SYNCHRO-CURVATURE RADIATION AND MAGNETIC PAIR PRODUCTION OF RELATIVISTIC ELECTRONS IN STRONG CURVED MAGNETIC FIELDS

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Most of common curved magnetic fields with axial symmetry in astrophysics can be expressed in a local cylindrical coordinate system (R, φ, Z) as

$$\vec{H} = \vec{H}(0, H_\varphi, 0), H_\varphi/H_o = (R/R_o)^N , \qquad (1)$$

where H_o, R_o and N are real constants. It has been known that the non-zero curvature of the magnetic field lines can impose an additional pitch angle on the electrons moving in the field (1).

Based on the discussions about the critical pitch angle $\psi_{cr} \simeq \beta c/R_{mc}\omega_H$, where ω_H is the relativistic cyclotron frequency and R_{mc} the curvature radius of field lines, a criterion of the feature of synchro-curvature radiation from a relativistic electron with pitch angle ψ, moving in the field (1), is determined. The results show that when $\psi = \psi_{cr}$, which is generally associated with the primary electrons flying along magnetic field lines out of the polar cap of pulsars, both the curvature radiation mechanism and the synchrotron radiation mechanism would roughly make the same contribution to the total power emitted by the electrons. If $0 < \psi \ll \psi_{cr}$, compared with synchrotron radiation mechanism, the contribution of curvature radiation mechanism to the total radiation power will become much more significant, but if $\psi \gg \psi_{cr}$ the contribution of synchrotron radiation mechanism will be dominant. The magnetic bremsstrahlung from the resulted secondary pairs of cascade, moving in the region far from the stellar surface of pulsars, would mainly belong to the latter.

Under some extreme conditions like that of fast pulsars, the additional pitch angle effect would also affect the estimate of magnetic pair production, magnetic cascade shower and, to a certain extent, the estimate of γ-ray intensity from fast pulsars, provided that ψ_{cr} is large enough.

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