PAPER 17

A MODEL OF THE INNER CORONA BASED ON RADIO DATA

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The work of Ginzburg, Shklovskiĭ, and Martyn (1946) showed that the upper layers of the solar atmosphere (chromosphere and corona) are responsible for the sun's thermal emission in the radio-emission range. This was confirmed by a number of observations.

Observations of the distribution of radio brightness around the disk of the quiet sun were carried out in 1946-54. They established a number of peculiar features of the thermal radio emission; particularly the sun's increase of the effective radio temperature with wavelength increase, and the presence of a brightening on the optical edge of the solar disk in the centimeter and decimeter ranges.

Considerable emission occurs beyond the optical disk in the decimeter and meter ranges, and an elliptic form is exhibited by the radio-emitting region in those ranges at the epoch of minimum solar activity.

These main peculiarities were explained by means of a simple isothermal of the solar atmosphere (where $T_{chr} = 3$ to 5×10^4 °K and $T_{cor} = 10^6$ °K).

Thorough interferential observations of 1954–56 by Christiansen and Hindman at 21 cm, by Ovsiankin, Panovkin, and Shutov at 24 cm, by Ovsiankin and Panovkin at 50 cm, by O'Brien, Tandberg-Hanssen, Swarup, and Parthasarathy at 60 cm, and by Firor at 145 cm established that the increase of the radio-emission brightness existing in these ranges in the period of minimum solar activity does not take place at the edge of the optical disk, as had been predicted theoretically, but is displaced inside the disk, this displacement being the greater, the longer the wavelength. The essential facts cannot be explained by a simple isothermal model of the solar atmosphere.

Let us consider a model of the solar corona, in which the existence of a temperature gradient is taken into account. The totality of the astrophysical data (Allen) makes possible a determination of the general aspect of temperature changes with the distance from the surface of the sun. The temperature increases rapidly from the comparatively cold chromosphere (T about 5×10^5 °K) up to 3×10^6 °K in the internal corona. A monotonic temperature decrease is observed with passage to the outermost layers.

First-approximation models taking into account the temperature gradient and the degree of inhomogeneity were calculated. These models afford a satisfactory explanation of the observational facts concerning the distribution forms in the decimeter range. In the outer layers these models agree with the model by O'Brien and Bell, suggested by them to explain the existing distribution in the meter range.

According to this model, the corona is supposed to be optically denser (at the expense of the degree of inhomogeneity) as compared with that observed formerly. The maximum value of the temperature falls within 1.1 - 1.3 of of the optical radius and equals about 3×10^6 °K. The electron density and temperature in the polar regions are less than in the equatorial region.

The data obtained do not contradict the data on the ultraviolet emission of the solar corona and are in satisfactory agreement with the astrophysical results.