The observed discrepancy between the ages of the pulsar and the nebula can be attributed to the large number ($\sim 10^4$) "collapses" of the period and the associated changes of dT/dt. A similar situation (but with opposite sign) occurs apparently in the case of CP0950, for which dT/dt is anomalously small ($\sim 3 \times 10^{-16}$), and therefore the "age" turns out to be unreasonably large for a pulsar with a relatively short period. A similar effect takes place apparently also in the case of the pulsar NP0532 in the Crab Nebula.

2. Attention is called to the fact that the tangential velocity of NP0532 is anomalously large, ~150 km/sec. It is possible that the tangential velocity of PSR0833-45 is also of the order 100–200 km/sec. This reinforces the result of V. V. Vitkevich, obtained from the analysis of the fluctuations of the amplitude of the pulses of pulsars, that the tangential velocities can reach 1000 km/sec. The reason for such large pulsar velocities may be the "sling effect" or the asymmetry of the ejection of the matter during the time of the supernova outbursts.

3. An attempt was made, within the framework of the model of rotating neutron stars, to obtain a general idea of the directivity pattern only from an analysis of the result of the observations, without involving any hypotheses concerning the mechanism of pulsar radiation. The total number of pulsars in the galaxy can be estimated at $\sim 3 \times 10^4$. If the average age of the pulsars (whose periods are $\sim 1^S$) is $\sim 10^7$ years, then the frequency of pulsar production in the galaxy is about once every few hundred years, in good agreement with the frequency of the supernova outbursts. If the directivity pattern were to be "pencil-like" with an aperture angle $\sim 10°$, then the total number of pulses would be larger by one order of magnitude and the frequency of their formation would be unreasonably large. This argument favors the "knife-like" diagram. Another argument favoring such a diagram is the very fact of the presence of observable pulsars in such well known peculiar objects are Vela X and the Crab Nebula. It would be strange to assume that in addition to all their surprising properties these pulses have one more and perhaps the most curious property, namely the axis of their "pencil-like" diagrams point to the earth. The PSR0833-35 model recently proposed by Radhakrishnan, with a "pencil-like" diagram, is incorrect, since it does not account for the observed almost 100% linear polarization of this pulsar.

Finally, the fact that the interpulses are never observed accurately in the middle of the period is a serious argument against the model of Radhakrishnan and favors the "knife-like" diagram. A difficulty of the latter is the interpretation of the unequal magnitude of the amplitude of the pulse and the interpulse. This difficulty can be eliminated by introducing the concept of the presence of a certain polar diagram in the plane of the "knife," which in turn should be perpendicular to the magnetic axis of the pulsar. Thus, the proposed model corresponds to radiation in two almost parallel planes perpendicular to the bundle of forced lines emerging from the northern and southern magnetic pulse, respectively.

4. The mechanism of pulsar radio emission should reduce to a certain coherent process. If these are plasma oscillations, then it follows from simple energy considerations that the plasma should be relativistic. Transformation of the longitudinal plasma waves into transverse electromagnetic waves by stimulated scattering indicates that the pulsars can be regarded as masers. Under real conditions these masers are always saturated. Under such conditions, the power of the radio emission is determined by the power of the "pumping" mechanism. Since in the case of NP0532 this mechanism should also ensure radiation that is more intense by millions of times in the optical and the x-ray bands, the simple transport of particles from the surface of the neutron star into the generation region, as can be readily shown, is insufficient. The "pumping" can be ensured only by a powerful and very effective acceleration mechanism, which compensates for the tremendous losses of the relativistic electrons to radiation. Such a mechanism may be, for example, the acceleration of plasma particles by the magnetic dipole radiation of a rotating neutron star, considered by Ostriker and Hahn.

5. The most natural mechanism of optical and x-radiation of NP0532, in our opinion, is the inverse Compton effect of the relativistic electrons (which are responsible for the coherent radio emission) on the radio quanta. Favoring this assumption is, in particular, the practical absence of delay between the start of the radio and optical pulses. The energy of the relativistic electrons, obtained from the condition of transformation of the radio quanta with frequency $\sim 5 \times 10^{17}$ Hz into optical quanta, is $E \sim 10^9$ eV. The concentration of the plasma electrons is then $\sim 3 \times 10^{11}$ cm^{-3}. To ensure the observed power of the optical radiation it is necessary that a lifetime of such electrons be $\sim 10^{-7}$ sec, which is ~1000 times larger than the value that follows from the simple theory with allowance for the value of field of the radio quanta in NP0532. However, at high energy density of the radio quanta, a major role can be played also by stimulated inverse Compton effects. This leads to maser effects and ensures a sufficient directivity of the optical radiation.

The theory should explain why optical radiation is observed only in NP0532. The answer apparently is that in NP0532 the energy density of the radio emission in the generation region is larger by hundreds and thousands of times than in other pulsars. This circumstance contributes to transformation of the radio quanta into optical quanta via the stimulated inverse Compton effect.

V. V. Vitkevich, I. F. Malov and Yu. P. Shitov. Concerning the Model of a Pulsar as a Rotating and Pulsating Neutron Star.

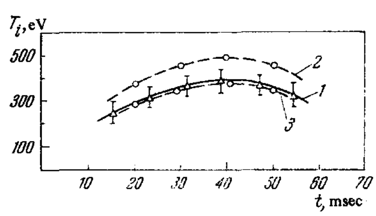
It is indicated in the communication that it is impossible to account for the second-class periods of pulsars by starting from the hypothesis of a pulsating neutron star, since the observed periods exceed the permissible pulsation periods (for example, the second-class period of CP0808 is 53 msec, and the permissible periods are ~10 msec). An attempt is made to represent the pulsar as an unstable compressing object. It is shown that in this model one obtains a decrease in the period of revolution, and this contradicts the observations. It is possible to explain the second-class periods of the pulsars, either by foregoing the hypothesis wherein the pulsar pulsates as a whole, or by finding other equations of state for the neutron stars.

L. A. Artsimovich. Heating of Ions in "Tokamak" Machines.

Results are reported of experiments on heating of ions in a toroidal plasma pinch with the "Tokamak" machine. It was shown earlier that by choosing the necessary ratios of the longitudinal and transverse magnetic fields it is possible to obtain a stabilized plasma pinch with a lifetime on the order of 5×10^{-2} sec. The heating of the electrons is due to the Joule loss of the current in the plasma. It is shown that heating of the ions in the plasma at relatively high concentrations ($\sim 3 \times 10^{13}$ cm^{-3}) occurs mainly as a result of Coulomb collisions with hot electrons, whereas at lower plasma density the heating of the ions calls for the presence of specific plasma processes connected with development of instabilities.

One of the most important experimental problems with the "Tokamak" is the determination of the ion temperature T_i. For many years T_i was determined from the energy spectrum of the neutral atoms emerging from the plasma pinch. Such atoms result from charge exchange of the plasma ions with the atoms of the neutral gas, and contain information concerning the energy of the plasma ions. This method was developed at the Physico-technical Institute of the USSR Academy of Sciences (Leningrad). For an independent estimate of T_i at an ion temperature exceeding 300 eV, use was also made of registration of the neutron emission from the volume of the toroidal chamber as a result of the D-D reaction. Although the intensity of the neutron emission is small ($\sim 10^6$ neutrons per pulse), the sensitivity of the apparatus makes it possible to measure T_i for $\sim$30–40 msec.

The $T_i(t)$ curves obtained from an analysis of the spectrum of the neutral atoms (curve 1) and the intensity of the neutron radiation (curves 2 and 3, assuming different forms of the $T_i(t)$ distribution inside the



plasma pinch) are shown in the figure, from which we see that measurements of $T_i(t)$ by two independent methods give satisfactory agreement. The ion temperature turns out to lie within 300–400 eV for the entire measurement interval.

A. A. Galeev and R. Z. Sagdeev. Paradoxes of Classical Diffusion of Plasma in Toroidal Magnetic Traps.[1,2]

The authors consider of the increase of classical plasma diffusion, due to the presence of particles locked in the region of a weak toroidal magnetic field. It is assumed that the larger classical diffusion[1] compared with that in straight systems) has already been observed in the simplest traps having axial symmetry ("Tokamak"). Therefore particular attention is paid to the distinguishing features of this effect in traps that do not have actual symmetry. By way of a concrete example, a model of a triple-loop stellarator with small toroid ratio is considered. The magnetic field near the magnetic axis z (which is aligned with the minor axis of the torus) is of the form

$$B_z = B_0\{1-\varepsilon_h \cos[3(\vartheta-\alpha z)]-\varepsilon_t \cos\vartheta\} \qquad (\varepsilon_t \ll \varepsilon_h \ll 1). \qquad (1)$$

It is noted that in an axially-symmetrical magnetic field ($\epsilon_h \equiv 0$) the trajectories of the "trapped" and transiting particles differ in their topology, but each changes over continuously into the other (Fig. 1). Consequently, a small change of the particle velocity along the field can transform the particle from a "trapped" one into a particle that passes through, but changes the inclination of the particle to the magnetic surface also by a small amount.

On the other hand, particles that are "trapped" in the region of a weak helical field in a stellarator ("banana") are capable of moving under the influence of the toroidal drift by a finite amount, while those that pass through follow the magnetic surface strictly (Fig. 2 shows the trajectory of a "trapped" particle which goes over into the region of the weak toroidal field into a particle that passes through; the figure is borrowed from the article of A. Komin et al. ("Atomnaya

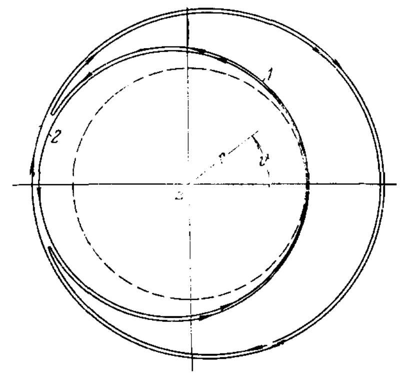


FIG. 1. Trajectories of "trapped" (1) and transiting (2, 2′) particles in a magnetic field with axial symmetry.

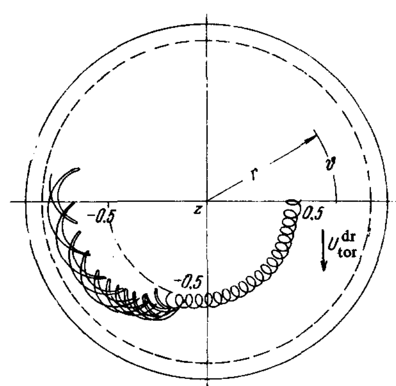


FIG. 2. Trajectory of a particle changed from a "trapped" one into a transiting one by the inhomogenities of the helical field.