A STUDY OF GAMMA SPECTRAL BREAK IN AGN

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Since its launch, CGRO has detected more than 20 γ-ray emitting AGN, most of them associated with powerful, radio-loud, flat-spectrum objects, exhibiting VLBI superluminal motions. In the case of 3C279, the huge value of the apparent luminosity ($\sim 10^{48} erg.s^{-1}$) and the variability time-scale of a few days (Hartmann *et al.*, 1992) gives a very large compacity $\ell_{app} \simeq 200$, that is, the medium should be completely thick to γ-rays. This contradiction can be explained if the γ-rays originate from a relativistic jet pointing at a small angle with respect to the line of sight(Maraschi *et al.*, 1992). However, the still large value of compacity suggests the existence of an inner, more compact region where pair production can take place efficiently (Henri *et al.*, 1993). This supports the so-called "two-flow" model, where the superluminal motion is attributed to the expansion of a relativistic pair plasma heated by a MHD jet from an accretion disk (Sol *et al.*, 1989). Hence we propose to interpret the spectral break observed in many objects around a few MeV (Lichti *et al.*, 1993) by an opacity effect due to *photon- photon absorption by pair production.*

Assuming that photons of energy $\varepsilon_1 m_e c^2$ interact only with X photons of energy $m_e c^2/\varepsilon_1$, and for a cylindrical jet of transverse radius $r(z)$, the opacity to pair production is $\tau_{\gamma\gamma}(z) \simeq \sigma_T \dot{n}(1/\varepsilon_1) r^2(z)/c\varepsilon_1$ where $\dot{n}(1/\varepsilon_1)$ is the density of photons produced per second by Inverse Compton process at energy $1/\varepsilon_1$. The total luminosity can then be evaluated as $L_\gamma \simeq m_e c^2 \int_{z_\gamma}^{\infty} \varepsilon_1 \dot{n}(\varepsilon_1, z) S(z) dz$, where z_γ is defined by $\tau_{\gamma\gamma}(z_\gamma) = 1$. The jet can become optically thin to γ-rays only by a decrease of soft photons and/or pair flux along z. Then one obtains $L_\gamma = L_{thin} \varepsilon_1^{-\Delta\alpha}$, where $\Delta\alpha = \frac{s-1}{2}$ for a power-law distribution of electron with an index s and an exponential decrease of soft photons. The break energy is equal to 511 keV *blueshifted by the Doppler factor.* Pair annihilation photons can produce a bump at this break energy. A crucial prediction of the model is that variability at high energy should lag the low energy one, in contrast with optically thin models.

References

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