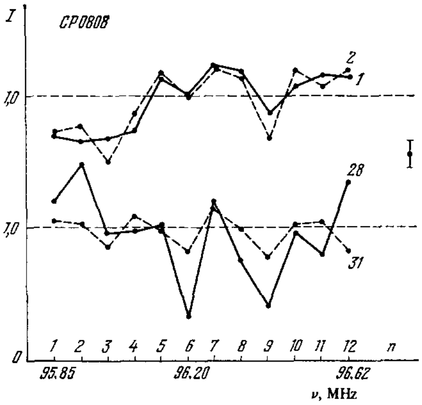

FIG. 1

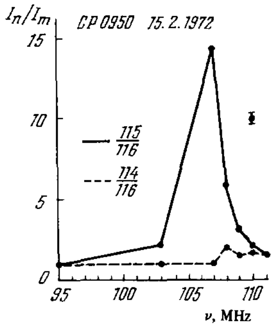

FIG. 2

their directional diagrams) relative to the surface of the neutron star.

3. The radio-frequency radiation spectra of the pulsars CP 0808, CP 0834, CP 0950, CP 1133, and CP 1919 manifest a fine structure characteristic of the emission process itself (apart from the structure due to diffraction by the inhomogeneities of the interstellar plasma). The fine structure has characteristic scales at frequencies of 200–300 kHz and less than 70 kHz and varies over a characteristic time less than the pulsar period with a root-mean-square intensity modulation ≈30%[7]. Examples of the spectra of individual pulses of CP 0808 are shown in Fig. 1 (12/8/1970).

In some pulses of the pulsar CP 0950, cases have been detected in which the radio-frequency radiation intensity increases sharply in a comparatively narrow frequency band $\Delta\nu = 1-3$ MHz[8]. This increase, which reached 10 times and more, was observed in the 110-MHz region: it is shown in Fig. 2, where the ratios of the spectra of three successive pulses of CP 0950 (Nos 114–116) are given. These two phenomena that have been detected in the spectra of the pulsars may be the key to the understanding of the mechanism underlying their radio emission.

4. The interstellar plasma, which determines to a considerable extent the nature of the radio-frequency radiation received from the pulsars, is very effectively investigated with the aid of pulsars. From the measured characteristic scales of the fine structure of the spectra in the direction of an entire series of pulsars were determined the weighted mean of the longitudinal component $H_{\parallel}$ of the magnetic field of the Galaxy[9,10], the characteristic dimension a, and the root-mean-square value of the electron concentration ΔN_e in the inhomogeneities of the interstellar plasma[2,10] (see the table).

Pulsar	10^{10} cm	ΔN_c, 10^{-5} cm^{-3}	$H_{\parallel}$, 10^{-6} Oe
CP 0808	1.0	1.1	—
CP 0834	2.4	5.6	—
CP 0950	1.3	0.9	—
CP 1919	1.4	2.8	—
CP 1133	2.4	8.0	1.2
AP 1237	2.4	7.5	2.1
MP 0031	—	—	1.25
CP 0329	—	—	2.7
MP.0628	—	—	1.6
PP 0943	—	—	1.4
PSR 2218	—	—	0.95

The phase increments accumulated in the inhomogeneities up to the nearest pulsars CP 0808, CP 0950, and CP 1133 were determined at the same time (from the distinctive features of their spectra), thereby significantly improving the accuracy of determination of the parameters a and ΔN_e. It is shown that the electron concentration ΔN_e in the inhomogeneities apparently possess a considerable anisotropy in the galaxy[10].

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V. V. Zheleznyakov. On the Origin of Pulsar Radiation. The theory of pulsars deals with three main problems: 1) type and structure of the central body—the star, 2) the structure and dynamics of the surrounding mantle—the magnetosphere, and 3) the emission mechanism for pulsars. The ideal, but extremely complicated way of constructing the theory is to successively solve these problems. A simpler, but more restricted approach characteristic of radioastronomy is possible; it consists in finding those conditions in the stellar magnetosphere which will guarantee in the framework of the chosen mechanism the generation of radiation with the observed characteristics. The possibility of a consistent selection of the parameters of the emitting system then allows us to evaluate the reality of the emission mechanism.

Let us suppose, on the basis of the generally accepted assumption that a pulsar is a rotating star with a strong magnetic field, that somewhere in the magnetosphere of the star—for example, above a magnetic pole—is localized a radiation source. If the radiation has a directed character, then we shall observe on earth periodic radiation pulses as the star rotates. Since directivity arises for all pulsars in a broad band, starting from radio-frequency radiation and ending with γ rays, it is natural to suppose that it is the result of a general effect that does not depend on the specific generation mechanism. The directional diagram may be formed owing to the relativistic motion of the source around the neutron star (the Smith model[1]). For this to occur the source should be localized in the region of the light cylinder. A number of important characteristics of the observable pulsar radiation can be explained in the framework of this model[2]: 1) the nondependence or weak dependence of pulsar-pulse duration on the frequency of the radio emission—for a power-law spectrum typical of pulsars; 2) the variation from pulse to pulse of the duration of the subpulses—for the pulsar CP 1919 which has a second period; 3) the distinctive features of the polarization of pulsar radiation (the variation from pulse to pulse of the plane of polarization observed in the optical band for the pulsar in the Crab and for a number of pulsars at radio frequencies; the distinctive change of the sign of the polarization at the center of the CP 0328 pulse).

The differences in the character of the frequency spectra and in the value of the effective temperature of the radio, optical, and x-ray emissions, as well as the existence of three types of pulsars (I—with emission only in the radio-frequency region, II—with emission only in the x-ray region, III—with emission in the optical and x-ray region) indicate important differences in the emission mechanisms in these wave bands. The high effective temperatures T_{eff} of the radio emission indicate a coherent mechanism; the substantially lower T_{eff} in the optical and x-ray region allows the emission to be explained on the basis of noncoherent mechanisms[3]. A detailed analysis of the noncoherent synchrotron mechanism for the pulsar in the Crab nebula carried out[4] in the framework of the Smith model showed that the spectrum observed in the infrared and optical and x-ray regions can be obtained in a system with linear dimensions $L \sim 5\times 10^7\,\delta^{1/17}$ cm, magnetic field $H \sim 6\times 10^4\,\delta^{4/17}$ Oe, emitting-electron concentration $N \sim 10^{12}\,\delta^{-7/17}$ cm^{-3}, and a characteristic electron energy $\sim 10^8\,\delta^{-2/17}$ eV. Here all the quantities have been expressed in terms of the ratio δ of the magnetic-field energy in the source to the energy of the emitting electrons. This parameter can be determined ($\delta \sim 10^2 - 10^5$) if we assume that γ rays are produced owing to the inverse Compton effect in the same system. If the magnetic field in the source is known, the field H_* on the surface of the neutron star can be estimated. If the character of the magnetic field is not too different from the dipole field, then $H_* \sim 2\times 10^{11}$ Oe, which agrees with the estimate for the field obtainable for a neutron star from arguments based on magnetic-flux conservation during the contraction of the star.

The specific radio-emission mechanism remains at present unclear. However, the comparative proximity of the position of the radio source in the magnetosphere of the pulsar in the Crab nebula to the optical source allows us to conclude that the magnitude of the magnetic field, and, probably, the particle concentration in the source are of the same order of magnitude as the respective quantities for the optical source. Consequently, the generation of radio-frequency radiation in pulsars occurs under conditions significantly different from solar conditions: in the sun's corona, usually the frequency $\omega \geq \omega_L, \omega_H$ (ω_L is the natural frequency of the plasma and ω_H is the electron gyrofrequency), whereas for pulsar radio emissions $\omega \ll \omega_L, \omega_H$. It is possible that radiation at so low frequencies is either the synchrotron radiation of ions, or radiation of the synchrontron type emitted during the accelerated motion of the charged particles along curved magnetic lines of force (curvature radiation)[5]. The problem of the escape of the radio-frequency radiation from the dense plasma of the source into the interstellar medium becomes vitally important here.

The contents of the report will be published in "Vestnik AN SSSR" (Bulletin of the Academy of Sciences of the USSR).

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1) The foregoing results were obtained by a large group of authors (working mainly at GRRI) in whose name the present communication has been made. The results were presented at the 7th All-Union Conference on Radioastronomy (Gor'kii, 1972) and is being published in the journal "Izvestiay Vuzov (Radiofizika)" in the Conference Report.

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Translated by A. K. Agyei