Ultimate synchrotron cutoff in gamma-ray spectra of blazars as a signature of the converter mechanism

B.Stern[1,2], Y.Tikhomirova[2]

1- Institute for Nuclear Research of RAS, Moscow, Russia
2 – Astro Space Centre of Lebedev Physical Institute of RAS, Moscow, Russia

- The main mechanism of particle acceleration responsible for gamma-ray emission of blazars is still unknown. One of the possibilities is the converter mechanism (Derishev et al. 2003, PhRvD, 68, 3003; Stern 2003, MNRAS, 345, 590) which can take a form of a runaway photon breeding in relativistic jets.
- There exist s a robust upper limit on the energy of synchrotron radiation in high energy astrophysics: ($m_e c^2 /\alpha$) where the upper limit refers to the reference frame of the fluid with frozen in magnetic field. This is the maximal energy of synchrotron photons which can be emitted by an electron with an arbitrarily high initial energy after it has been deflected by angle π in magnetic field. Stern & Poutanen(2008, MNRAS, 383, 1695) have performed numerical simulations of the photon breeding and obtained some spectra where the ultimate synchrotron cutoff can be seen. This can hardly take place in the case of other mechanisms. The observation of such a feature would be a strong argument for the important role of converter mechanism in high energy radiation of jets.
- We have performed a series of simulations in order to outline the area of conditions where the ultimate synchrotron cutoff can be observed and to demonstrate the variety of spectral shapes in MeV-TeV range which can be produced by the photon breeding mechanism. Large Particle Monte-Carlo Code (LPMC) for particle propagation and interactions (Stern et al.1995, MNRAS, 272, 291) and two dimensional ballistic model for the jet dynamics were used.
- Simulations demonstrate that the ultimate synchrotron cutoff in its clear form is a relatively rare phenomenon. In the framework of the photon breeding mechanism the cutoff in GeV range appears when the compactness of the external radiation is just above the threshold of the supercritical photon breeding. If the compactness exceeds the threshold by factor a few, then the spectrum becomes almost flat or the synchrotron component moves to a softer range (see Fig.1).

We have considered available observed data. EGRET data (see Fig.2) do not give a reliable confirmation of the existence of the synchrotron component, however there is a number of indications. GLAST will be able to reveal the cutoff.

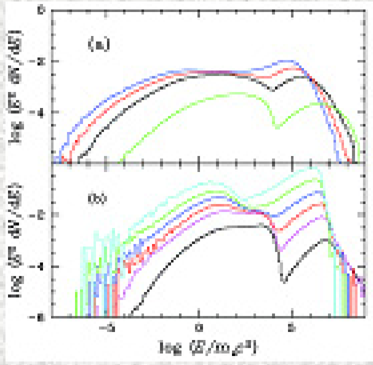

Fig.1 Spectra produced by the photon breeding mechanism obtained with numerical simulations. Panels (a) and (b) represent different models of external radiation. Curves from bottom to top correspond to the disk luminosity of 0.5×10^{44}, 10^{44}, 1.4×10^{44}, 2×10^{44} erg s^{-1}(a) and 10^{43}, 2×10^{43}, 4×10^{43}, 8×10^{43}, 1.6×10^{43}, 3.2×10^{43} erg s^{-1} (b).

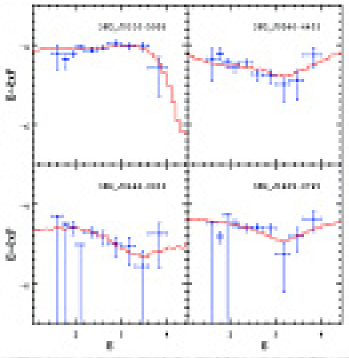

Fig.2 Examples of EGRET spectra sampled from 19 spectra with best statistics which resemble some two-component simulated curves (see Fig.1). EGRET data do not reject the existence of the cutoff.