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An Expanding Plasma Model for the X-ray/radio knots in KPC-scale Jets of Active Galactic Nuclei

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Abstract. We model the observed X-ray/radio knots in Active Galactic Nuclei (AGN) as isotropically expanding spherical plasma clouds fed continously by non-thermal electrons. The time-dependent electron distribution and the emitted photon spectrum are computed using the standard kinetic equation considering synchrotron, adiabatic and inverse Compton cooling processes. We use this model to study the knots of $1136-135$ and $1150+497$, recenly observed by *Chandra*.

1. Introduction

The detection of X-rays from radio/optical knots in Kpc scale jets of AGN by *Chandra* (Chartas et al. 2000; Tavecchio et al. 2000; Sambruna et al. 2002) suggest the possible emission mechanism could be any of the processes such as synchrotron self compton (SSC), inverse compton scattering of the cosmic micro wave back ground (IC/CMB) or synchrotron process itself. The SSC interpretation would require large jet power and magnetic field much lower than equipartition value (Tavecchio et al. 2000; Schwartz et al. 2000), whereas, IC/CMB interpretation needs significantly smaller jet power and near equi-partition magnetic field. Indeed, if the X-ray flux is greater than the extrapolation of optical/radio spectra, then IC/CMB interpretation of X-ray emission is favoured, else the emission may be by synchrotron process.

The existing models invoke a short duration injection of non-thermal electrons which cool by synchrotron and inverse Compton processes. Since the high-energy electrons cool efficiently they are depleted in time giving rise to a time-dependent high-energy cutoff in the non-thermal electron distribution and hence producing a high-frequency exponential cutoff in the observed spectra. On the other hand, if the acceleration is due to internal shocks then for a shell of size 1kpc, the acceleration process can last for $\approx 10^{11}s$ due to which, the depleted high-energy electrons are replenished giving rise to a time-dependent break in the non-thermal particle spectrum and in the corresponding photon spectrum.

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2. Results and Discussion

The kinetic equation describing the evolution of electron distribution and hence the photon spectrum is computed considering synchrotron, adiabatic and inverse Compton cooling processes. The results of our calculations are shown in Fig. 1. The continous injection of non-thermal particles gives rise to a time-dependent break in the particle spectrum at Lorentz factor $\gamma = \gamma_c$ for which the radiative cooling time-scale equals the observation time. For $\gamma << \gamma_c$, radiative cooling is unimportant and the emitted photon spectral index $\alpha = (p-1)/2$, p being the injected particle index. Whereas, for $\gamma >> \gamma_c$, radiative cooling dominantes and $\alpha = p/2$. In the short duration injection models, an exponential cutoff at high energies is predicted. The above result can be confirmed in comparison with the other models by the future measurements of radio, optical and X-ray spectral indices.

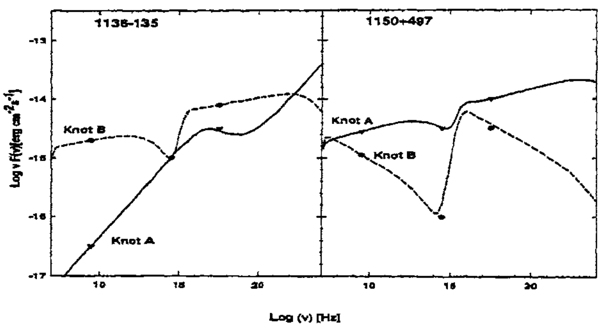

Figure 1. Observed fluxes in radio, optical and X-ray with model spectra. Data are taken from Pesce et al. 2001 and Sambruna et al. 2002. Triangles(circles) correspond to knotA(B).

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