V. V. Zheleznyakov and E. Ya. Zlotnik. *Diagnostics of neutral current layers under space conditions.* In recent years, studies of neutral current layers have occupied a significant place in the physics of solar activity, since it is in these layers that the processes that give rise to solar flares appear to unfold. Naturally, great interest will attach to any method of detecting and diagnosing neutral current layers in the solar corona (including those based on their intrinsic radio emission). Most promising in this respect are the thermal emission mechanisms, for which reconstruction of the parameters of the emitting region from observed radio emission characteristics is a simpler and more specific problem than the same procedure for nonthermal mechanisms.[1]

The cyclotron mechanism (magnetic bremsstrahlung of nonrelativistic electrons in a magnetic field) makes the basic contribution to the thermal radio emission of the current layers. This radiation originates only from a thin region on the periphery of the current layer, where the magnetic field H_0 is of quasihomogeneous nature. As a result, the frequency spectrum of the cyclotron radiation takes the form of relatively narrow cyclotron lines with a simple-multiple frequency ratio. Study of the conditions of generation of the radiation and its escape from the corona has shown[2] that the individual lines correspond to harmonics $\omega = s\omega_{H_0}$ (ω is the frequency of the radiation, $\omega_{H_0} = eH_0/mc$ is the electron gyrofrequency on the edge of the current layer, and s is the number of the harmonic), which are superimposed on the cyclotron radiation spectrum of the corona region bounded below by the current layer. The radiation of the $s=1$ harmonic does not escape the corona; the line $s=2$ is fully polarized (the sign of the polarization corresponds to the ordinary wave); the ordinary wave dominates in the low-frequency part of the line $s=3$, and the extraordinary radiation in its high-frequency wing; the fourth harmonic is partially polarized as an extraordinary wave; higher harmonics are faint and quite smeared out. The emission from the part of the corona's active region that is situated above the current layer has a continuous spectrum with an effective temperature $T_{eff} = T_c$ (where T_c is the temperature of the corona) at frequencies $\omega < 2\omega_{H_0}$ for ordinary and at $\omega < 3\omega_{H_0}$ for extraordinary waves; there is practically no radio emission from this region at higher frequencies.

The special nature of the frequency spectrum and the polarization enables us to observe and study neutral layers in the corona through their thermal cyclotron radio emission if the kinetic temperature in the layer is $T \sim 10^7$–10^8 °K and the layer thickness is $l \gtrsim 10^2$ cm. The cyclotron lines lie at the beginning of the decimeter band (wavelengths 10–20 cm) if $H_0 \sim 300$ Oe. To record cyclotron lines in the solar corona reliably and to study them, it is necessary to have spectrographs with a total frequency overlap $\Delta\omega/\omega \gtrsim 3$ or multichannel receiving equipment working in the same range (with an interval of $\lesssim 0.05\omega$ between adjacent channels), combined with highly directional (fractions of 1′) antenna systems. However, cyclotron lines can evidently be detected in the solar radio emission with even more modest facilities.

Study of the propagation of electromagnetic waves through a neutral layer has shown[3] that a new type of linear interaction occurs here under certain conditions. However, over a broad range of angles between the direction of the magnetic field and the wave-propagation direction, this interaction does not occur in the solar corona, and the sign of the polarization remains unchanged during passage across the neutral layer. This has made it possible to explain the opposite polarization of the two components of "bipolar" solar radio emission sources observed in the meter-wave band.[4]

[1] V. V. Zheleznyakov, Élektromagnitnye volny v kosmicheskoĭ plazme (Electromagnetic Waves in the Cosmic Plasma), Nauka, Moscow, 1977.

[2] V. V. Zheleznyakov and E. Ya. Zlotnik, Thermal Cyclotron Emission of Neutral Current Layers in the Sun's Corona, Sol. Phys., 1979 (in press).

[3] V. V. Zheleznyakov, Zh. Eksp. Teor. Fiz. 73, 560 (1977) [Sov. Phys. JETP 46, 292 (1977)].

[4] V. V. Zheleznyakov and E. Ya. Zlotnik, Izv. Vyssh. Uchebn. Zaved. Radiofiz. 20, 1444 (1977).