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Relation of Core Dominance Parameter and Extended Spectral Index for Radio Sources

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Abstract. The correlations between differences of two core dominance parameters and core/extended spectral index are investigated. The extended spectral index is associated with the differences very well, while there is a weak relationship between core spectral index and the differences. The average core spectral index tends to be a 'constant' ∼0.0.

Key words. Core dominance parameter: jet: spectral index.

1. Sample and results

A sample of 158 radio sources is obtained from some literatures (Fan *et al*. 2011 and references therein). Each source has two core and extended flux densities at both 1.5 and 5 GHz.

AGN emissions ($S_{\rm T}$) are divided into boosted ($S_{\rm C}$) and isotropic extended ($S_{\rm E}$) ones (Fan *et al*. 2010, 2011) in a relativistic beaming model. The ratio of the two parts is defined as a core dominance parameter, viz. $R = \frac{S_{\rm C}}{S_{\rm E}}$. If we have the data of the two bands (ν_1, ν_2), the core and extended spectral indices can be calculated by the formulae, $\alpha_{\rm C} = -\frac{\log(S_{{\rm C},\nu_1}/S_{{\rm C},\nu_2})}{\log(\nu_1/\nu_2)}$ and $\alpha_{\rm E} = -\frac{\log(S_{{\rm E},\nu_1}/S_{{\rm E},\nu_2})}{\log(\nu_1/\nu_2)}$, then we have two dominance parameters, viz. $R_1 = \frac{S_{{\rm C},\nu_1}}{S_{{\rm E},\nu_1}}$ and $R_2 = \frac{S_{{\rm C},\nu_2}}{S_{{\rm E},\nu_2}}$. From the above equations, we have $\log R_1 - \log R_2 = -\log \frac{\nu_1}{\nu_2} \cdot (\alpha_{\rm C} - \alpha_{\rm E})$. Here, $\nu_1 = 1.5$ and $\nu_2 = 5$ GHz, so, $\log \frac{\nu_1}{\nu_2} = -0.523$, then

$$\log R_1 - \log R_2 = 0.523\alpha_{\rm C} - 0.523\alpha_{\rm E}. \qquad (1)$$

For the relations of $\log R_1 - \log R_2$ against $\alpha_{\rm C}$ and $\alpha_{\rm E}$, we have $\log R_1 - \log R_2 = -(0.524 \pm 0.016)\alpha_{\rm E} + (0.027 \pm 0.018)$, with $r = 0.934$ and $p < 10^{-4}$ (Fig. 1(a)). $\log R_1 - \log R_2 = (0.529 \pm 0.110)\alpha_{\rm C} - (0.159 \pm 0.046)$, with $r = -0.361$ and $p < 10^{-4}$ (Fig. 1(b)).

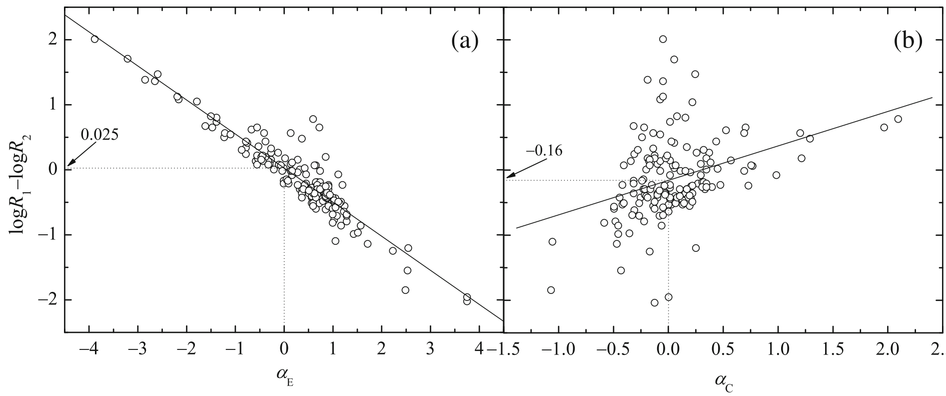

Figure 1. The correlations between the differences of two-core dominance parameters and core/extended spectral indices, (**a**) $\log R_1 - \log R_2$ vs. α_{E}, and (**b**) $\log R_1 - \log R_2$ vs. α_{C}.

2. Discussion and conclusion

Our results show that there is a very good correlation between $\log R_1 - \log R_2$ and α_{E} (Fig. 1(a)), while there is a weaker relationship for $\log R_1 - \log R_2$ and α_{C} than for $\log R_1 - \log R_2$ and α_{E} is obtained (Fig. 1(b)).

Equation (1) tells us that only when α_{C} is a constant, $\log R_1 - \log R_2$ is linearly related to α_{E}, which corresponds with our statistical results (Fig. 1(a)). It is suggested that the core spectral index is supposed to be a constant, while the extended spectral index is a variable. These result in a weak (even number) correlation between $\log R_1 - \log R_2$ and α_{C} (Fig. 1(b)). If it is authentic and core emission spectral index is a 'constant', we should be able to determine the 'constant', α_{C}. According to the fit line in Fig. 1(a), when $\alpha_{\mathrm{E}} = 0$, then $\log R_1 - \log R_2 = 0.025$, and according to equation (1), we have $\alpha_{\mathrm{C}} = 0.048$.

The extended emission spectral index is associated with the differences of two core dominance parameters in AGNs, while the relationship between core spectral and the differences is very weak. It suggests that the emissions from core and extended components are from different mechanisms. The core emission spectrum is flatter than the extended spectrum, and the core spectral index is a constant $\sim$0.0.

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