THE NONLINEAR DISPERSION RELATION AND THE RELATIONSHIP OF THE FORMING SOLITON AREA TO THE EVOLUTION OF PULSARS

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Based on Zakharov's equations, Karpman et al. claimed that there were solitons in the magnetosphere. According to the model proposed by Goldreich and Julin, there is a strong induced electric field in the magnetosphere. It seems that we should include the nonlinear effects of the electric field on the polarization of hydrogen atoms if there really are some hydrogen atoms spreading in the magnetosphere of the pulsar. Assuming the magnetosphere is symetric, therefore the electric polarization of hydrogen atoms is of the form $P=\chi^{(1)}E + \chi^{(3)}E^3$. We treat $\chi^{(1)}$ and $\chi^{(3)}$ as scalars because most hydrogen atoms in the universe are in the ground state and $\chi^{(3)}$ is much smaller than $\chi^{(1)}$.

The effect of a strong magnetic field on an electron in orbital motion may be ignored if $B \leqslant 10^{8}$ Gauss for the case of some pulsars. When the external E-field is comparable with the interior of a hydrogen atom, the induced nonlinear term of P is significant. In laser experiments carried out in labs physicists have observed as high as three-order nonlinear effects when the intensity of coherent lights reaches 10^{3} statvolt /cm. So we may set the interior field intensity of a hydrogen atom as an upper and 10^{3} statvolt/cm as a lower limit, and including the limit of B-field, delimit the region where nonlinear effects dominate.

Although the strong magnetic field makes a plasma anisotropic and the electric conductivity is not a scalar, either, we can expect that $\sigma_{\perp}$ is much larger than the Hall conductivity so that we obtain a one-dimentional equation derived from the Maxwell equations and get the nonlinear dispersion relation as $\omega=\omega(k, E^{2})$. Finally we obtain the nonlinear Schroedinger equation. The localized steady solution of this equation for the case $\kappa>0$ is solitons. Therefore the solitons still exist even though the conditions for establishing the Zakharov's equations are not satisfied.

It is plausible for a pulsar with smaller polar magnetic intensity and a longer rotating period to generate solitons and emit radiation near to the star according to the curvature radiation of solitons, but for an opposite case, near the light cylinder. The area emitting energy in the magnetosphere may be associated with the age and further the evolution of pulsars.

D. J. Helfand and J.-H. Huang (eds.), The Origin and Evolution of Neutron Stars, 461.