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ENERGETIC AND STRUCTURAL ANALYSIS OF COMPACT EXTRAGALACTIC SOURCES DERIVED FROM THE HIGH-FREQUENCY SPECTRAL TURNOVER

Carlos Roberto Rabaça and Zulema Abraham
Instituto Astronômico e Geofísico
Universidade de São Paulo

RESUMO. É feita uma análise da correlação obtida entre a luminosidade e o tamanho linear de fontes compactas extragaláticas a partir da determinação do mais alto "turnover" espectral e da suposição de que o mesmo está associado à auto-absorção sincrotrônica de uma componente homogênea única.

ABSTRACT. We study the correlation between luminosity and linear size of a sample of compact sources obtained from the determination of the last spectral turnover and from the suposition that it is associated with the synchrotron self-absortion of an unique homogeneous component.

Key words: QUASARS — RADIATION MECHANISMS

. INTRODUCTION

High-frequency monitoring programs have provided large amount of data from compact ktragalactic radio sources (Gear et al. 1985, 1986; Aller et al., 1985; Ledden and O'Dell,)85; Maraschi et al., 1986; Ghisellini et al., 1986; Salonen et al., 1987; Teräsranta et al.,)87; Botti and Abraham, 1988). At radio frequencies these sources are dominated by incoherent ynchrotron emission from different compact regions, resulting in a composite spectrum emarkably flat. Milliarcsecond-scale VLBI maps give observational support to this idea. owever, these maps do not solve the innermost component, being limited to centimeter and .llimeter wavelengths, where sometimes this component is still self-absorbed. Consequently, ost of our knowledge of the innermost component must come from the monitoring data obtained ver as many decades in frequency as possible.

Recent works (Valtaoja et al., 1988; Rabaça, 1988; Impey and Neugebauer, 1989) have erived the form of the spectral energy distribution of a sample of compact extragalactic adio sources and have made a quantitative analysis of the behavior of the composite spectrum ı time and/or in different frequencies.

We use the spectra presented in these works to investigate possible correlations etween energetic and structural characteristics of the innermost component of different types compact sources.

:. MODEL

We can figure the inferred components in the spectrum of compact extragalactic adio sources as being bright spots in an underlying jet. The most common assumption is that ach component has the spectrum of an homogeneous synchrotron source. In this way, the bserved outbursts can be identified as new components and/or strong instabilities in the ocal plasma of a pre-existing component. At the frequency in which all the components become ptically thin the spectrum steepens (latest spectral turnover), connecting smoothly to the nfrared continuum - unless there is a contribution of a thermal plasma envelope.

Assuming that at frequencies higher than the last turnover the flux is dominated by ne core component itself (or by the actual basis of the jet), the turnover will be associated ith the synchrotron self-absortion of the innermost component, discarding the possibility of uperposition. With this model, it is possible to derive the luminosity at the turnover nission frequency L_m, and the linear size r of this component using three parameters etermined graphically from the composite spectrum of the sources:

- the hightest turnover frequency (ν_m) ,
- the flux density at this frequency (S_m) ,
- the spectral index of the optically thin region (α) ,

provided that the magnetic field intensity B and the Doppler factor δ are the same for all tl sources, and the redshift z is known (see that we don't use the variability timescale t derive the size of the innermost component). The formulas used are:

$$L_m = 4 \pi D_L^2 S_m (1+z)^{-1} \delta^{3+\alpha}$$
$$r = \Theta D_L (1+z)^{-2}$$
$$\Theta \approx S_m^{1/2} \nu_m^{-5/4} B^{1/4} (1+z)^{1/4} \delta^{1/4}$$
$$D_L = c (H_o q_o)^{-2} \{ q_o z + (q_o-1) [(1+2q_o z)^{1/2} - 1]\}$$
$$\alpha = - d\log S/d\log\nu$$

where Θ is the angular size of the component, D_L the luminosity distance, H_o the Hubbl constant, and q_o the desacceleration parameter of the universe.

III. SAMPLE AND RESULTS

We have selected a sample of 55 sources with a well defined last turnover from th works of Valtaoja et al. (1988), Rabaça (1988), and Impey and Neugebauer (1989). They ar classified as blazar quasar, non-blazar quasar, BL Lac galaxy, or blazar galaxy. Althoug this sample is not complete it represents very well the class of compact extragalactic radi sources. Intrinsec parameters were calculated by taking $B = 10^{-4}$ Gauss, $\delta = 1$, $q_o = 0.5$, an $H_o = 100$ km s^{-1} Mpc^{-1}. The derived parameters are shown in Figs. 1 and 2; where ν_{mo} is th last turnover frequency refered to the rest frames of the sources.

IV. DISCUSSION

In Fig. 1 we see an overlap of the different types of sources. While blazar quasa are spread over the (L_m, ν_{mo},α)-space, it is possible to recognize some particular behavio for the other types of sources. Non-blazar quasars fill the high-luminosity, low-frequenc turnover part of the (L_m, ν_{mo})-plane, with an average spectral index of 0.8. Galaxies (two o them identified with blazars) occupy the low-luminosity, almost flat-spectrum, low turnove part of the figure space; and BL Lac objects the opposite end. All but the BL Lac behavi agree with the results of Valtaoja et al. (1988). This different behavior for BL Lacs is d to the fact that Valtaoja et al. have considered only the part of the radio spectra limited b their data in the derivation of the turnover parameters, while the last turnover appears a higher frequencies.

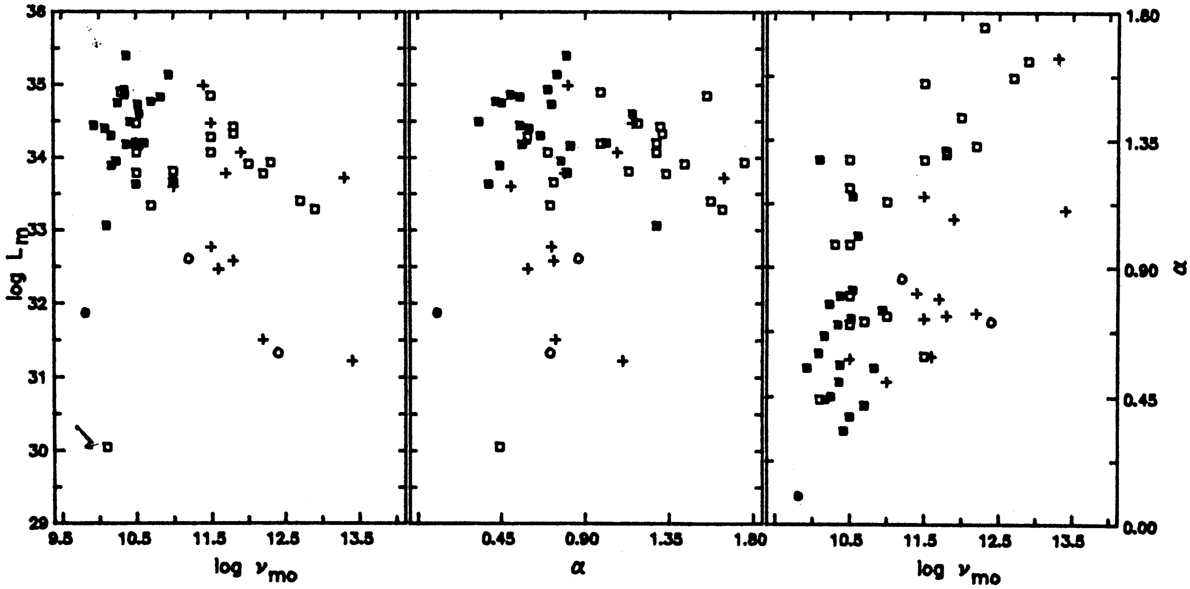
By a visual inspection of Fig. 1 it is also possible to see that the thre parameters in the (L_m, ν_{mo},α)-space show some degree of correlation. The best correlation i obtained at the (α, ν_{mo})-plane. Adiabatic and radiation losses can explain the steepenin observed for the sources with high last turnovers. There is almost no correlation in th (L_m, ν_{mo}) and (L_m,α) planes when we consider all the sources, but the correlation seems t increase when we separate them into blazar and non-blazar objects, a tendency also obtained b Valtaoja et al. (1988).

At Fig. 2 we see the (L_m,r,z)-space. There is a direct correlation in the (L_m,r) plane, indicating that the more compact the source, the less energectic it is. Although ther is not a correlation in the (r,z)-plane, what is in agreement with results obtainted wit largest angular size-versus-redshift tests, we can see a quantitative separation betwee blazar and non-blazar objects.

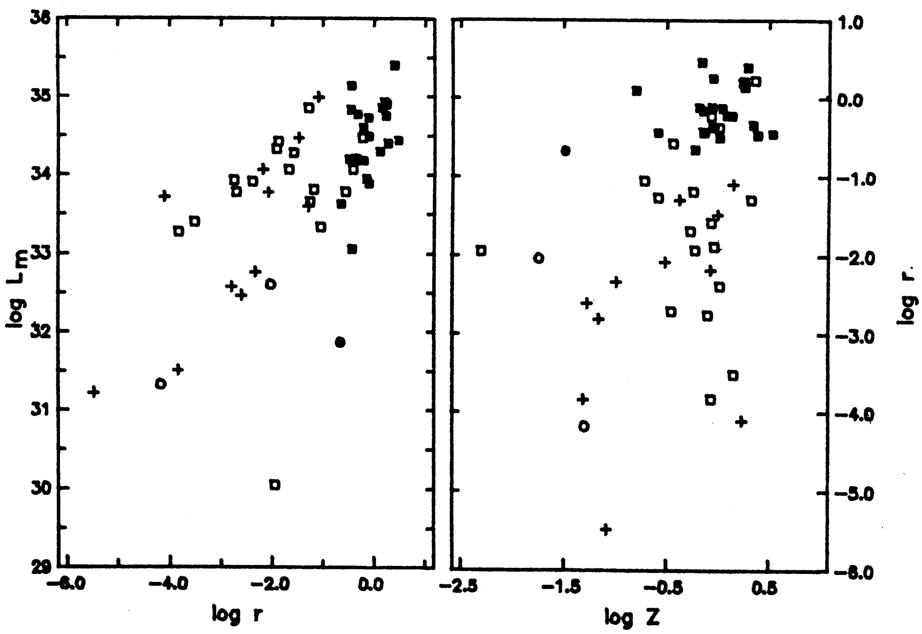
V. CONCLUSIONS

The results obtained with the 55 compact sources in the (L_m, ν_{mo},α)-space extend the previous results of Valtaoja et al. (1988) for blazar objects. They show there is a continuum distribution of the properties among the distinct types of sources, demonstrating that they are not qualitatively different.

We interpret the results obtained at Fig. 2 as the evidence of one or both of th followings:



'ig. 1 – (L_m, ν_{mo}, α)-space. The luminosities L_m are given in $erg.s^{-1}.Hz^{-1}$; and the turnover frequencies ν_{mo}, at the rest frames of the sources, are given in Hz. Symbols are: blazar quasars (white squares), non-blazar quasars (black squares), BL Lacs (crosses), blazar galaxies (white circles), and non-blazar galaxy (black circle).



ȝ. 2 – Graphics of the (L_m, r) and (r, z) planes. The linear size r is in parsec. The symbols is explained in the text of Fig. 1.

- a selection effect due to the suposition that most of the contribution to the flux density in the low-frequency turnover sources is due to an unique component.
- the fact that the Doppler effect biases the correlations, boosting the luminosities and enlarging the apparent sizes of the low-frequency turnover compact sources. As non-blazar sources are preferably identified as these ones, we would not be observing their nuclear region but a jet component. In this case the non-blazar cores would be intrinsically less intense than the blazar ones, and be masked by the optically thin radiation of the jet.

We are not able to discard one of the supositions above since VLBI observations are still restricted to a few number of the sources in the sample. The results express the necessity of obtaining more and more data at high-frequencies, where the cores become optically thin and outbursts reach their maximum development. We believe that, if we can separate quiescent and flaring components using more variability data, the quality of the results will improve.

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C.R. Rabaça and Z. Abraham: Departamento de Astronomia, Instituto Astronômico e Geofísico, USP, Caixa Postal 30627, 01051 São Paulo SP, Brazil.