Deep Chandra Images of the X-ray Jets in PKS 0208–512 and PKS 1202–262


PKS 0208-512

Abstract

We have followed up the discovery of X-ray jets in the quasars PKS 0208-512 at z = 0.999, and PKS 1202-262 at z = 0.789, (Marshall et al. 2005), with deeper Chandra images. We interpret the overall SED in terms of inverse Compton scattering on the cosmic microwave background, in relativistic jets directed close to our line of sight.

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Discussion

The broadband SED’s (cf. Figs 5 & 6) do not allow a single power law electron distribution to produce both the radio and X-ray emission via synchrotron radiation. Under the hypothesis of minimum energy, the X-rays can be made from the same electron population by inverse Compton scattering off the cosmic microwave background (IC/CMB). We deduce that the PKS 0208-512 jet is moving with bulk Lorentz factor \( \Gamma \approx 6 \) and PKS 1202-262 has \( \Gamma \approx 10 \), and that their internal magnetic fields are \( B \approx 10^{-6} \mu G \).

With the deeper observations shown here we can study the spatial structure in more detail. We note that the X-rays carry the bulk of the radiated power from the jet (Figs 3 & 4, right panels). The relative constancy of the X-ray to radio (Figs 3 & 4, left panels) supports the IC/CMB picture, in which both radio and X-rays arise from relatively low energy electrons, with long lifetimes (Figs 7), while synchrotron X-rays would arise from electrons with very short lifetimes (Figs 8). X-ray emission in both jets terminates abruptly where the radio image has a large angle bend.

Figure 2. Images of PKS 1202-262, Chandra from upper left: HST F841f, HST F475w, ATCA 8.6 GHz, Chandra 0.5 – 7 keV. The red F841f image shows two spots, indicated as “XV” on the X-ray image, possibly associated with the jet, and two galaxies, indicated as ellipses on the X-ray image, which may be relevant to the jet dynamics. There are not visible on the F475w image. The 8.6 GHz contours, in factors of \( \sqrt{2} \) starting at 1 mJy, are superposed in green on the X-ray image.

Figure 3. X-ray (green) and 8.6 GHz radio (red) profiles along the jet of PKS 0208-512. The projection starts about 15’ from the quasar, and is 4” wide perpendicular to the jet. The left panel is observed data, with the radio data arbitrarily normalized. In the right panel, we present the energy flux profile for each band. On the top horizontal scale we give the distance from the quasar core, considering our modelled angle to the line of sight.

Figure 4. X-ray (green), 8.6 GHz radio (red), and 4.8 GHz (blue triangles) profiles along the jet of PKS 1202-262. The projection starts about 15’ from the quasar, and is 3” wide perpendicular to the jet. The left panel is observed data, with the radio data arbitrarily normalized. In the right panel, we present the energy flux profile for each band. On the top horizontal scale we give the distance from the quasar core, considering our modelled angle to the line of sight.

Figure 5. Spectral energy distribution of distinct spatial regions of the PKS 0208-512 jet.

Figure 6. Spectral energy distribution of distinct spatial regions of the PKS 1202-262 jet.