RELATIVISTIC BEAMING OF X-RAYS FROM QUASARS

Ajit Kembhavi, Sanjay Wagh and D. Narasimha
Tata Institute of Fundamental Research
Bombay 400005, India

ABSTRACT. A method is suggested for estimating the beamed and unbeamed components of the X-ray emission from quasars. It is shown that the beamed component correlates well with the core radio luminosity, while the unbeamed component shows no such correlation.

It has been shown recently by Kembhavi et al[1] that the X-ray emission in radio quasars is very well correlated with their core radio emission. Further, in a linear regression model $\log L_x = b \operatorname{Log} L_c +$ constant, the slope b is found to increase with decreasing core radio spectral index. This result has been interpreted by Browne and Murphy[2] in terms of a two component model for the X-ray emission, one isotropic and one relativistically beamed. They postulate that $L_x^b \alpha L_e$, $L_x \alpha L_e^{1/2}$, where L_x^b, L_x^u and L_e are the beamed X-ray, unbeamed X-ray and extended radio luminosity respectively. An observed strong correlation between L_c and the core radio luminosity L_e then explains the results of Kembhavi et al. However, an examination of highly beamed ($R=L_c/L_e > 10$) and unbeamed ($R < 0.1$) sources shows that the relations postulated by Browne and Murphy are not tenable. We therefore suggest a different model.

Following Orr and Browne[3] we write $L_x^b/L_x^u = R_{tx}\, g_x(\beta,\theta)$, where R_{tx} is the ratio of the beamed and unbeamed X-ray luminosities when the milliarcsecond scale relativistic jet is transverse to the line of sight; $g_x(\beta,\theta)$ is the X-ray beaming factor. For a given source this is determined from the ratio $R = L_c/L_e$, given the radio and X-ray spectral indices, which we assume to be 0.0 and -0.7 respectively. We further assume that $L_x^b = A_{xc} L_c$, A_{xc} = constant. We now minimize the function $F = \Sigma (\log L_x^T/L_x)^2$, treating A_{xc} and R_{tx} as free parameters. The summation extends over the radio quasars with adequate data[1,2], $L_x^T = L_x^b + L_x^u$, and L_x is the observed X-ray luminosity for each source.

In the minimization of F, if we use sources with $R < 1$, we find that at the minimum of F, $A_{xc} = 2.71 \times 10^{-7}$ and $R_{tx} = 0.038$. Using sources with $R < 10$, we find that $A_{xc} = 1.86 \times 10^{-7}$ and $R_{tx} = 0.023$. Using the

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parameters for $R < 1$, given the X-ray luminosity L_x and R for any source, $R_{tx}\,g_x$ can be determined, and the beamed and unbeamed luminosities may be separately obtained. We find that the beamed X-ray luminosity obtained in this way is highly correlated with L_c (confidence > 99.999%), while the unbeamed component does not show such a correlation.

Using our model we have generated the distribution of the two point spectral index α^u_{ex} connecting the extended radio luminosity to the unbeamed X-ray luminosity. We expect that α^u_{ex} for the highly beamed sources ($R > 10$) should show a similar distribution. We however find that if the two distributions are to be similar as per the Kolmogorov-Smirnov test (see Figure), then for the beamed sources $R_{tx} = 0.0014$. This discrepancy in the value of R_{tx} could mean that (i) the hypothesis of a single value of R_{tx} for the whole sample is not tenable and a distribution must be used, (ii) L_e has been over-estimated for quasars with $R > 10$ and (iii) the X-ray spectral index α_x is different for different R.

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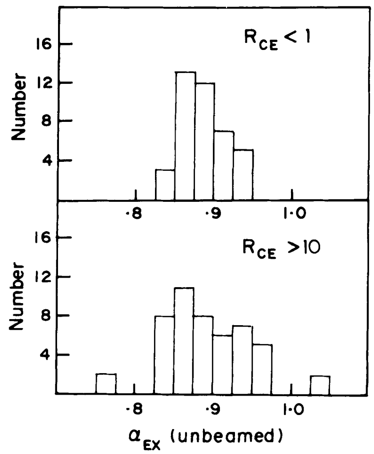

The upper panel shows the distribution of α^u_{ex} for quasars with $R < 1$, obtained from our model. The lower panel shows the α^u_{ex} distribution for $R > 10$, which provides the best fit with the upper distribution.

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