PAIR PRODUCTION IN INTENSE ELECTROMAGNETIC FIELDS OF PULSARS

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The possible existence of strong electromagnetic fields in pulsars has motivated extensive interest in investigation of various quantum electrodynamics processes. In particular, the process of converting high energy photons into electron-positron pairs is of great significance in pulsar theory.

In order to obtain the absorption coefficient in external field, it is necessary to calculate the exact electron wave function through solving the Dirac equation in this field. However, this is too complicated to solve in the presence of electric and magnetic field. Eluding this difficulty Tsai uses the Schwinger's proper-time method directly to calculate the vacuum polarization in strong field (Tsai and Erber, 1974) by two ways — pertubative expansion and Green function — and then extracts the absorption coefficient of photons from the optical theorem.

The purpose of this paper is to calculate the vacuum polarization in electromagnetic field using the proper-time method with a way of pertubative expansion, then to evaluate the absorption coefficient and obtain some results in the weak-field approximation. The absorption coefficient for unpolarization is

$$\bar{\varkappa} = \frac{3\sqrt{3}}{16\sqrt{2}} \frac{\alpha e}{m} \sqrt{B^2 + E^2} \sin\vartheta \exp\left(- \frac{8}{3} \frac{m^3}{(\omega \sin\vartheta)\, e\, (B^2 + E^2)^{\frac{1}{2}}}\right)$$

It indicates that in the presence of both electric and magnetic field, a way to get absorption coefficient is to change (B+E) for B in the one obtained in the existence of B alone. By virtue of R-S model for pulsars, the electric field strength parallel to magnetic field is about 10^{10} V/cm in the gap. It is much lass than B, implying that we can ignore it at all because of its insignificant role indeed. Our results coincide with those obtained by Urrutia (1978) from the electron Green's function.

References

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