GAMMA RAYS AND JETS IN ACTIVE GALACTIC NUCLEI

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ABSTRACT: It will be shown that the jets observed in AGN's are the result of the high energy gamma rays recently observed by the EGRET and Whipple collaborations interacting with a medium of density typical of that expected in galaxies. All of the observed properties of the jets follow from this interaction.

In all of the blazars from which gamma rays have been observed by EGRET the high energy gamma rays contribute an energy comparable to or greater than that of the lower energy radiation. Gamma rays in the energy range of interest (100 MeV to 5 TeV) interact with atoms almost entirely by producing electron pairs with a small component of Compton electrons at the low end of the energy range. This production occurs with close to 100% efficiency. Synchrotron radiation is emitted close to the forward direction by these pairs in the magnetic field produced by the Compton electrons. A substantial fraction of the synchrotron radiation is emitted by the pairs in distances of the order of parsecs. Most of the gammas will interact in one radiation length of the medium (13 atoms/cm^3 for 10^5 pc.). It is now simple to see how all of the jet properties arise. The jets remain collimated because the gamma rays travel in straight lines. The low energy synchrotron radiation is produced in approximately the right quantities and in the correct frequency range by the magnetic field produced by the Compton electrons (the pairs are statistically charge symmetric). All of the synchrotron energy needed is available from the gammas so there is no need for a high energy charged particle beam, an engine to accelerate particles or a beam confining mechanism. Electron pairs are produced the entire length of the jet as the gammas interact. The kinks and bends occur because the direction of the gamma beam wiggles slightly with time. The irregular structure observed along the jets is caused by the chaotic interaction between the pairs, the Compton electrons and the magnetic field as well as by intensity variations. The charged particles and magnetic field act rather like a two dimensional undamped plasma perpendicular to the beam direction. Given the observed presence of the gamma rays and their well known interactions, these phenomena must occur with an efficiency close to 100% which precludes the need for any other source for the phenomena observed in jets.

T. J.-L. Courvoisier and A. Blecha: Multi-Wavelength Continuum Emission of AGN, 381.