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A PLASMA MODEL OF CRAB NEBULA AND PULSAR Np0532 RADIATION IN ROENTGEN AND GAMMA RANGES

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Lately, a significant progress in the study of processes, taking place in pulsar magnetospheres has been achieved; it allows to develop consistent pulsar radiation models. Namely, it was shown that near the pulsar surface a rapid birth of electron-positron pairs must take place.

As a result, two-component electron-positron plasma, moving from a neutron star along magnetic field lines with velocities corresponding to Lorentz-factors $10^2-10^3$ and $10^3-10^7$ is generated in pulsar magnetosphere.

In Np0532 case the electron-positron plasma concentration near pulsar surface attains $10^{20}\,\text{cm}^{-3}$. Plasma particles in a strong magnetic field $B\sim 10^{12}$ quickly lose transverse momentum and the momentum distribution of particles relaxes to a one-dimensional. This one-dimensional distribution appears to be unstable with respect to oscillations, excited in electron-positron relativistic plasma. Among them the longitudinal Langmuire oscillations are characterized by the largest growth rate. Their rapid evolution leads to a plateau formation on the distribution function due to quasi-linear interaction of resonance particles with Langmuire oscillations. As a result, particle distribution relaxes to a one-dimensional one with elongated tail without humps /1/. Such an asymmetric one-dimensional distribution appears to be unstable with respect to perturbations, excited at the cyclotron resonance with beam particles.

The instability evolution requires a number of restrictions. In particular, the condition of the lack of hose instability, smallness of damping on plasma particles and resonance condition $\omega - \omega_n \sim \frac{1}{\gamma^3}$

Considering also $B = B_0 (\frac{\gamma}{\gamma_0})^3$, $n \approx n_0 (\frac{\gamma}{\gamma_0})^3$

($B_0$, $\gamma_0$ - magnetic field strength and plasma density near a neutron star surface, $\gamma_0$ star radius). In an observer's system we shall get inequality

$$\frac{\gamma^3}{\gamma_0^3} \approx \frac{\omega_0}{\omega_n} \left( \frac{\eta}{\gamma_0} \right)^2 \frac{1}{\gamma_0^3}, \frac{\omega_0}{\omega_n} \approx \frac{4\pi e^2 n}{m}, \frac{eB_0}{mc} = \frac{1}{\gamma_0^3} \left( 1 \right)$$

Magnetic field is slightly inhomogeneous and in the presence of velocity transverse components it can significantly influence the particle distribution character. In the weakly inhomogeneous field a force, directed transverse the magnetic field would affect a particle. This force at the relativistic character of the motion should have a form $G_1 \sim \frac{mc^2}{\gamma} \frac{eB}{c} \frac{1}{\gamma}$

Pitch-angles appearance, on account of owing quasi-linear diffusion results in magnetic bremsstrahlung and braking-byradiation force origin. This latter one has both transverse and longitudinal compo -
ments. \( \tilde{r}_e = -\alpha \psi, \quad \tilde{r}_2 = -\alpha \psi^2 \gamma^2, \quad \alpha = \frac{3}{2} \frac{\omega^2}{c^2} \)

Then from kinetic equation we obtain

\[
\dot{\tilde{p}} + (\tilde{p}, \psi, \tilde{r}) \equiv 2 \beta \int (\tilde{p}, \psi, \tilde{r}) \times \left( 1 - \frac{3}{4} \left( H - E_i(\tilde{p}, \psi^2) \right) \right) \]

where \( \beta = \frac{\gamma^2 c^2}{2 \omega^2} \).

Using (2) we shall find synchrotron irradiation spectrum, which falls in roentgen range region \( I_{\gamma} \sim \gamma^{-\alpha} \)

where \( \alpha \) - spectrum index appears to be \( \sim 1 \), that is in a good accordance with observed curves. The greater part of beam energy, due to adiabatic invariant existence, is carried out beyond the light cylinder into Crab nebula and is irradiated there. Only a small part of the energy (about 1%) is irradiated directly from the pulsar with a close spectrum indice.

REFERENCES