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# Dependence of Core and Extended Flux on Core Dominance Parameter for Radio Sources

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**Abstract.** Based on two extragalactic radio source samples, the core dominance parameter is calculated, and the correlations between the core/extended flux density and core dominance parameter are investigated. When the core dominance parameter is lower than unity, it is linearly correlated with the core flux density, but it is not correlated with the extended flux density. When the core dominance parameter is higher than unity, it is not correlated with the core flux density, but it is linearly correlated with the extended flux density. Therefore, there are different results from different samples. The results can be explained using a relativistic beaming model.

*Key words.* Active galactic nuclei—jet.

## 1. Introduction

In a relativistic beaming model, the Active Galactic Nuclei (AGNs) emissions are divided into two components, namely, the boosted and the isotropic extended ones (Urry & Shafer 1984). The ratio of the two parts is defined as a core dominance parameter (e.g., Orr & Brown 1982). To calculate the core dominance parameter, some authors used the ratio of flux densities but some others used the ratio of luminosities (e.g., Fan *et al*. 2008, 2010, 2011; Yuan & Wang 2012; Wang *et al*. 2011; Browne & Perley 1986; Punsly 1995, and reference therein), so the core dominance parameter $R = S_C/S_E$ or $R = L_C/L_E$.

Some authors have investigated the relation between core dominance parameter and flux (or luminosity) from various samples (Yuan & Wang 2012; Orr & Brown 1982; Wang *et al.* 2011; Browne & Perley 1986). For instance, Murphy *et al.* (1993) studied a complete sample of 89 powerful core-dominated radio sources with core flux density, $S_C^{5\ \mathrm{GHz}} > 1$ Jy at 5 GHz. Hough & Readhead (1989) defined a complete sample of 42 radio quasars to make a statistical analysis of the large scale structure to check for consistency with the beaming hypothesis in the central components. In this paper, we combine the data by Murphy *et al.* (1993) and by Hough & Readhead (1989) to investigate the correlations between the core dominance parameter and the core/extended flux density.

## 2. Sample and data processing

The paper by Hough & Readhead (1989) gave a sample of 42 radio quasars, in which 32 sources have both core and total flux at 5 GHz. In 1993, Murphy *et al*. presented a complete sample of 89 powerful core-dominated radio sources, in which 67 sources were listed to have the flux densities for both the core and the extended components at 1.64 GHz. From the above two samples, we can select the sources with both core and extended (or total) flux densities, and have a new sample of 99 radio sources. There are 32 sources from the paper by Hough & Readhead (1989) and 67 sources from the paper by Murphy *et al.* (1993).

Because the data given in the two papers belong to different frequencies (5 GHz and 1.64 GHz), therefore, we will transform the data to the same frequency. Since most data are given at 1.64 GHz, we transformed the 5 GHz data to 1.64 GHz data. We assumed the core spectral index $\alpha_{\rm C} = 0.0$ and the extended spectral index $\alpha_{\rm E} = 0.80$ (Yang *et al.* 2012) ($S_\nu \propto \nu^{-\alpha}$) when we transformed 5 GHz data to 1.64 GHz data.

To calculate the core dominance parameter at 1.64 GHz, we $K$-corrected the core flux density, and the core dominance parameter was calculated as $R = S_{\rm C}/S_{\rm E}$.

## 3. Results

From our samples, we consider the relations between $R$ and $S_{\rm C}$ (and $S_{\rm E}$) as follows (see also Fig. 1):

$$\begin{aligned}\log S_{\rm C} &= (0.87 \pm 0.05)\log R + (2.86 \pm 0.07),\ r = 0.96,\ p < 10^{-4},\\ \log S_{\rm E} &= -(0.10 \pm 0.04)\log R + (2.69 \pm 0.06),\ r = -0.46,\ p = 0.0084,\end{aligned}$$

for the 32 sources from Hough & Readhead (1989).

$$\begin{aligned}\log S_{\rm C} &= (0.02 \pm 0.04)\log R + (3.15 \pm 0.07),\ r = 0.06,\ p = 0.65,\\ \log S_{\rm E} &= -(0.93 \pm 0.04)\log R + (3.36 \pm 0.08),\ r = -0.93,\ p < 10^{-4},\end{aligned}$$

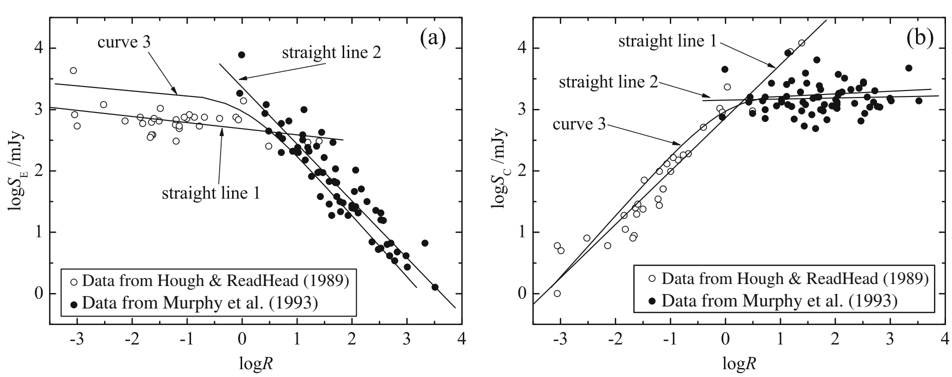


**Figure 1.** Correlations between core dominance parameter and core/extended flux density. The open circles represent the data from a paper by Hough & Readhead (1989), while the filled points represent the data from a paper by Murphy *et al.* (1993). Straight lines 1 and 2 are obtained by the linear regression from Hough & Readhead (1989) and Murphy *et al.* (1993) data respectively. In (**a**), curve 3 is from the theoretic equation (2), and in (**b**), curve 3 is from the theoretic equation (3).

for the 67 sources from Murphy *et al.* (1993).

Here, $r$ is the correlation coefficient and $p$ is the chance probability.

## 4. Discussion and conclusion

From our results, we arrive at the following conclusions:

There is a weak anti-correlation between extended flux density and the core dominance parameter in Hough & Readhead (1989), but a strong anti-correlation between them is shown in Murphy *et al.* (1993).

There is a strong correlation between core flux density and the core dominance parameter in Hough & Readhead (1989), but there is almost no correlation between them in Murphy *et al.* (1993).

So, data from different samples give opposite results. Why are there different results? In fact, these different results can be explained by using a beaming model.

From a two-component beaming model, we have

$$S_{\mathrm{T}} = S_{\mathrm{C}} + S_{\mathrm{E}} \quad \text{and} \quad R = \frac{S_{\mathrm{C}}}{S_{\mathrm{E}}}. \tag{1}$$

Here, $S_{\mathrm{T}}$ is the total flux density, $S_{\mathrm{E}}$ the extended flux, $S_{\mathrm{C}}$ the core flux, and $R$ the core dominance parameter.

For the log $R$–log $S_{\mathrm{E}}$ relation, from equation (1), we have

$$\log(1 + R) = -\log S_{\mathrm{E}} + \log S_{\mathrm{T}}. \tag{2}$$

We assume $S_{\mathrm{T}}$ is a constant in equation (2). When $R$ is much larger than unity, then $\log R \sim -\log S_{\mathrm{E}} + \log S_{\mathrm{T}}$, namely, log $R$ is anti-correlated with log $S_{\mathrm{E}}$. When $R$ is much smaller than unity, there is no correlation between log $R$ and log $S_{\mathrm{E}}$ .

For the log $R$–log $S_{\mathrm{C}}$ relation, from equation (1), we have

$$\log R - \log(1 + R) = \log S_{\mathrm{C}} - \log S_{\mathrm{T}}. \tag{3}$$

We assume that $S_{\mathrm{T}}$ is a constant in equation (3). When $R$ is much smaller than unity, then $\log R \sim \log S_{\mathrm{C}} - \log S_{\mathrm{T}}$, namely, log $R$ is correlated to log $S_{\mathrm{C}}$. When $R$ is much greater than unity, there is no correlation between log $R$ and log $S_{\mathrm{C}}$.

From Fig. 1, it is sure that the data obtained by the two samples fit the theoretic curves in equations (2) and (3) very well. Therefore, the data from both samples show the same dependence of flux density on core dominance parameter and there is no contradiction any more.

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## References

Browne, I. W. A., Perley, R. A. 1986, *Mon. Not. R. Astron. Soc.*, **222**, 149.
Fan, J.-H., Yang, J.-H., Pan, J. *et al.* 2011, *Research in Astron. Astrophys.*, **1**, 1413.
Fan, J.-H., Yang, J.-H., Tao, J. *et al.* 2010, *Publ. Astron. Soc. Japan*, **62**, 211.
Fan, J.-H., Yuan, Y.-H., Liu, Y. *et al.* 2008, *Publ. Astron. Soc. Japan*, **60**, 707.
Hough, D. H., Readhead, A. C. S. 1989, *Astron. J.*, **98**, 1208.
Murphy, D., Browne, I. W. A., Perley, M. F. 1993, *Mon. Not. R. Astron. Soc.*, **264**, 298.
Orr, M. J. L., Brown, I. W. A. 1982, *Mon. Not. R. Astron. Soc.*, **200**, 1067.
Punsly, B. 1995, *Astron. J.*, **109**, 1555.
Urry, C. M., Shafer, R. A. 1984, *ApJ*, **280**, 569.
Wang, Y.-X., Liu, Y., Pi, F.-P. *et al.* 2011, *J. Astrophys. Astr.*, **32**, 59.
Yang, R. S., Yang, J. H., Nie, J. J. 2012, *J. Asthrophys. Astr.*, **35**, 403.
Yuan, Z., Wang, J. 2012, *Astrophys. J.*, **744**, 84.