THE ASTROPHYSICAL JOURNAL, 310:325–333, 1986 November 1

SPECTRAL PROPERTIES OF BLAZARS. II. AN X-RAY OBSERVED SAMPLE

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Received 1985 August 2; accepted 1986 April 14

ABSTRACT

All the blazars observed in X-rays in various reference lists and all those belonging to X-ray selected samples are considered. It is found that X-ray selected objects have, on average, radio (5 GHz) to ultraviolet (2500 Å) and ultraviolet to X-ray (2 keV) spectral indices significantly flatter than radio-selected objects. The monochromatic luminosity distributions show that X-ray selected and radio-selected blazars have the same average X-ray luminosity, and that the X-ray selected ones are underluminous at ultraviolet and radio frequencies. It is argued that the objects with flat overall spectrum, which may be called radio-weak, discovered from X-ray searches are the dominant members of the blazar population in terms of space density, while radio-loud blazars with the same X-ray luminosity are a minority. The results are interpreted in the framework of a model where the X-ray emission is isotropic, while that at lower frequencies is relativistically beamed. Radio-loud blazars should be those with the beam pointing towards us.

Subject headings: BL Lacertae objects — quasars — radiation mechanisms — spectrophotometry — ultraviolet: spectra — X-rays: sources

I. INTRODUCTION

In the course of an investigation of the detailed spectral properties of blazars, based on a sample observed in the far ultraviolet (Ghisellini *et al.* 1986, hereafter Paper I), it was noticed that sources selected on the basis of their X-ray emission have substantially flatter spectra in the infrared, optical, and ultraviolet bands with respect to otherwise selected sources. The difference in shape appears to extend to the overall energy distribution, in that the composite spectral indices from radio to ultraviolet and from ultraviolet to X-ray frequencies are correlated, respectively, with those in the infrared and ultraviolet bands and are systematically lower for X-ray selected objects. These results were, however, based on only six X-ray selected objects and, in order to make further progress, it appeared of basic importance to extend the analysis to all the X-ray observed objects, relaxing the requirement of far-ultraviolet observations.

In this paper, we discuss a sample of 75 objects, 13 of which can be considered X-ray selected. The criteria adopted in the compilation of the sample are specified in § II. Essentially we consider all the blazars in a few classical reference lists which were observed in X-rays, and all those discovered through their X-ray emission. We use radio (5 GHz), ultraviolet (2500 Å), and X-ray (2 keV) fluxes to construct composite spectral indices and discuss the systematic differences between X-ray selected and otherwise selected objects (§ III). It is confirmed that X-ray selected objects have flatter overall spectra, and are therefore weaker radio emitters relative to their X-ray emission, than otherwise selected objects. No significant spectral differences are found between blazars with weak or strong emission lines. The former are usually defined as BL Lac objects, the latter as highly polarized quasars (HPQs) or optically violently variable quasars.

In § IV we present the monochromatic luminosity distributions at radio, optical, and X-ray frequencies for the 52 objects with known redshift. Here we find what we consider the most important result of the analysis, viz., that X-ray selected blazars have the same average X-ray luminosity as otherwise selected blazars and are underluminous at UV and radio frequencies. This point is crucial, since it implies that X-ray selection should not *a priori* introduce any bias toward flat- or steep-spectrum objects. On this basis it is argued that the radio-weak, X-ray selected BL Lac objects are, in terms of space density, the dominant members of the blazar population.

In § V the results are interpreted in the framework of synchrotron emission models involving relativistic plasma jets. A picture is proposed in which the bulk Lorentz factor Γ increases along the jet, and X-rays are produced near the jet nozzle i.e., quasi-isotropically, while the radio emission derives from regions further away along the jet, with higher values of Γ.

II. BLAZARS OBSERVED IN X-RAYS

Since the class of blazars is not unambiguously defined, we have tried to avoid introducing our own personal prejudices by referring to a few published source lists. The main one is that of the review of Angel and Stockman (1980), which was the first to adopt systematically the blazar classification. We also considered the confirmed HPQs from the survey of Moore and Stockman (1984), excluding the radio-quiet, broad absorption line QSO 2225−055, whose polarization is likely to be of different origin. Of the resulting 63 objects, 55 were observed with the *Einstein Observatory* and two with the *EXOSAT* observatory. For 53 of them published results were found, 50 fluxes and three upper limits. For the remaining four objects we were unable to find information, but this uncertainty should not greatly affect our conclusions, due to the small number of objects involved. We treated as reference lists also two X-ray surveys, that of Schwartz and Ku (1983) and that of Biermann *et al.* (1981), and derived nine and five objects respectively. In both cases the authors report a detection rate of 100%. We are therefore confident that X-ray weak objects have not been accidentally neglected.

As far as we know, the only X-ray observed blazars not included in the group defined above are those which appear *only* in the list of Weiler and Johnston (1980). Of these, 13 were observed with *Einstein*, but only for two have we found published fluxes. Due to the large fraction of unknown results we did not include objects from the latter list in our sample.

To the known blazars with sufficient X-ray information we add all the blazars discovered recently from optical identification of X-ray sources. Two of them, PKS 0548−322 and PKS 2155−304, already appear in Angel and Stockman (1980); a third one, 2A 1218+304, appears in Schwartz and Ku (1983). Eight more are added to the sample. They comprise H0323+022, recognized as a BL Lac object by Feigelson *et al.* (1986), four objects discovered in the *Einstein* Medium Sensitivity Survey of Maccacaro *et al.* (1984), and three objects serendipitously discovered by Chanan *et al.* (1982) and Ulmer *et al.* (1983). The entire set of blazars thus assembled comprises 75 objects. It includes 31 of the 33 objects observed in the far-ultraviolet with *IUE* and discussed in Paper I.

We will consider as X-ray selected (XS) not only the sources which were actually discovered from X-ray observations, but also those which appear above the completeness limit in the *HEAO 1* A-1 survey (Wood *et al.* 1984). These are the six objects considered XS in Paper I. Four of them were actually X-ray discovered. The XS group thus contains in all 13 objects.

The other 62 objects of the list were not selected on the basis of their X-ray emission. They all derive from radio surveys except for Mrk 180, I Zw 187, and NGC 1275, which were picked up from optical samples. In the following, we refer to all these objects as otherwise selected, meaning at wavelengths other than X-rays, or, for brevity, as radio-selected (RS), since this is appropriate for 59 of 62 objects.

It is clear that neither the whole group nor the subgroups of XS or RS objects constitute complete samples.

A further distinction between the objects of the entire group is the strength of the emission lines. Those which are reported to have strong emission lines in the Angel and Stockman (1980) catalog and all those deriving from the quasar survey of Moore and Stockman (1984) are considered here as strong-line objects.

III. SPECTRAL PROPERTIES

For the 44 objects not included in Paper I, the relevant information is given here in Table 1 with compilation criteria similar to those adopted for Table 1 of Paper I. Columns (1) and (2) give the coordinate designation and name of the objects. The letter X in column (3) indicates that the object belongs to the X-ray selected group, and the letter E that it has strong emission lines. Column (4) gives the redshift when available.

The flux densities at 5 GHz, at 5500 Å (*V* band), and at 2 keV (in three cases this is an upper limit) are reported in columns (6), (8), and (10). References are given for each entry. Preference was given to measurements simultaneous or close in time to the X-ray observations. In the radio band, VLA measurements were chosen whenever available. In the optical band, values corrected for starlight contribution and for extinction were preferentially taken. The X-ray data derive in all cases from *Einstein* observations.

For uniformity with Paper I and other papers (e.g., Zamorani *et al.* 1981), we use the flux at 2500 Å in the definition of composite spectral indices. This is obtained extrapolating the value measured in the visual band with the average spectral index of blazars in the optical–ultraviolet band derived in Paper I, $\langle \alpha_{UV} \rangle = 1.4$.

Composite spectral indices connecting the radio (5 GHz) and the UV bands (2500 Å), α_{RU}; the UV (2500 Å) and the X-ray (2 keV) bands, α_{UX}; and directly the two extreme frequencies, α_{RX}, are defined as usual (e.g., Paper I). For reducing monochromatic fluxes to the source's rest frame, the average redshift of the whole sample is used, $\langle z \rangle = 0.6$, when the actual redshift is unknown. For the same purpose the spectral indices adopted in the radio, ultraviolet, and X-ray bands are $\alpha_R = 0$, $\alpha_{UV} = 1.4$, and $\alpha_X = 1$.

The observed distributions of the broad-band indices for the entire sample comprising the objects discussed in Paper I are shown in Figure 1, where shaded areas correspond to XS objects. The mean values, neglecting upper limits, are given in Table 2 for the whole group, and separately for the sugroups of XS and RS objects and for the subgroup of strong emission line (E) objects. We have also computed the probability distributions and average values of the spectral indices, taking into account the three upper limits in the way developed by Avni *et al.* (1980). We find that the averages computed in this way do not differ from those of the observed distribution within the errors, and therefore we neglect upper limits in the following.

It clearly appears from both Figure 1 and Table 2 that XS blazars have significantly lower spectral indices than the rest of the sample in the three considered spectral ranges. This confirms for a wider sample the result obtained in Paper I and noted in somewhat different forms by Chanan *et al.* (1982), Stocke *et al.* (1985), and Ledden and O'Dell (1985). The first two papers remark on the radio weakness of XS objects, while the latter choose to define them rather as X-ray strong. In Paper I we showed that the shape of the overall energy distribution is also related to the flatness of the spectrum in the IR–UV range.

It is remarkable that XS objects never have strong emission lines. The average spectral indices of strong emission line objects are larger than those of XS blazars and indistinguishable from those of RS blazars.

The role of selection effects in producing the observed distributions is obviously important: since selected objects are those which are brighter in the selection band, it is expected that radio and X-ray selection may sample different portions of the intrinsic α_{RX} distribution of the blazar population. Nevertheless, the above results contain significant information regarding the original population. For instance, there is no *a priori* reason why radio-bright objects should never have flat overall spectra leading to high X-ray fluxes. The rareness of such objects must be a property of the blazar population. These points are discussed further in § IV on the basis of luminosity distributions.

TABLE 1

RELEVANT DATA FOR THE X-RAY OBSERVED BLAZARS[a]

Coordinates (1)	Name (2)	Comment[b] (3)	z (4)	Reference (5)	F_R[c] (Jy) (6)	Reference (7)	F_V[d] (mJy) (8)	Reference (9)	F_X[e] (μJy) (10)	Reference (11)
0048−097	OB−081	...	...		0.85	1	0.88	2	0.033	3
0106+013	PKS	E	2.107	4	2.4	5	0.169	6	0.109	7
0109+224	...	...	...		0.45	8	2.42	9	0.125	10
0212+73	...	...	...		2.4	11	0.096	11	0.114	12
0229+341	3C 68.1	E	1.238	13	0.83	14	0.0363	15	<0.025	16
0317+183	...	X	0.19	17	0.012	18	0.198	18	0.57	18
0336−019	CTA 26	E	0.852	6	2.6	14	0.17	15	0.06	10
0338−214	PKS		0.048	19	0.94	19	2.2	20	0.066	21
0403−132	PKS	E	0.571	9	2.8	9	0.505	9	0.148	22
0141+009	...	X	...		0.083	23	1.05	23	1.2	23
0420−014	PKS	E	0.915	9	1.8	9	0.242	9	0.26	7
0422+004	OF 038		...		1.09	1	0.607	1	0.216	10
0454−234	PKS		0.89	24	2.06	5	0.242	20	0.055	21
0454+84	...		...		1.25	11	0.242	11	0.026	11
0458−020	...	E	2.286	6	1.7	5	0.17	6	0.02	25
0528−250	PKS	E	2.76	6	0.94	20	0.183	26	0.081	26
0808+019	...		...		0.66	1	0.96	1	0.18	16
0818−128	OJ 131		...		0.68	1	1.52	1	<0.035	16
0906+015	PKS	E	1.018	6	1.04	5	0.383	6	0.109	7
0906+430	3C 216	E	0.670	6	1.8	5	0.156	6	0.045	16
1147+245	...		...		0.86	1	0.96	1	0.04	16
1207.9+394	...	X	0.59	27	0.0061	27	0.086	27	0.097	27
1235+631	...	X	0.297	17	0.007	1	0.14	27	0.116	27
1253−055	3C 279	E	0.538	9	16	9	0.319	9	0.7	28
1400+162	OQ 100		0.244	9	0.16	1	0.505	2	0.05	29
1402+0416	...	X	0.21	30	0.021	27	0.554	27	0.075	27
1408+020	...	X	...		0.001	31	0.105	31	0.071	31
1413+135	PKS		0.26	26	1.23	20	0.038	20	0.033	26
1514+197	...		...		0.5	1	0.61	1	<0.017	29
1522+155	MC 3	E	0.628	9	0.6[f]	14	0.461	9	0.022	6
1538+149	4C 14.60		...		1.14	1	0.483	2	0.075	29
1704+6077	...	X	...		0.004	31	0.066	31	0.0296	31
1749+096	...		...		1.47	1	0.73	5	0.18	16
1803+78	...		...		2.3	11	0.607	11	0.076	11
1921−293	OV 236		0.3525	21	5.05	20	0.383	20	0.285	26
2007+77	...		...		1.5	11	0.607	11	0.053	11
2131−021	4C 2.81		0.056	21	2.12	5	0.127	20	0.054	26
2201+044	4C 04.77		0.028	21	0.3	1	3.19	2	0.165	26
2201+171	...	E	1.08	21	0.7	9	0.116	9	0.051	26
2230+114	CTA 102	E	1.037	6	3.5	9	0.461	9	0.3	21
2234+282	B2	E	0.795	6	1.06	5	0.0096	6	0.03	6
2251+158	3C 454.4	E	0.859	6	10.2	20	1.39	9	0.282	26
2254+074	OY 091		...		0.52	1	1.05	2	0.049	29
2345−167	PKS	E	0.6	9	3.6	9	0.242	9	0.092	7

[a] Those included in Paper I are omitted here.
[b] X, X-ray selected objects; E, strong emission-line sources.
[c] Flux at 5 GHz.
[d] Flux in the V band.
[e] Flux at 2 keV.
[f] Extrapolation from 408 MHz ($\alpha_R = 0$).

REFERENCES.—(1) Weiler and Johnston 1980. (2) Cruz-Gonzales and Huchra 1984. (3) Madejski and Schwartz 1983. (4) Richstone and Schmidt 1980. (5) Kuhr *et al.* 1981. (6) Moore and Stockman 1984. (7) Ku *et al.* 1980. (8) Owen *et al.* 1980. (9) Angel and Stockman 1980. (10) Owen *et al.* 1981. (11) Biermann *et al.* 1981. (12) Biermann *et al.* 1982. (13) Boksenberg *et al.* 1976. (14) Moore and Stockman 1981. (15) Neugebauer *et al.* 1979. (16) Ledden and O'Dell 1985. (17) Gioia *et al.* 1984. (18) Maccacaro *et al.* 1984. (19) Wright *et al.* 1977. (20) Perley 1982. (21) Schwartz and Ku 1983. (22) Blumenthal *et al.* 1983. (23) Ulmer *et al.* 1983. (24) Allen *et al.* 1982. (25) Henricksen *et al.* 1984. (26) Urry 1984. (27) Stocke *et al.* 1985. (28) Tananbaum *et al.* 1979. (29) Maccagni and Tarenghi 1981. (30) Marshall 1985. (31) Chanan *et al.* 1982.

A linear regression analysis shows that α_{RX} is strongly correlated with α_{RU} and α_{UX} for the whole sample (10^{-3} chance probability), for the RS subgroup (2×10^{-3} chance probability) and, with lower significance, for the XS group as well (5×10^{-2} chance probability). Similar results were obtained by Ledden and O'Dell (1985) on the basis of an independent compilation of blazar data. On the other hand, no correlation between α_{UX} and α_{RU} appears for the whole group, while for the two subgroups (XS, RS) separately a correlation of negative sign is indicated. In Table 3 the parameters of the linear regressions and the correlation coefficients are given for the various cases. Since there is an algebraic relation between the three indices, and the sensitivity of radio and X-ray surveys allows only a small interval in α_{RX} to be sampled, selection effects enter into these correlations in a very complicated way. We will not attempt to discuss them further.

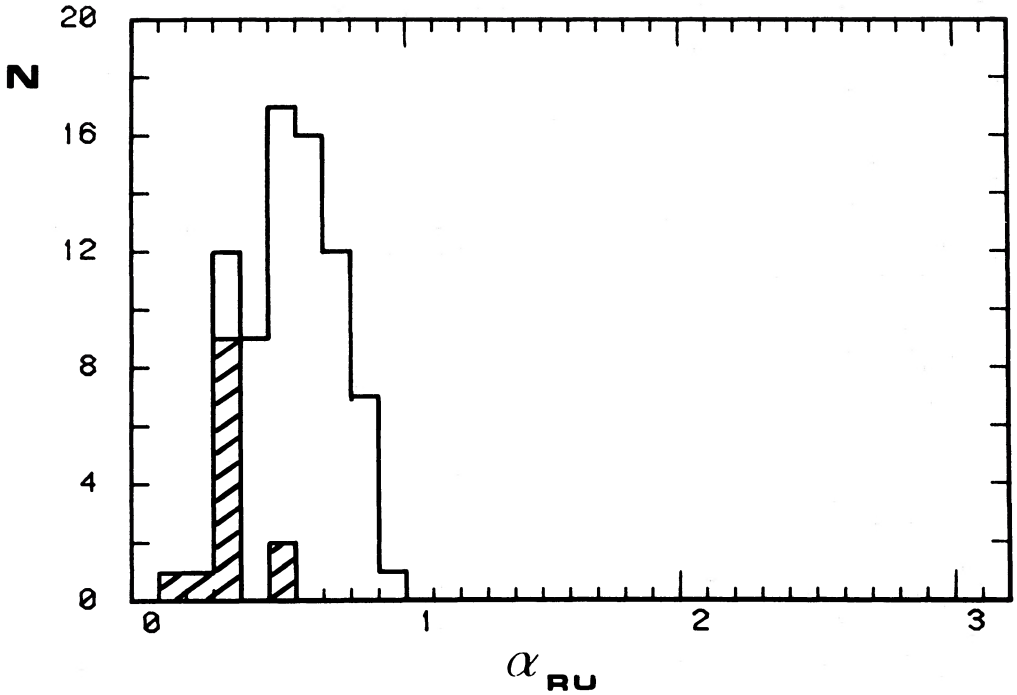

FIG. 1a

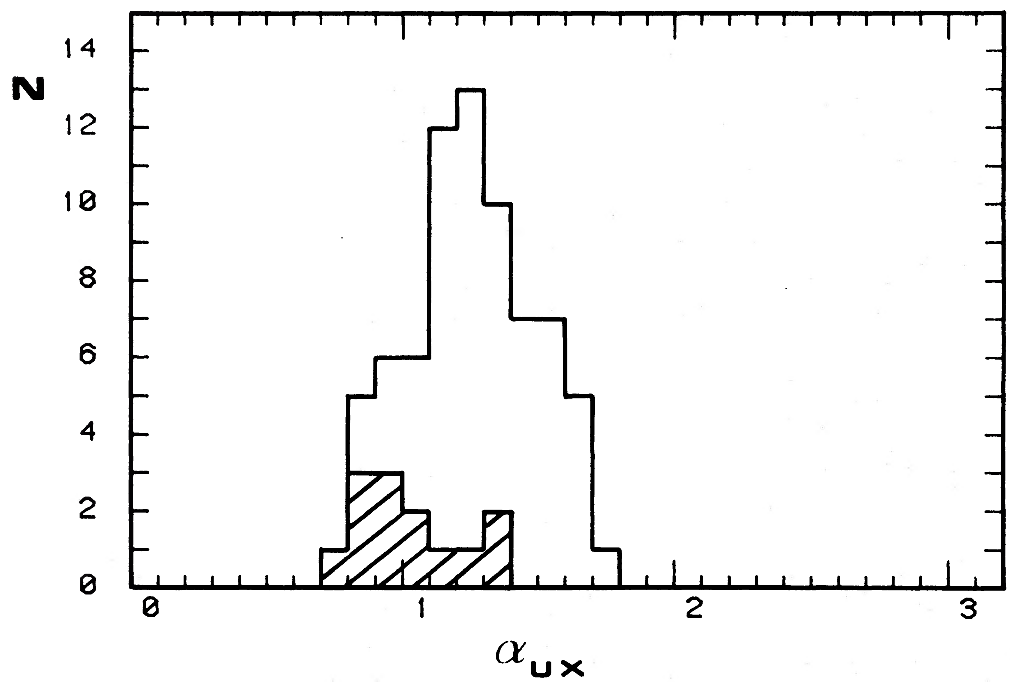

FIG. 1b

FIG. 1.—Distributions of composite spectral indices of all X-ray observed blazars. Shaded areas correspond to X-ray selected objects. (a) Radio (5 GHz) to ultraviolet (2500 Å) index α_{RV}, (b) ultraviolet (2500 Å) to X-ray (2 keV) index α_{VX}, (c) radio (5 GHz) to X-ray (2 keV) index α_{RX}.

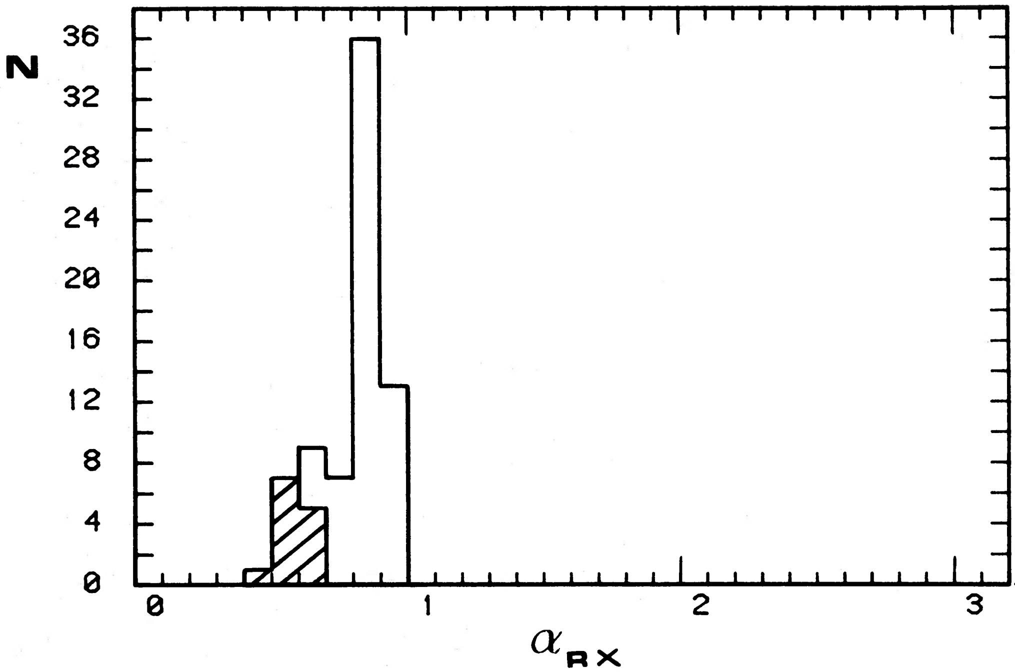

FIG. 1c

TABLE 2
MEAN SPECTRAL INDICES AND LUMINOSITIES

Parameter	All	X-ray Selected	Radio-selected	Strong-Line Objects
α_{RU}	0.59 ± 0.02 (75)	0.37 ± 0.03 (13)	0.63 ± 0.02 (62)	0.69 ± 0.02 (22)
α_{UX}	1.25 ± 0.03 (72)	1.03 ± 0.05 (13)	1.30 ± 0.03 (59)	1.23 ± 0.04 (21)
α_{RX}	0.80 ± 0.01 (72)	0.59 ± 0.02 (13)	0.85 ± 0.01 (59)	0.86 ± 0.01 (21)
α_{UX}^{eff}	$1.11^{+0.03}_{-0.03}$ (72)	$0.96^{+0.04}_{-0.03}$ (13)	$1.18^{+0.04}_{-0.03}$ (59)	$1.14^{+0.07}_{-0.05}$ (21)
log L_R	33.44 ± 0.20 (53)	31.57 ± 0.09 (10)	33.87 ± 0.19 (43)	34.43 ± 0.19 (22)
log L_{UV}	30.19 ± 0.14 (53)	29.51 ± 0.19 (10)	30.35 ± 0.16 (43)	30.71 ± 0.18 (22)
log L_X	27.01 ± 0.13 (52)	26.85 ± 0.16 (10)	27.07 ± 0.16 (42)	27.54 ± 0.15 (21)

NOTE.—Parentheses enclose number of objects used for each entry; cgs units are adopted for monochromatic luminosities.

TABLE 3
RESULTS OF LINEAR CORRELATION ANALYSIS BETWEEN COMPOSITE SPECTRAL INDICES

y	x	N	m	q	r	P
			All			
α_{RU}	α_{UX}	72	-0.084	0.689	-0.119	$\sim 30\%$
α_{RX}	α_{UX}	72	$+0.270$	0.465	$+0.497$	$< 10^{-3}$
α_{RX}	α_{RU}	72	$+0.619$	0.440	$+0.803$	$< 10^{-3}$
			X-ray Selected			
α_{RU}	α_{UX}	13	-0.254	0.631	-0.504	$\sim 10\%$
α_{RX}	α_{UX}	13	$+0.155$	0.425	$+0.466$	~ 10
α_{RX}	α_{RU}	13	$+0.348$	0.457	$+0.529$	~ 5
			Radio-selected			
α_{RU}	α_{UX}	54	-0.368	1.11	-0.589	$< 10^{-3}$
α_{RX}	α_{UX}	54	$+0.078$	0.748	$+0.223$	$\sim 10\%$
α_{RX}	α_{RU}	54	$+0.367$	0.617	$+0.657$	$< 10^{-3}$

NOTE.—Linear correlation obtained considering x as the independent variable and assuming a relation $y = mx + q$; N is the number of points, r is the correlation coefficient, and P is the chance probability.

IV. LUMINOSITY DISTRIBUTIONS

The distribution of the available redshifts of the objects listed in Table 1 plus those of Paper I is shown in Figure 2. The deficiency of intermediate redshifts, $0.1 < z < 0.4$, may be due to observational difficulties either in finding objects or in determining redshifts in this range, in the absence of strong emission lines. The XS objects have redshifts lower than average.

For the 52 objects with known z it is possible to study the luminosity distributions. Values of $H_0 = 50$ and $q_0 = \frac{1}{2}$ were assumed, and the fluxes were k-corrected as described in Paper I. The distributions of the radio (5 GHz), ultraviolet (2500 Å), and X-ray (2 keV) monochromatic luminosities are shown in Figure 3. It appears from the figures and from the logarithmic averages presented in Table 3 that XS objects have the same X-ray luminosity as otherwise selected objects. On the other hand, they have significantly lower radio and UV luminosities with respect to RS objects. For this reason we call radio-weak the objects with flat overall spectrum ($\alpha_{RX} < 0.7$) and radio-loud those with steep overall spectrum ($\alpha_{RX} > 0.7$), rather than X-ray strong and X-ray normal respectively, as chosen by Ledden and O'Dell (1985). Within the RS group the

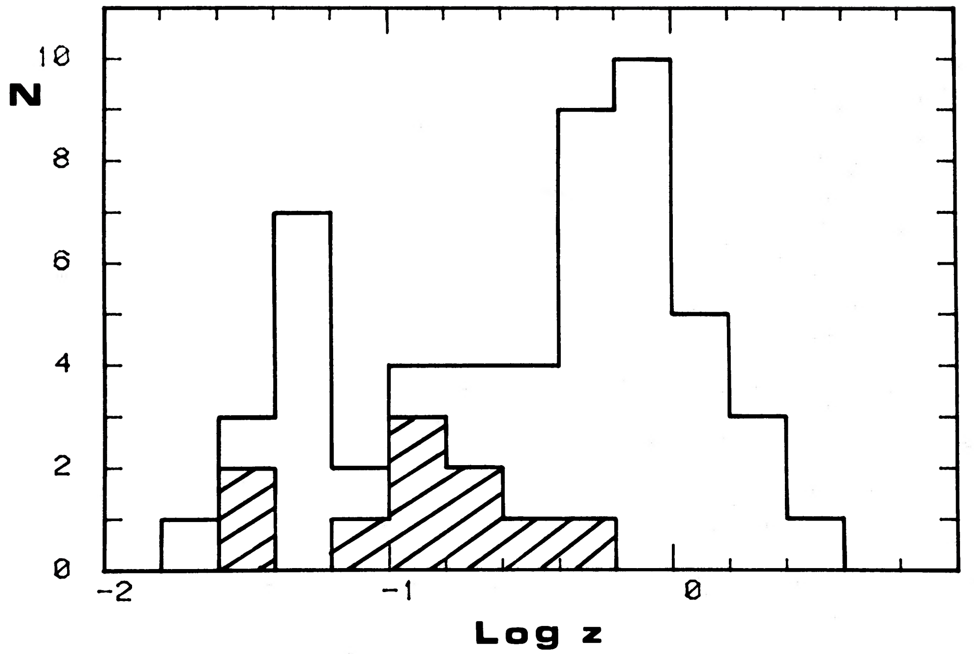

FIG. 2.—Redshift distribution for all X-ray observed blazars. Shaded areas correspond to X-ray selected objects.

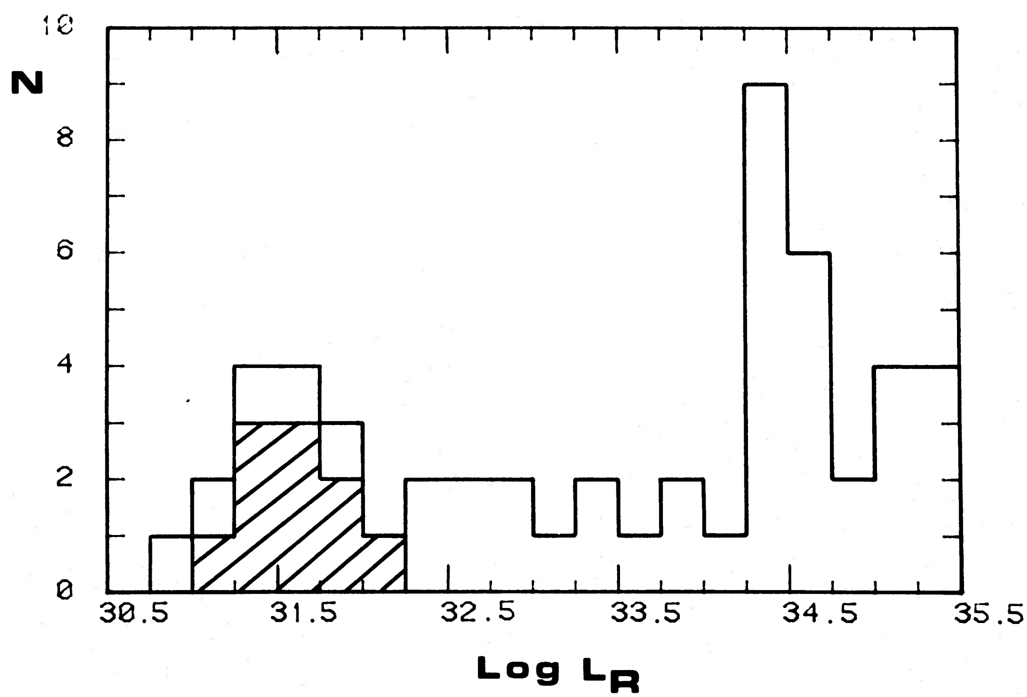

FIG. 3a

FIG. 3.—Distribution of monochromatic luminosities in cgs units for all X-ray observed blazars. Shaded areas correspond to X-ray selected objects. (a) Distribution of radio (5 GHz) luminosity, (b) distribution of ultraviolet (2500 Å) luminosity, (c) distribution of X-ray (2 keV) luminosity.

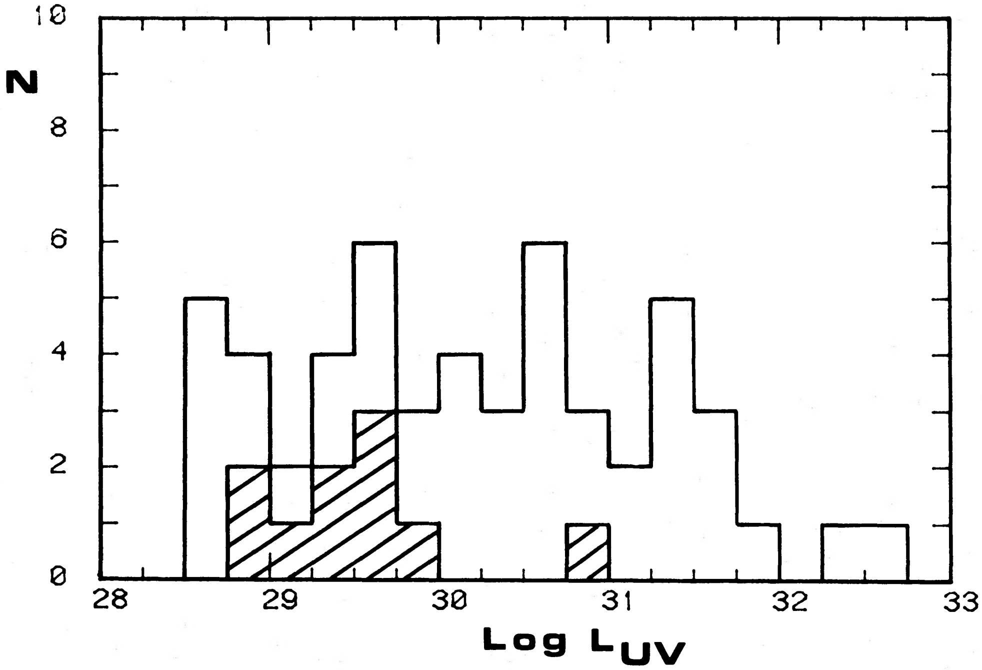

FIG. 3b

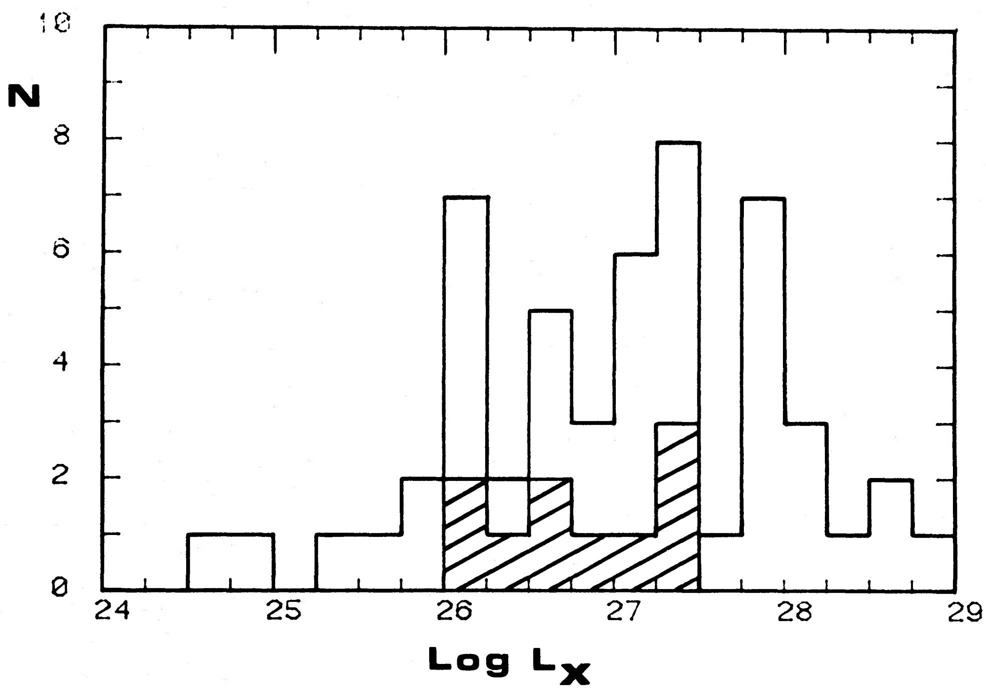

FIG. 3c

objects with strong lines (HPQs) are distinctly more luminous than average at all frequencies, and this is related to a larger value of the average distance.

We consider that the coincidence of the average X-ray luminosity of the XS and RS samples bears important implications. In fact, given that the two subgroups do not differ in X-ray luminosity, X-ray selection should not, in principle, discriminate against radio-loud blazars. Since, on the contrary, all XS blazars are radio-weak, we are forced to conclude that radio-weak objects are intrinsically more abundant than radio-loud objects with the same X-ray luminosity. In other words, the space density of radio-weak blazars is much larger (by at least a factor of 10) than that of radio-loud blazars with the same X-ray luminosity. Note that this does not conflict with the fact that the majority of known blazars are radio-bright, since this reflects simply the mode of formation of blazar lists, which depends heavily on radio selection.

The result obtained here for radio-loud and radio-weak blazars is reminiscent of the situation for radio-loud and radio-quiet quasars.

V. IMPLICATION FOR EMISSION MODELS

There exists a wide consensus that the electromagnetic spectrum of blazars derives at low frequencies from synchrotron radiation. The correlation found in Paper I between the spectral index in the UV band and α_{UX}, and here between α_{RX} and α_{UX}, indicates that synchrotron emission should extend up to 2 keV.

The proposed models differ in the specification of the spatial structure of the source (homogeneous or inhomogeneous) and in their assumptions about the bulk motion of the emitting relativistic plasma. In particular, the hypothesis that the blazar phenomenon is due to relativistic enhancement of the emitted radiation in the observer's direction, associated with relativistic bulk motion (relativistic beaming) has been under discussion since it was first proposed by Blandford and Rees (1978).

Our main result is that the average X-ray luminosity of objects with widely different broad-band spectra, which have been defined as radio-weak and radio-loud, is essentially the same. This suggests a common mechanism responsible for the X-ray emission and, at the same time, requires us to understand what causes the differentiation in the broad-band spectra. A possible reason for the different overall spectral shapes is simply that the electron spectra are intrinsically different. Since, however, this assumption seems somewhat ad hoc, we propose in the following a more appealing picture, coherent with recent ideas about the structure of these sources.

Consider jet models, in which plasma flows in an elongated region defined by external boundary conditions (e.g., Marscher 1980; Königl 1981). Suppose that the bulk velocity increases along the jet, becoming highly relativistic. In a specific computation Reynolds (1982) has shown that the bulk Lorentz factor Γ can increase along the jet on a scale which may be 100 times the scale of the injection region. Let us further assume that synchrotron X-rays are generated near the injection region (nozzle), while lower frequencies are produced at larger radii (see Ghisellini, Maraschi, and Treves 1985 for a discussion of models of this type). With those hypotheses, X-rays are emitted from plasma with low Γ, i.e., quasi-isotropically, while lower frequencies would be increasingly boosted along the jet axis. The observed spectrum would then depend on the orientation of the jet, with lower frequencies enhanced (steep overall spectra) in the case of alignment of the jet with the line of sight.

We propose that radio-weak blazars are objects with randomly oriented jets, and radio-loud blazars are those in which the jet points to the observer. Since this should occur with a probability $1/(4\Gamma_{max}^2)$, one can account at the same time for both the different shape of the overall spectrum and the different space density.

Although the model is only qualitative at the present stage, it has some interesting implications. One is that at low frequencies ($<10^{15}$ Hz), radio-weak objects should be less rapidly variable than radio-loud ones. A second one is that rather small values of Γ_{max} are indicated, $\Gamma_{max} = 5$–3, in order to avoid a too large diminution of the radio flux for the misaligned observer.

These estimates are based on the simple picture of a narrow continuous jet and may be revised if a more realistic model is adopted. In fact, it has been shown (Lind and Blandford 1985) that the dependence of the observed flux on the jet orientation can vary greatly according to which physical conditions are envisaged to produce the emission and the relativistic flow (e.g., discrete plasmoids or shocks propagating in a quasi-stationary medium).

VI. CONCLUSIONS

We have shown that the broad-band spectrum of the available sample of XS blazars is significantly different from that of "classical," RS, blazars. Nevertheless, the average X-ray luminosity of the two subgroups of blazars is the same. If this coincidence is not fortuitous, it implies that X-ray selection should be objective with respect to the radio properties of blazars. The fact that XS blazars happen to be always radio-weak must then be the result of a space density higher than that of radio-loud blazars.

This inference could be directly verified if a complete RS sample of blazars were available. The space density derived from the latter should be compared with that computed by Schwartz and Ku (1983), which is based on the XS objects of the Piccinotti *et al.* (1982) survey and therefore refers essentially to radio-weak objects.

We have also argued that the effects of relativistic beaming may be strong at radio frequencies but not at X-ray frequencies, and that radio-weak blazars may be the parent population of the relativistically enhanced, radio-loud objects.

Observational tests of the model can derive from variability studies at different frequencies or from the comparison of parameters based on the relation between the possibly beamed and unbeamed radiation components, such as the core dominance parameter R defined by Antonucci and Ulvestad (1985) in the radio band.

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