Parsec Scale Jet of the GPS Quasar PKS 1127-145: Similarity to MeV-Blazars?

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1. INTRODUCTION

PKS 1127-145 is the high redshift quasar ($z=1.18$), with the large scale (at least 300 kpc) X-ray jet associated with the weak radio emission (Siemiginowska et al. 2002). The extended radio structure is much weaker (nearly 3 orders of magnitude) than the core emission. We propose that the high energy emission from the inner “core-jet” region of the quasar PKS 1127-145 can be described in terms of the blazar phenomenon. To justify our choice we focus on the shape and luminosity, and hence the origin, of the X-ray and $\gamma$-ray radiation. We argue that the X-rays observed by Chandra are produced in the jet pointing towards the observer and its spectral index ($\alpha_x \approx 0.3$) may suggest that this radiation results only from the ERC (External-Radiation-Compton process), without contribution of any other process. Another argument supporting the idea that the high energy radiation is produced in the jet can be justified by the fact of the detection of this source in the 2nd Egret Catalogue (Thompson et al. 1995). Motivated by this we argue that the “inner-core” region of the quasar PKS 1127-145, at least at certain points, resemble an MeV-Blazar (the type of blazar which produces the majority of the observed radiation much further from the jet apex than the GeV-Blazar). Additional factor that supports this idea is the observed (like in other MeV-Blazars) pronounced UV-bump.
2. THE OBSERVATIONS

Chandra/ACIS-S Observations of PKS 1127-145 (z=1.18).

Source extraction region: 2.5 arcsec centered on the source. We use apply_acisabs in CIAO to correct ARF for ACIS QE degradation. Model fitting in Sherpa assuming absorbed power law model: $N(E) = AE^{-\Gamma} \exp\left(-N_H^{gal}\sigma(E) - N_H^{abs}\sigma(E(1+z_{abs}))\right)$ photons cm$^{-2}$ sec$^{-1}$ keV$^{-1}$. $A$ is the normalization at 1 keV, $\Gamma$ is the photon index of the power law. We have assumed two components for the absorption:

1/ related to the effective Galactic absorption characterized by the equivalent neutral hydrogen column $N_H^{gal} = 3.8 \times 10^{20}$ atoms cm$^{-2}$. This is constant during the fitting.

2/ the intervening absorber located at redshift $z_{abs}$, with $N_H^{z_{abs}}$ as the equivalent hydrogen column. $\sigma(E)$ and $\sigma E(1 + z_{abs})$ are the corresponding absorption cross sections (Morrison & McCammon 1983, Wilms, Allen and McCray 2000) We applied the pileup model available in Sherpa (jdpileup). Best fit model parameters: $\Gamma = 1.29 \pm 0.05$, $N_H^{z_{abs}=0} = 5.66 \pm 0.07 \times 10^{20}$ atoms cm$^{-2}$, Flux (2-10keV) $= 5.35 \times 10^{-12}$ ergs cm$^{-2}$ s$^{-1}$. 

3. THE MODEL

In our ERC model (eg. Sikora et al. 2001) the high energy radiation results from inverse-Compton scattering of soft photons, having their origin outside the jet, by relativistic electrons/positrons accelerated in the jet internal shocks. The injection of the particles is approximated by the power-law function, $Q \propto \gamma^{-p}$, with $\gamma$ ranging from $\gamma_{\text{min}}$ to $\gamma_{\text{max}}$. The X-rays are produced by the electrons in so-called slow cooling regime and the $\gamma$-rays by electrons in fast cooling regime (see Sikora et al. 2002). The electron energy dividing both regimes is given by equality of the electron cooling time scale, $t'_e = \gamma/|\dot{\gamma}|$, to the shock lifetime, $t' \approx \Delta r_{\text{coll}}/(c\Gamma)$, where $|\dot{\gamma}| \approx \sigma_T u'_{\text{ext}} \gamma^2/(m_e c^2)$, $u'_{\text{ext}}$ is the energy density of the external radiation field, and $\Delta r_{\text{coll}}$ is the distance over which the collision of inhomogeneities takes place. Hence, that energy is $\gamma_c = (m_e c^2 \Gamma)/(\sigma_T \Delta r_{\text{coll}} u'_{\text{ext}})$. The break in the electron energy distribution is imprinted in the Compton spectrum at the frequency $\nu_c \sim \mathcal{D}^2 x_c^2 \nu_{\text{ext}}$ where $\nu_{\text{ext}}$ is the frequency of the external photons and $\mathcal{D} = 1/\Gamma(1 - \beta \cos \theta)$ is the Doppler factor. The spectrum around $\nu_c$ changes its slope by $\Delta \alpha_{x\gamma} \simeq 0.5$. Because of the spectral similarities of PKS 1127-145 with the MeV-blazars, we assume that $u'_{\text{ext}}$ is dominated by thermal radiation of the hot dust. Additionally to the spectral components ERC(IR) and synchrotron which fit the observations, we present self-consistently computed the SSC and the ERC(BEL) components (Błażejowski et al. 2003 in preparation).
4. RESULTS AND DISCUSSION

Fig.1 shows that the entire observed high energy spectrum can be due to Comptonization of IR radiation, but with possible contribution from ERC(BEL) at energies $> 1\text{GeV}$. The SSC component is very weak and, therefore, the X-ray spectrum keeps the very hard slope. Another common for MeV-blazars feature is co-existence of the prominent UV thermal bump – characteristic for radio-lobe dominated quasars (and radio-quiet AGNs), with extremely luminous $\gamma$-ray component – as observed only in FSRQ. This co-existence can be explained as follows. Due to the longer distance from the jet apex, in comparison to more typical FSRQ represented by GeV-Blazars, the synchrotron component is affected in two ways. First, the ratio $u'_{IR}/u'_{B}$ is higher, than the ratio $u'_{BEL}/u'_{B}$ in GeV-blazars (where $u'_{IR}, u'_{B}, u'_{BEL}$ are energy densities of IR radiation, magnetic field and BEL respectively). This results in lower synchrotron spectrum in MeV-Blazars than in GeV ones, provided both type of objects emit comparable bolometric luminosity. Secondly, the whole synchrotron component is shifted into smaller frequencies (because the average frequency of the synchrotron radiation is $\nu_{SYN} \propto \hat{B}'$ and in our model magnetic field scales with distance like $\hat{B}' \propto 1/r$). Both together cause that dilution of the thermal UV bump by synchrotron component is lowered and the bump becomes visible. Lower synchrotron luminosity explains also, why the SSC component is weak.
5. REFERENCES

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FIGURE CAPTION

The broad-band spectrum of the “core-jet” structure of the quasar PKS 1127-145 and the applied model (SYN - synchrotron radiation, SSC - Comptonization of synchrotron radiation, ERC(IR) - Comptonization of the dust radiation, ERC(BEL) - Comptonization of the BEL radiation, bbody - monotemperature thermal dust radiation, uv bump - UV radiation from the disc). The observational data are obtained from archival data, NED and Chandra. The model parameters are as follows: \( r_0 = 6.25 \times 10^{18} \) cm; \( \gamma_{min} = 1.0; \gamma_{max} = 6.0 \times 10^3 \); the bulk Lorentz factor \( \Gamma = 10 \); the half-opening angle of the jet: \( \theta_j = 1/10 \); the observer is located at an angle: \( \theta_{obs} = 1/10 \); the magnetic field scales with the distance like \( B'(r) = (8.0 \times 10^{17})/r \) Gauss; the luminosity of the disc \( L_{UV} = 1.0 \times 10^{47} \) erg/s; maximal temperature of the dust \( T_{d,max} = 800 \) K; covering factor of the dust \( \xi_{IR} = 0.5 \); covering factor of the BEL clouds \( \xi_{BEL} = 0.08 \), minimal distance of the dust \( r_{d,min} = 1.84 \times 10^{19} \) cm, \( p = 1.55 \).
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\[ \log(\nu \lambda L_\nu) \text{ [erg s}^{-1}] \]

- \text{ERV(IR)}
- \text{ERV(UV)}
- \text{SYN}
- \text{bbody}
- \text{uv bump}
- \text{SSC}