ON THE PROPAGATION OF RADIO EMISSION IN THE CROWN OF THE QUIET SUN WITH MAGNETIC FIELD

N.Tsvyk

Radio Astronomy Institute of NASU, Kharkiv, Ukraine
tsvyk@rian.kharkov.ua

ABSTRACT. There are searching for factors that influence on the brightness temperature distribution of the quiet Sun at decameter radio waves which may explain the ellipsoidal shape and other features in the radio brightness profile.

Key words: quiet Sun, crown, radioemission, refraction

We estimate the influence of a magnetic field on the propagation of radio emission in the quiet solar crown, using a spherical model of the electron density distribution similar to Baumbach-Allen with constant temperature (10^6K). Models of the regular magnetic field of quiet Sun are: (1) the magnetic field with all turbulent magnetic field aligned along the pre-existing dipole lines that "enhanced" by turbulent currents to a level (Perebejnos et al., 2011) approximated as: $B \cong 5.29 G \cdot r^{-2.3+0.1\ln(r/2)}$; (2), (3) dipole and quadruple magnetic fields, modified by currents at the solar equator on r- and θ- axis to the values with changing a sign at r~2.5, see in details: (Sykora et al., 2003). The magnetic field strength was 0.1-0.2 G at the height of 2-4 R_0 (R_0 = 6.96 10^{10} cm; r measured in R_0 units).

The mechanism of radio emission from the quiet solar corona is the thermal radiation with the optical thickness less then (0.5). Due to the magnetic field, the radio waves of given frequency split into two modes, ordinary and fast extraordinary. There was carried out the refraction of rays in the solar corona, focusing rays and its absorption due to the free-free transitions and plasma damping (losses to the plasma currents). The emission flux is integrated over all layers along the ray path, that limited by a point of "tangle of parallel rays" (at the level where the beams have reflected by plasma resonance) and a position of the observer. Because of the ordinary mode is brighter and goes at lower heights (above the plasma resonance) then the extraordinary one (in a level higher than the first hybrid plasma frequency), we should observe a small circular polarization of the radio emission of the quiet Sun. The magnetic field shifts the radio rays on 0.1-0.3 R_0 in the Sun disk plane from those positions in the model without the magnetic field. Thus, the ordinary rays decline in a direction perpendicular to the magnetic field lines, and fast extraordinary rays "dragged" along the lines. Due to such refraction, it is appeared the slight brightening spots near the center of the visible Sun (<0.5 R_0), as of which place can be predict the magnetic field structure.

The calculations give the top of Solar brightness temperature is nearly $3 \cdot 10^5$ K at 20 MHz in good agreement with observations (Brazhenko et al., 2012), and the apparent solar radius are approximately equal to the sizes of the corona at the level of a plasma resonance. The ratio of the polar and equatorial solar radii calculated of 0.97±0.05, so the magnetic field has a little influence on the radio rays in the solar corona, and it can not be a factor in explaining the ellipsoidal asymmetry observing in the solar corona size, equal of 0.7. The probable cause of the ellipsoidal shape of the observed Sun in decameter wavebands may be non-spherical distribution of the plasma density in the corona, as show (Stanislavsky, Koval, 2013). With less likely, the effect of Sun's asymmetry can also give an asymmetrical profile of the plasma temperature.

References

Stanislavsky A.A., Koval A.A.: 2013, *Radiofizika i radioastronomia*, **18** (in press.).

Brazhenko A.I., Koval A.A. et al.: 2012, *Radiofizika i radioastronomia*, **17**, 3.

Sykora J. et al.: 2003, *Solar Phys.,* **212**, 301.

Perebejnos V.A. et al.: 2011, *Izv. CRAO,* **107**, 64.

Thejappa G., Kundu M.R.: 1994, *Solar Physics,* **149**, 31.