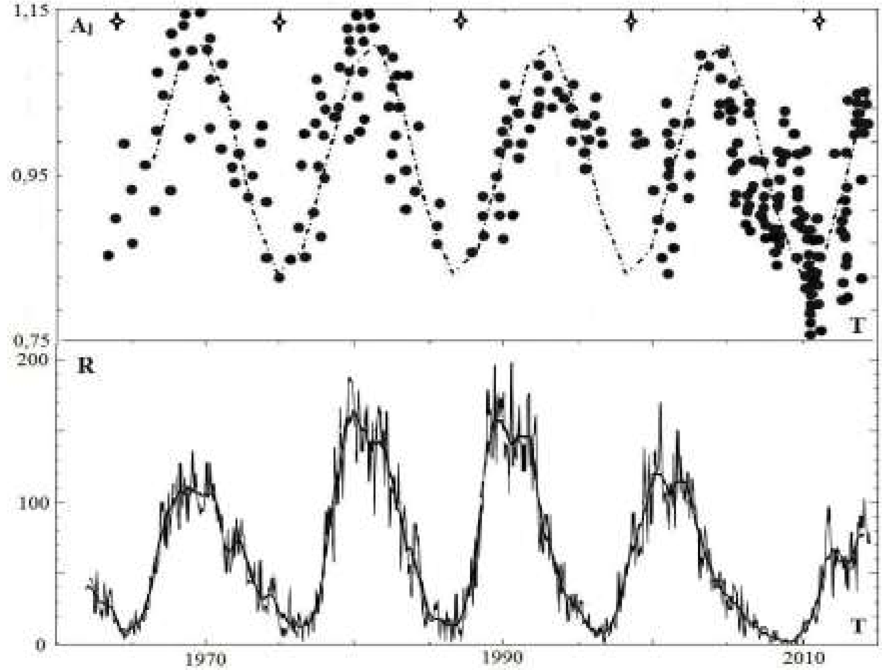

Fig. 1. Top – changing of the factor activity of Jupiter's hemispheres A_J with time T. Below – the changing of the solar activity index R with time T (http://sidc.oma.be/html/sidc_ graphics.html).

When Jupiter moving along the orbit around the Sun there is appreciable difference between inflow of solar energy to different latitudes [14, 15, 21]. The summer solstice occurs in the planet's perihelion. Therefore, due to the orbital eccentricity (e≈0.048) northern hemisphere receives on ≈21% greater of solar energy flow to the atmosphere [1]. These can be responsible on changing of its optical characteristics. Our investigations showed [11, 18, 20, 21] the cyclicality of seasonal changes in proposed by us factor activity A_J of planet's hemispheres with the period of its revolution around the Sun (≈11.86 years).

Analysis of series of the observational data on Jupiter's integral stellar magnitude M_J in the filter V [15], obtained from 1850 to 1991, and a comparison with change of Wolf numbers W, characterizing the variations of solar activity (SA), have shown that in the odd maximums of SA have minimal values of M_J, and in the even maximums – maximal. That is, in change of the Jupiter's brightness is much evident the ≈22.3-year magnetic cycle, rather than ≈11.1-year cycle of the SA. Application to series of these data of our program on spectral analysis on a method entropy maximum [13] allowed to find also a manifestation of the doubled value of orbital period (~23.9 years), and the orbital period (~11.88 years). Changing of the solar radiation flow to the Jupiter's atmosphere because of the variations of SA affects the planet globally. It is observed in the character of the variation of the Jupiter's integral brightness in visible light. A seasonal cycles should appear in changing of the optical properties of the southern, or/and the northern planetary hemispheres. In Fig. 1 (top) by circles are plotted relations brightness northern to southern part of tropical and temperate latitudinal zones A_J. The sign ✧ marked the moments of passage through the perihelion of Jupiter's orbit at a distance of about 4.96 AU from the Sun; dashed line shows an approximation of results of calculations by a sinusoid with a period 11.91±0.07 of Earth years. [20] "Nodes" of values A_J=1 are repeated after the time slightly less than 6 years. It is close to a half-period of Jupiter's rotation around the Sun. But depending A_J(T) it follows that the proposed activity factor of Jupiter's hemispheres not always varies symmetrically relative to its value A_J=1. So in 1969, 1981, 1993, 2004.5 and 2015, Jupiter passed through the aphelion of its orbit in the first two dates are practically at the moment of maximum of solar activity, and then gradually was shifted on 1-2 years after the maximum; that is, already on the decline of SA. This is caused by the fact, that the orbital period of Jupiter around of the Sun has a value $T_J \approx 11.86$, and the period of SA $T_{SA} \approx 11.1$ years.

Solar activity can be characterized by an index R (Fig. 1, bottom), whose dependency with time has a broad maximum with average values R≈105, 155, 170, 115 and 70, respectively in 1967-1970, 1979-1982, 1989-1992, 1999-2003 and 2011-2015. In close to these dates times, summer on the planet was in southern hemisphere. If at the time of perihelion passage, and for 1-2 years before these moments in 1963.8, 1975.6 and 1987.5, the value of SA index was minimal (R≈0-15), in 1998.7 and 2010.6 the SA index was already notable (R≈20-45). That is, in these moments we register the increasing of planet's heating on ≈21% because of its location close to the Sun, and because of selective influence of increased SA on the northern hemisphere. Since 1999, became appreciable a significant "deregulation" in the periodicity of their changes. We see an increasing interconnection of effects on the Sun and the planet at increasing of intensity of solar radiation and growth of the SA.

The radiation at different wavelengths penetrate to different layers of atmosphere. Because of the inertia of the atmospheric climate system the long-term changing of solar energy by 0.1% would lead to a change in the visible atmosphere on a time scale of a decade or more; at changing of solar influx on tenths of a percent, significant changes can occur in the upper troposphere and lower stratosphere during the time from a month to several years. If irradiation sharply change at 1% or more, the atmospheric changing may be noticeable within a few days [4]. It is well known [16, 17, 19] that the intensity of ultraviolet (UV) radiation at 100-390 nm varies by 10-200% in the solar cycle. Therefore, variations in solar radiation in this range can associate the solar cycle with atmospheric circulation [3]. The presence of methane and ammonia in the Jupiter's atmosphere leads to the formation of complex hydrocarbons and ammonia compounds [2, 6]. Therefore, the solar activity cycle and consequences of the orbital motion alters the composition of Jupiter's atmosphere. This leads to different duration of periodicity in Jupiter's brightness changing, and in reflective characteristics of individual features of the disc [5, 8, 12, 14, 15, 18, 20]. For hydrogen-helium atmosphere, taking into account the radiative opacity of hydrocarbons, near the level of the tropopause, characteristic time of radiative relaxation $\tau_R \approx 10^8$ seconds (3.17 years) [7, 14]; it decreases exponentially to 10^5 seconds (≈10 days) in the upper stratosphere, and increases up to ten years at the level of the visible layer of the Jupiter's main cloud cover [1, 7, 9, 10]. In [11] we have pointed out that the range of brightness variations A_J in blue part of spectrum is almost on 25% more than in visible spectrum. A corresponding "node" of equality of brightness on the hemispheres of the temperate and tropical latitudes $A_J \approx 1$, the data in the blue region of the spectrum, are a few years earlier than in the visible spectral range. This confirms the fact that blue part of the reflected light by the Jupiter's clouds formed slightly higher in the atmosphere at lower pressure values. Change the distance to the Sun is stronger affects on the deeper atmospheric layers (lower and middle troposphere), where τ_R is large (about ten years). Solar activity stronger affect the upper troposphere and stratosphere where τ_R significantly lower, and the atmosphere "respond" to changes in solar radiation much faster (a few years, months or days). Comparison of the time variation of changes in factor activity of hemispheres of Jupiter A_J with change of the index of solar activity R and the motion of the planet in its orbit, indicates on the delay of reaction of visible cloud layer on the mode of the Sun's irradiation to atmosphere $\tau_R \approx 6$ years. It agrees well with τ_R for hydrogen-helium atmosphere, obtained in [9, 10]. Since 1999, there has been discrepancy progress time depending on the index of factor A_J and R, can be explained by reasons the mentioned uncoordinated actions on the planet's atmosphere. For example, simultaneously images obtained in the visible light and in the absorption bands of methane in 725 and 890 nm indicate this.

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