

First Chandra Images of GPS quasars

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Abstract.

We have observed two GPS quasars with *Chandra* X-ray Observatory, PKS 1127-145 ($z = 1.187$) and B2 0738+393 ($z = 0.63$), and discovered ~ 300 kpc X-ray jets in both sources. Such large scale X-ray emission has not been seen in GPS sources so far. We discuss the implication of this discovery on our understanding of the GPS phenomenon.

1. Introduction

Giga-Hertz Peaked Spectrum (GPS) and Compact Steep Spectrum (CSS) (see O’Dea 1998 for review) sources are known to have compact radio morphology ($< 1\text{kpc}$ - 10kpc respectively). They have been interpreted as either young counterparts of FR I radio galaxies or as “frustrated” AGN, in which the radio jets are not able to penetrate the host galaxy’s gas and dust. There are just a few examples of GPS galaxies with a very faint Mpc scale radio structures, which are interpreted as relics of past activity in the source (Baum et al 1990). Only a small sample of GPS/CSS sources was observed with low resolution X-ray telescopes before Chandra, indicating that associated intrinsic absorption could be present in some sources. The high spatial resolution of Chandra allows us to study also the environment of these sources within arcsec from the strong compact core. Here we present the discovery of X-ray jets in the two GPS quasars indicating that X-ray emission associated with the relativistic plasma is present at large distances from the nucleus of GPS quasar. Details of data analysis are provided in Siemiginowska et al (2002a, 2002b) and Bechtold et al (2001).

1.1. PKS1127-145

X-ray jet in PKS 1127-145 is ~ 30 arcsec long corresponding to $\sim 330h_{50}^{-1}$ kpc at the quasar redshift. The jet curves. The ratio of individual knots to the core is $\sim 1 : 450$. The X-ray emission is stronger at the core and declines towards the end of the jet. Comparison of X-ray, optical and radio data rules out thermal

emission, SSC and a simple direct synchrotron emission as primary source of the X-ray jet emission. Inverse Compton scattering off CMB photons (EIC/CMB) with $\Gamma_{bulk} \sim 2 - 3$ can readily accommodate the observations.

1.2. B2 0738+393

X-ray jet in B2 0738+393 is ~ 35 arcsec long. The jet is curved with a few enhancements and the core to knots ratio of $\sim 1 : 200$ X-ray emission is getting fainter moving away from the core. The X-ray emission in the two outermost knots can be explained by synchrotron model, but for knot A at 10 arcsec distance from the core, the synchrotron emission requires unusually high acceleration efficiencies: in the synchrotron model the high energy break needs to be at $\nu > 10^{19}$ Hz. EIC/CMB process requires Γ_{bulk} of ~ 10 and might be a possible explanation for knot A X-ray emission.

2. Conclusions

We conclude that X-ray jets in both GPS quasars extend far away from the nucleus and the X-ray emission is most likely due to the interactions between relativistic jet particles and Cosmic Microwave Background photons. X-rays from EIC/CMB can trace low energy ($\gamma \sim 10^3$) population of particles which are not detectable in the radio band and can delineate the relic structure. Our observations may be compatible with the intermittent activity model of GPS sources, in which “old” electrons from previous activity are detectable in X-rays, via CMB while new components expand into the medium formed by the previous active phase.

We should also point out that the heterogeneous GPS/CSS samples may include regular quasars, so alternatively GPS quasars could simply be extended radio sources whose core is boosted towards us. Future studies of extended emission structures in GPS/CSS samples in both radio and X-rays should help in discriminating between different types of objects and creating homogeneous samples.

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