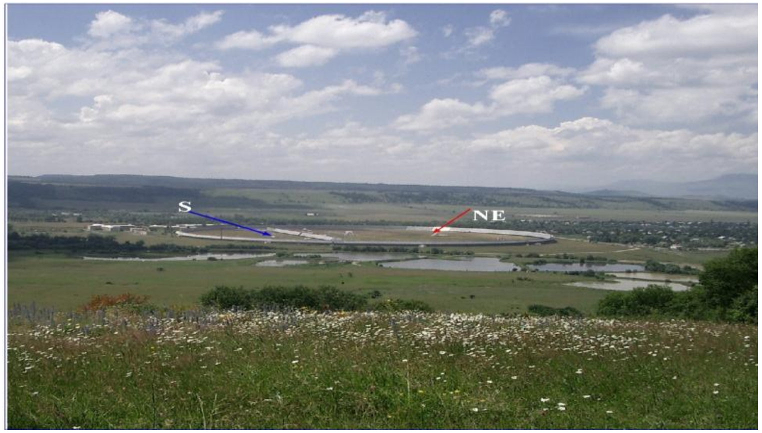
# Features of the physical characteristics of the radiation of polar coronal holes in the Sun according to observations in the radio range

O. A. Golubchina *

*St. Petersburg Branch of Special Astrophysical Observatory, St. Petersburg, Russia*

e- *mail:golubchina_olga@mail.ru*

The solar eclipse on March 29, 2006 was observed in the "Relay" mode on the North-Eastern Sector of the **RATAN-600 radio telescope** (Fig. 1) at wavelengths **λ = (1.03, 1.38, 2.7, 6.2, 13.0, 30.7) cm** (Golubchina, 2021).



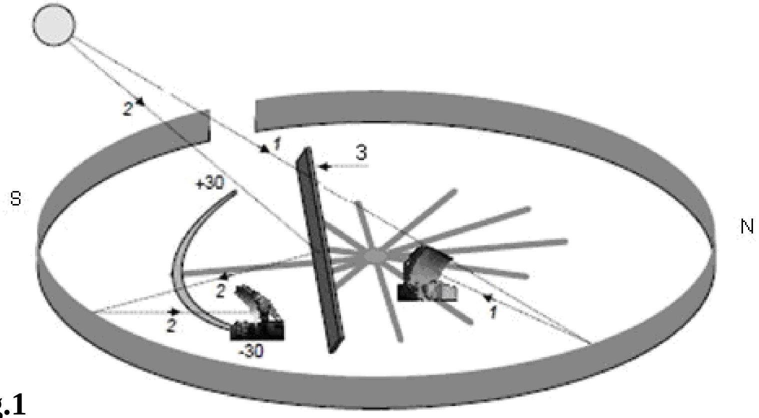
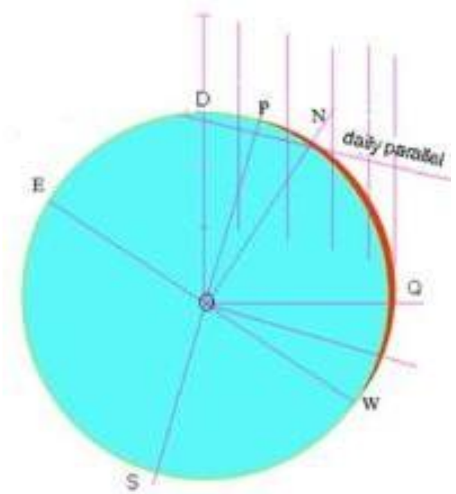




**Fig.1**

| λ, см | 1.03 | 1.38 | 2.7 | 6.2 | 13 | 30.7 |
|---|---|---|---|---|---|---|
| (rh x rv) arcmin | 0.4x17.3 | 0.6x19.3 | 1.2x19.4 | 2.6x25.0 | 5.7x35.8 | 13.4x84.4 |




•Fig.2

The open part of the optical disk of the Sun was 0.2 %. The center of the antenna radiation pattern was shifted +15 arc minutes to North from the center of the optical disk of the Sun (Fig.2). The RATAN-600 radio telescope has a knife-shaped antenna pattern (AP) (Table 1.).
The antenna temperatures of the Sun (Moon) ($Ta^S$, $Ta^M$) model are calculated according to obtained brightness temperatures $Tb^S$, $Tb^M$, using the antenna smoothing equations for the normalized vertical AP:

$$Ta(\varphi_0) = \int Tb(\varphi_0)\, A(\varphi - \varphi_0)\, d\varphi$$

(Golubchina, 2011).

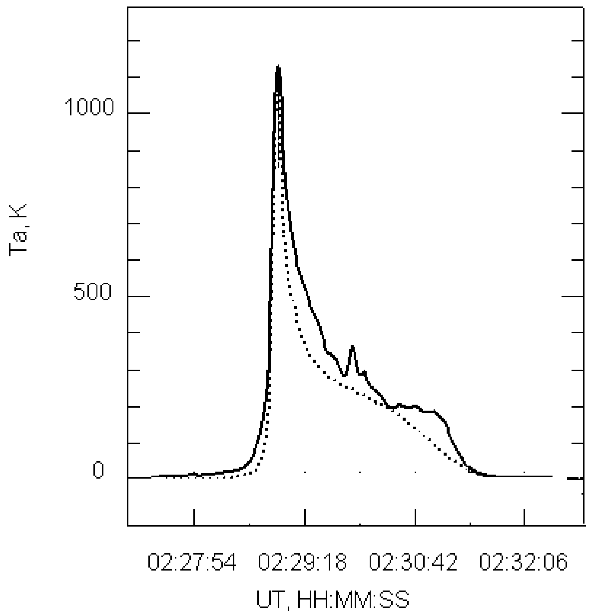



Fig.3

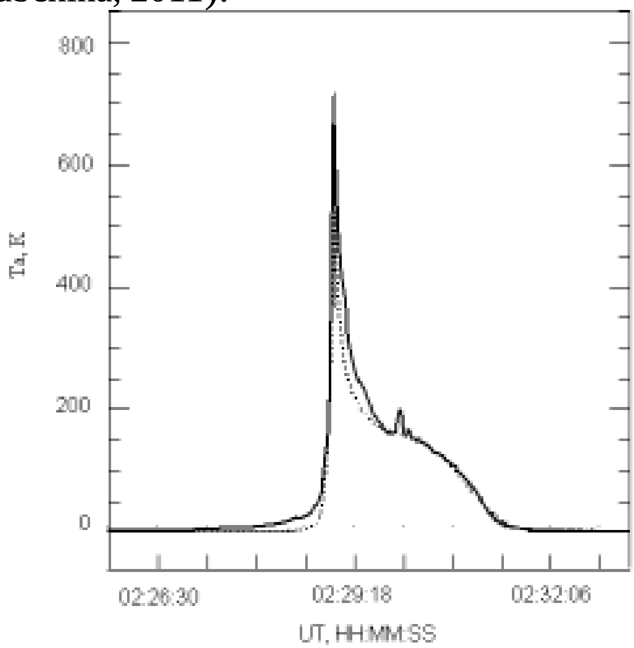



Fig.4

Fig.3. – $\lambda = 2.7$ cm   Fig.4. $\lambda = 1.38$ cm

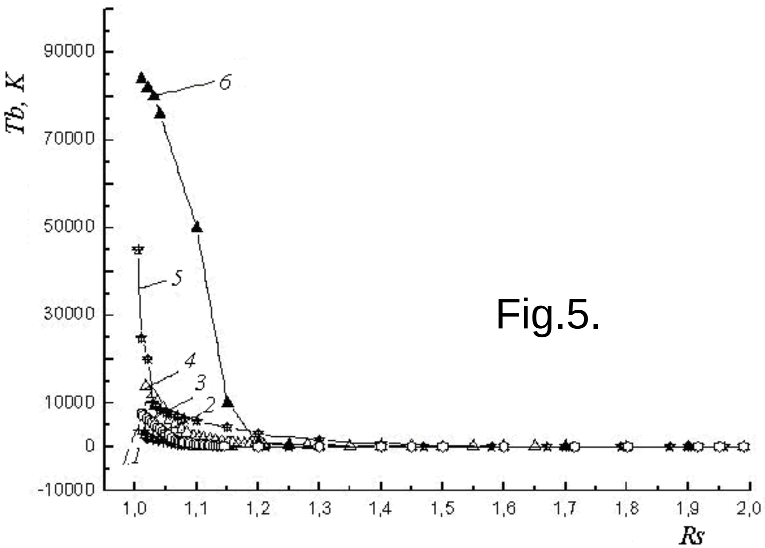



Fig.5.

- Fig.5. The distribution of the brightness temperature (Tb) with the distance from the center of the optical disk of the Sun (Rs) in the polar coronal region of the Sun on waves: 1 – 1.03 cm; 2 – 1.38 cm, 3 – 2.7 cm, 4 – 6 cm, 5 – 13 cm, 6 – 30.7 cm.
- Fig. 6. ( ★ ) - Tb, λ = 6.2 cm, 29.03.2006. (+) - Tb, λ = 4.0 cm, cm, quiet Sun

  (Borovik et al., 1990).
- Fig.7. ( ★ ) - Tb, λ = 2.7 cm, 29.03.2006. (+) - Tb, λ = 2.7 cm, quiet Sun (Borovik et

  al., 1990).

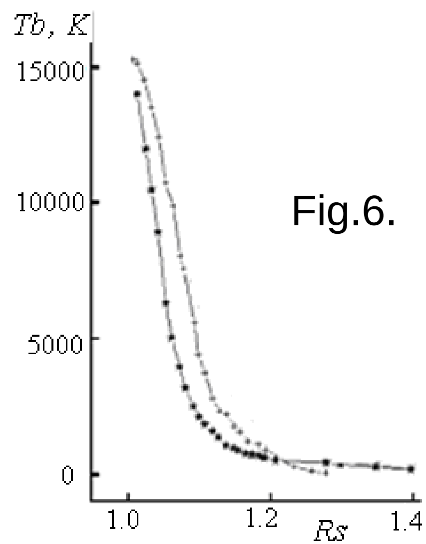



Fig.6.

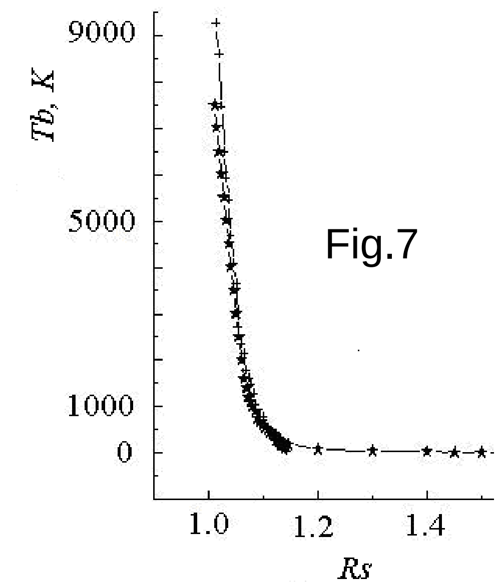



Fig.7

- Polar coronal holes are always visible at the poles of the Sun during periods of minimal solar activity, because at this time the rotationally oriented dipole component of the magnetic field prevails.
- CH can be organized in different places on the Sun's disk:
- 1. Random convective movements in the photosphere.
- 2. Reconnections of the force lines of an open magnetic field with closed force lines (Fig. 8; Munro, 1977; Fisk, 2001; Abramenko, 2006).

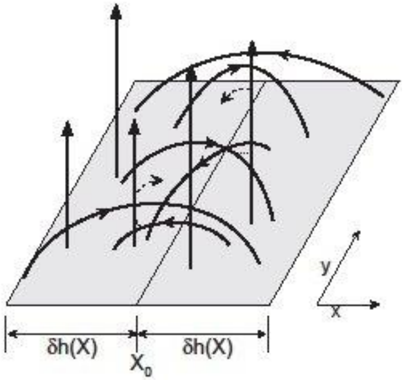



Fig.8.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\lambda^{(1)}$ (cm) | 6 | 15 | 31.6 | | $\lambda^{(2)}$ (cm) | 6.2 | 13 | 30.7 |
| CH (1) | Tb · $10^3$ K | 19.6 | 39 | 86 | CH (2) | Tb · $10^3$ K | 14 | 45 | 84 |
| S (1) | Tb · $10^3$ K | 24.7 | 63 | 174 | | Rs | 1.017 | 1.005 | 1.01 |

Table 2. Brightness temperatures (Tb, K) of a quiet Sun (S1), average semi-empirical consistent model data of a low-latitude coronal hole (CH1) against the background of a quiet Sun and a polar coronal hole (CH2) at close wavelengths. Here λ (1) are the data from the work of (Borovik 1990); λ (2) --results of the observation of the solar eclipse of March 29, 2006 on RATAN-600, Rs - the distance from the center of the solar disk of the measurement points closest to the solar limb during the solar eclipse.

# CONCLUSION

- 1. The observation of the solar eclipse of 29.03.2006 on RATAN-600 made it possible for the first time to determine the distribution of brightness temperatures over the North Pole of the Sun within the polar coronal hole on the Sun in a wide range of centimeter wavelengths (λ = 1.03, 1.38, 2.7, 6.2, 13.0, 30.7 cm) at a distance interval of ~ (1.005-2.0) Rs from the center of the optical disk of the Sun. :
- 2. A sharp decrease in the brightness temperatures of the radio emission of the polar coronal hole at centimeter wavelengths was detected (Fig. 7). (λ > 6 cm near the solar limb, which confirmed the real registration of the polar coronal hole over the North Pole of the Sun.
- 3. The polar coronal hole is not visible at short centimeter wavelengths (λ = 1.03, 1.38, 2.7 cm).
- 4. The coincidence of the brightness temperatures of the polar coronal hole and large low-latitude coronal holes at close wavelengths in the Northern hemisphere of the Sun indicate the identity of the temperature properties of the polar CH and low-latitude CH, regardless of their location on the Sun and, consequently, from the mechanism of their organization during the period of minimum solar activity (Fisk, 2001; Abramenko, 2006; R.H. Munro, 1977; O.A. Golubchina, 2017).
- The analysis of the results of the distribution of the brightness temperature of the polar coronal hole over the North Pole of the Sun at distances (1.005-2.0) Rs from the center of the optical disk of the Sun at centimeter wavelengths with the use of published data from other authors confirmed the conclusions we obtained from observations of the solar eclipse on 29.03.2006 on RATAN-600

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