THE ASTROPHYSICAL JOURNAL, 398:87–93, 1992 October 10

X-RAY SPECTRA OF BRIGHT CORE-DOMINANT QUASARS: NRAO 140 AND 4C 34.47

T. OHASHI,[1] M. TASHIRO,[1] K. MAKISHIMA,[1] T. KII,[2] F. MAKINO,[2] M. J. L. TURNER,[3] AND O. R. WILLIAMS[4]
Received 1992 February 3; accepted 1992 April 20

ABSTRACT

Two bright quasars NRAO 140 ($z = 1.258$) and 4C 34.47 ($z = 0.206$) have been studied with *Ginga*. The observed spectra in the energy range 2–20 keV, in the observer rest frame, are well described by power-law models. The measured 2–10 keV luminosities and energy indices are $L_X = 3.8 \times 10^{46}$ ergs s^{-1} and $\alpha = 0.72 \pm 0.11$ for NRAO 140, and $L_X = 5.3 \times 10^{44}$ ergs s^{-1} and $\alpha = 0.64^{+0.17}_{-0.14}$ for 4C 34.47 ($H_0 = 100$ km s^{-1} Mpc^{-1}; $q_0 = 0.5$); the intensity variation was less than about 10% during the ~ 1 day observation for each source. Upper limits, in the source rest frame, for iron line emission are EW < 200 and EW < 120 eV for NRAO 140 and 4C 34.47, respectively. The featureless X-ray spectra, whose slopes are flatter than those of BL Lac objects, and the high X-ray luminosities in excess of the extension of the IR-optical continuum are consistent with the synchrotron self-Compton emission accompanied by a moderate beaming toward us.

Subject headings: quasars: individual (NRAO 140, 4C 34.47) — radiation mechanisms: cyclotron and synchrotron — X-rays: galaxies

1. INTRODUCTION

The study of bright core-dominant quasars has several important aspects, since these sources are, to our knowledge, the brightest astronomical objects in the universe, at least in the X-ray band. They provide a test for models of the emission mechanism under the most extreme luminosities. The enormously high luminosity could reflect either the huge mass of the central black hole and/or, equally likely, a high degree of X-ray beaming. The high X-ray luminosity enables us to sample high-quality X-ray spectra for objects as far as $z > 1$. This in turn gives us an additional high-energy response, in the source rest frame, owing to the large redshifts. These are merits unique to the observational study of quasar energy spectra. Precise knowledge of the overall spectral shape of quasars would allow us to discriminate among proposed models for the quasar spectra and to reach a correct understanding of their emission mechanism.

Beaming, first proposed to account for rapid variation of AGNs and later confirmed in the form of VLBI superluminal motions (see, e.g., Zensus 1989), is the characteristic property for this class of objects and bears important consequences. If most known quasars are beamed toward us, there must be a parent population which has yet to be identified (see, e.g., Barthel 1989). The differences between some types of AGN may be explained in terms of differences in their beaming, leading to a unified scheme of AGN. BL Lac objects and OVV quasars are both strong candidates for X-ray beamed sources, but a systematic difference between their spectra has been noticed in the *Einstein* data (Worrall & Wilkes 1990). This difference requires further study in the harder energy band covered by *Ginga*. The X-ray beaming of quasars also allows for new possibilities for the dominant contributor to the cosmic X-ray background (CXB). If beaming is common to quasars as discussed by Barthel (1989), it naturally implies that numerous "unbeamed" objects in the parent population are X-ray emitters. With these important aspects on core-dominant quasars, we have investigated the X-ray spectra of two quasars which are associated with superluminal radio sources.

NRAO 140, at $z = 1.258$, is one of the brightest X-ray quasars. Its X-ray emission was first detected with the *HEAO-1* A2 experiment at a flux level of about 2×10^{-11} ergs cm^{-2} s^{-1} in the 2–10 keV band in 1978 February (Marscher et al. 1979). Subsequent X-ray studies, carried out with the *Einstein* SSS (Petre et al. 1984) and with the *Einstein* IPC and *EXOSAT* (Marscher 1988), indicates a 2 keV flux between 0.9–2 μJy and spectral index $\alpha = 0.6$ to -1.1. Compilation of the X-ray results indicate a change of N_H from $\lesssim 2 \times 10^{21}$ cm^{-2} to $\gtrsim 6 \times 10^{21}$ cm^{-2} between 1979 and 1980. Marscher & Broderick (1982) discovered superluminal motion in NRAO 140 and the recent VLBI measurement by Marscher (1988) indicates a velocity of 4.8 $h^{-1}c$, hereafter employing $H_0 = 100\ h$ km s^{-1} Mpc^{-1} and $q_0 = 0.5$. The X-ray and the radio fluxes declined by a similar factor (~ 2) between 1979 and 1985, suggesting a direct connection between the two frequency regions (Marscher 1988).

4C 34.47 (1721+343), at $z = 0.206$, is well known as the "largest quasar," showing a double-lobed structure as large as 560 h^{-1} kpc. The X-ray spectrum was measured with the *Einstein* IPC by Wilkes & Elvis (1987) and showed a 0.3–3.5 keV flux of 1.24×10^{-11} ergs cm^{-2} s^{-1} with a power-law energy index $\alpha = 0.5^{+0.6}_{-0.3}$. Superluminal motion in 4C 34.47 was recently detected by Barthel et al. (1989) at an apparent speed of $(2.5 \pm 0.2)\ h^{-1}c$. The discovery of superluminal motion in the largest quasar, which must also have significant motion perpendicular to the line of sight, has led Barthel (1989) to consider that all quasars may be beamed toward us.

We present the 2–30 keV spectra of the two quasars, NRAO 140 and 4C 34.47, observed with the LAC instrument on board *Ginga* (Makino & the ASTRO-C team 1987). Preliminary results have been reported by Ohashi et al. (1989a). This is the first case that high-quality spectra of these quasars have been obtained in this high-energy range. In particular, the high redshift ($z = 1.258$) of NRAO 140 allows us to look into the spectrum over a wide energy band.

[1] Department of Physics, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113, Japan.
[2] Institute of Space and Astronautical Science, 3-1-1, Yoshinodai, Sagamihara, Kanagawa, 229, Japan.
[3] Department of Physics and Astronomy, University of Leicester, University Road, Leicester LE1 7RH, England.
[4] Serco, ESTEC, Postbus 229, 2200 AG Noordwijk, The Netherlands.

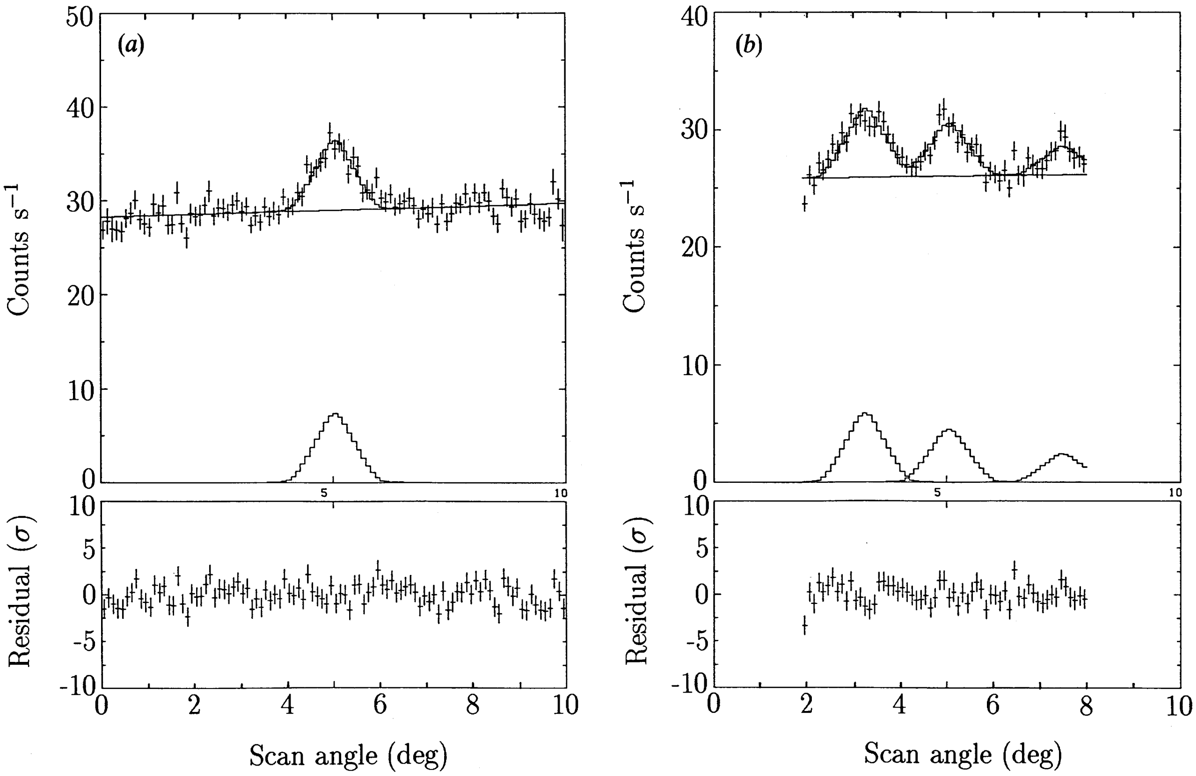

FIG. 1.—Scan profiles of count rate in 2–10 keV for (*a*) NRAO 140 and (*b*) 4C 34.47 regions, respectively. Two new point sources separated by 1°.8 to the north of 4C 34.47 and by 2°.4 to the south are found.

2. OBSERVATIONS AND RESULTS

2.1. *Observations*

NRAO 140 was observed from February 3, 15:10 (UT)–February 4, 10:05 in 1989, and 4C 34.47 from May 5, 17:19–May 6, 23:27 in 1989, respectively, with the LAC (Turner et al. 1989). The LAC instrument was in MPC-1 mode covering 2–37 keV, using either medium or low bit rate with time resolutions of 4 and 16 s, respectively. There are no cataloged contaminating X-ray sources in the field of views for the pointing observations (Harris et al. 1989; Wood et al. 1984). Prior to the pointing observation, each source was scanned for about 10 times to check for other, contaminating, sources in the field of view (1°.1 × 2°.0 FWHM). Background observations, in high Galactic latitude regions and with a correspondingly low Galactic N_H, were made two days before the pointing for NRAO 140 and one day before for 4C 34.47. Since the region containing NRAO 140 has a relatively high value for the Galactic N_H of 1.4×10^{21} cm^{-2} (Elvis, Lockman, & Wilkes 1989) it was necessary to allow for the extra absorption by modifying the background spectrum, using the interstellar cross sections of Morrison & McCammon (1983) prior to its subtraction from the source. This correction is $\lesssim 3\%$ of the NRAO 140 flux at 3 keV and $\lesssim 1\%$ at 5 keV, respectively. The high latitude background causes no problem for 4C 34.47 with the Galactic $N_H = 3.1 \times 10^{20}$ cm^{-2} (Elvis et al. 1989).

2.2. *Scanning Results*

Results of the scanning observations are shown in Figure 1, which shows count rate profiles in the 2–10 keV range. Both quasars are clearly detected at the expected positions. The scan profiles are fitted with a model consisting of point sources and a smooth background both convolved with the collimator response function. A single point source gives a good fit for the NRAO 140 data, however, two uncataloged X-ray sources are evident near 4C 34.47. Sky positions of the two sources are shown in Figure 2. Since the nearby sources are separated from 3C 34.47 by 1°.8 and 2°.4 in the scan plane, respectively, they do not significantly contaminate the pointing data. The observed intensities for the scans are 7.4 ± 0.7 counts s^{-1} and 4.5 ± 0.7 counts s^{-1} for NRAO 140 and 4C 34.47, respectively (1 count s^{-1} corresponds to about 0.1 mcrab). The statistical significances of the detection are 17 and 11 σ for NRAO 140 and 4C 34.47, respectively, in the energy range 2–10 keV. Since scan-

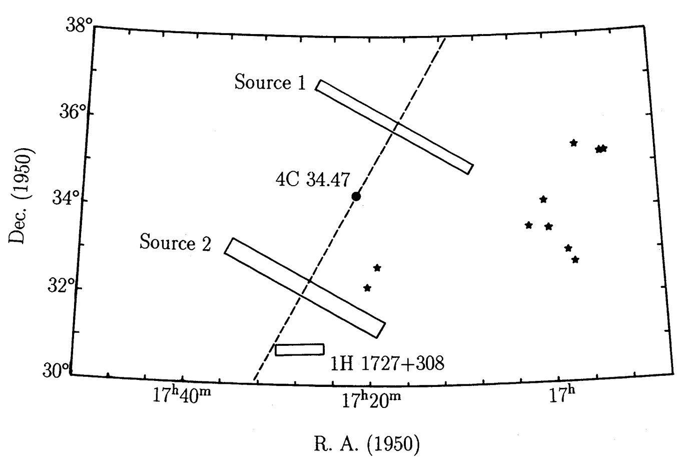

FIG. 2.—Positions of the new X-ray sources found near 4C 34.47. The field of view of the LAC detector and the scan path are indicated.

ning observatons give us effective reduction of the field of view, the source can be estimated with very little influence from the sky fluctuation (see Hayashida et al. 1989).

2.3. *Energy Spectra*

We present only data from the top layer of the LAC, whose background is significantly less than that of the middle layer (Turner et al. 1989). Figures 3*a* and 3*b* show the 2–10 keV light curves for the two quasars after background subtraction and aspect correction. Since the background subtraction results in a flux uncertainty of about 0.3 count s^{-1} in 2–10 keV (Hayashida et al. 1989) and the aspect correction also leaves 5% error in intensity, time variations are not significant for either of the objects. Upper limits for fractional variability are 7% for NRAO 140 and 13% for 4C 34.47, respectively, at 90% confidence. The observed intensities indicate *K*-corrected luminosities of 3.8×10^{46} ergs s^{-1} and 5.3×10^{44} ergs s^{-1} for NRAO 140 and 4C 34.47, respectively, in 2–10 keV. The inferred 90% upper limit of $\Delta L/\Delta t$ for a half-day time scale is 6×10^{40} ergs s^{-2} for NRAO 140 and 1.6×10^{39} ergs s^{-2} for 4C 34.47, respectively.

The background subtracted spectra for NRAO 140 and 4C 34.47 are shown in Figures 4*a* and 4*b* against the rest frame energy of the observer. In this plot, the background spectra taken at high Galactic latitudes (corrected with $N_H = 1.4 \times 10^{21}$ cm^{-2} for NRAO 140) are used. The model background described in Hayashida et al. (1989) provides a useful cross check, and gives consistent results. The intensity for the pointing observation is consistent with the scanning data for both quasars, confirming that the spectral results are not significantly affected by the fluctuation of CXB (Hayashida et al. 1989). Spectral fits with simple theoretical models were carried out. Both thermal bremsstrahlung and power-law models gave acceptable fits. However, temperatures for the thermal fits are greater than 15 keV (uncorrected for redshifts) for both objects, implying that the spectral shape is essentially a power-law form in the observed 2–30 keV range. We, therefore, adopt power-law models for the rest of the analysis. Table 1 lists the results of the power-law fits for the two quasars, and the confidence contours are shown in Figures 5*a* and 5*b*.

In order to check the consistency of our results we have included the middle-layer data, which increases the sensitivity above 10 keV by a factor of 2–3, and repeated the spectral fits in the energy range 2–30 keV. The results are consistent with the top-layer data, with the best-fit α changing by no more than 0.05 for either quasar. This implies that the observed spectra have a smooth power-law shape over the entire range. For a comparison with the previous observations, Table 1 lists the X-ray flux at 2 keV and in 0.3–3.5 keV inferred from the spectral fits. The *Ginga* flux for NRAO 140 is consistent with the 1980 IPC result but higher than the 1985 *EXOSAT* flux by a factor of about 2, both obtained by Marscher (1988). For 4C 34.47, the present flux is less than the Wilkes and Elvis value by about 20%.

Significant absorption with $N_H \sim 8 \times 10^{21}$ cm^{-2} in the spectrum of NRAO 140 has been observed with the *Einstein* IPC by Marscher (1988). The *Ginga* result in Figure 5 indicates $\log N_H = 20.9$–22.0 at 90% confidence. However, since absorption in the detector window is large at energies below 3 keV (see Turner et al. 1989) and the Galactic N_H is fairly large, we should treat the *Ginga* result as an upper limit. Taking $\log N_H < 22.0$, our result is consistent with the previous observations. For 4C 34.47, an upper limit of $\log N_H \sim 22.0$ is obtained. This is consistent with the *Einstein* result of $\log N_H < 20.7$ by Wilkes & Elvis (1987).

Two quasars, 3C 273 and 1E 1821+643, show significant iron emission lines in the X-ray spectra (Turner et al. 1990; Kii et al. 1991), and recent study of quasar spectra indicates that the data are consistent with the presence of an iron line with an equivalent width (EW) of the order of 100 eV in all quasars (Williams et al. 1992). We have, therefore, tried to search for iron lines in the spectra of NRAO 140 and 4C 34.47. Only upper limits are obtained for the redshifted iron *K* emission lines originally at either 6.4 or 6.7 keV. The upper limit on the EW is 90 eV (200 eV after correction for the redshift) for NRAO 140, and 110 eV (130 eV after redshift correction) for 4C 34.47, as shown in Table 1. The upper limit on EW for 4C 34.47 is significantly smaller than the level observed from the radio-quiet quasar 1E 1821+643 (EW ~250 eV), but consistent with the value for the radio-loud quasar 3C 273 (EW = 50

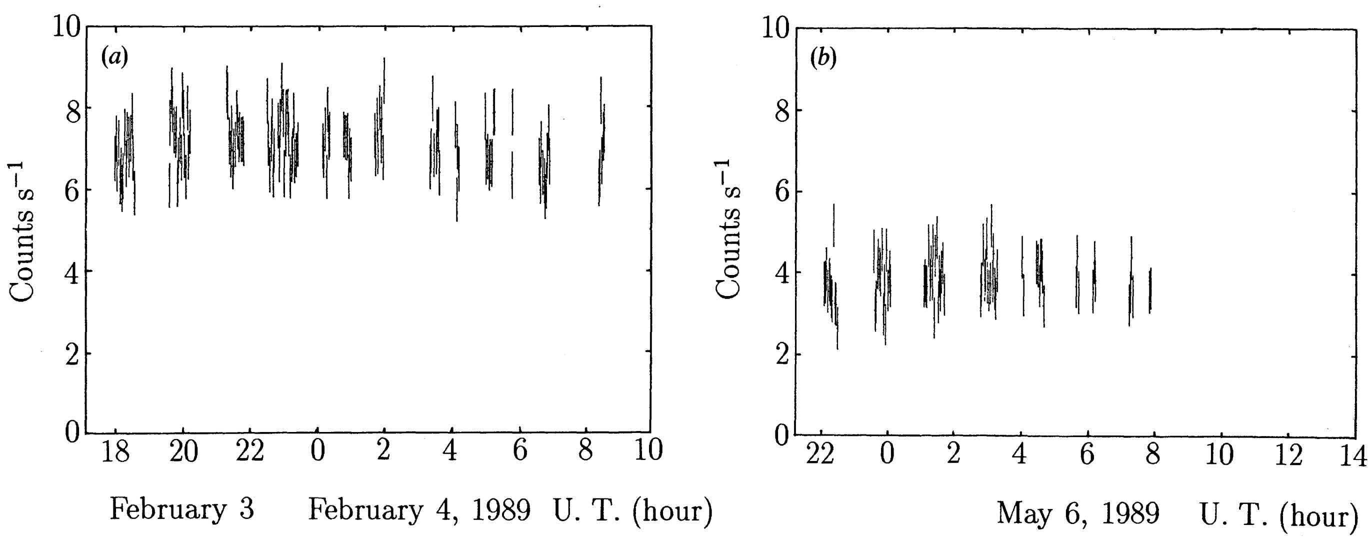

FIG. 3.—Light curves for (*a*) NRAO 140 and (*b*) 4C 34.47 in 2–10 keV during the pointing observations. The data are corrected for background and aspect, and each bin corresponds to 128 s. No significant variation is seen for both objects.

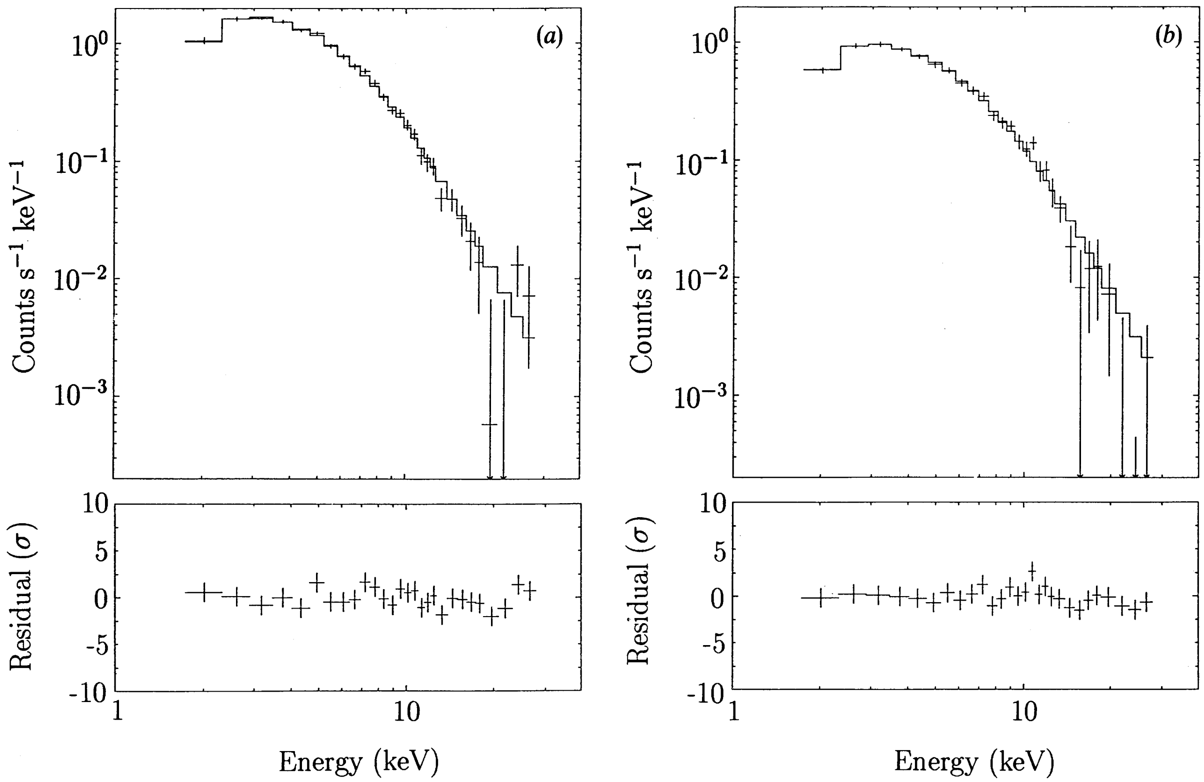

FIG. 4.—Observed pulse-height spectra for (*a*) NRAO 140 and (*b*) 4C 34.47, fitted with power-law models. The bottom panels indicate the residual of the fit.

eV). This result is consistent with the conjecture by Kii et al. (1991) that the continuum emission of radio-loud quasars may be enhanced due to X-ray beaming compared with radio-quiet objects.

The depth of the redshifted iron K-edge can also be constrained by the spectral fits. We fit the observed spectra with a power-law continuum absorbed by the Galactic N_H and by an iron *K*-absorption edge corresponding to various ionization states, ranging between 7.1 keV for neutral iron and 8.5 keV for hydrogen-like iron. Again, only upper limits are obtained for both quasars. The 90% upper limits on the equivalent N_H, assuming the cosmic abundance of iron by Allen (1973), are also listed in Table 1. Iron absorption features, in both quasars, are therefore significantly weaker than those commonly found in type I Seyfert spectra (Pounds et al. 1990; Matsuoka et al. 1990), which typically have features corresponding to an N_H of several times 10^{23} cm^{-2}.

3. DISCUSSION

The *Ginga* observations of NRAO 140 and 4C 34.47 have, for the first time, provided the 2–20 keV spectra of two core-dominant quasars. In particular, NRAO 140 ($z = 1.258$) is the

TABLE 1

SPECTRAL PROPERTIES OF NRAO 140 AND 4C 34.47

A.

Source	F_X(2–10 keV)[a] (ergs cm^{-2} s^{-1})	L_X(2–10 keV)[b] (ergs s^{-1})	α	log N_H (cm^{-2})	χ^2/ν
NRAO 140	2.0×10^{-11}	3.8×10^{46}	0.72 ± 0.11	<22.1	25.2/25
4C34.47	1.1×10^{-11}	5.3×10^{44}	$0.64^{+0.17}_{-0.14}$	<22.1	20.9/25

B.

Source	f(2 keV)[a] (μJy)	F_X(0.3–3.5 keV)[a] (ergs cm^{-2} s^{-1})	EW[c] (eV)	log $N_{H,Fe}$[d] (cm^{-2})
NRAO 140	1.85	1.4×10^{-11}	<200	<22.3
4C34.47	1.05	0.93×10^{-11}	<140	<23.0

[a] Including absorption with Galactic N_H (1.4×10^{21} cm^{-2} for NRAO 140 and 3.1×10^{20} cm^{-2} for 4C 34.47, respectively).

[b] *K*-corrected luminosity at the source.

[c] Equivalent width of 6.4 keV iron line at the source.

[d] The equivalent N_H corresponding to the depth of the iron edge for a solar abundance of iron ($10^{-4.4}$, Allen 1973).

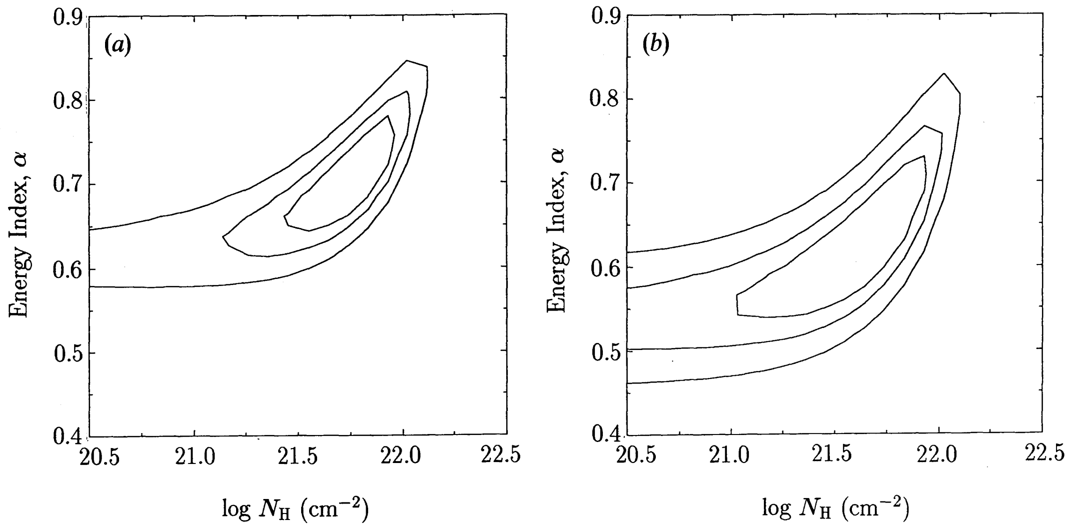

FIG. 5.—Confidence contours at 68%, 90%, and 99% for two interesting parameters for (*a*) NRAO 140 and (*b*) 4C 34.47 obtained with the spectral fits. The parameters are power-law energy index α, and hydrogen column density, N_H. The fits do not include systematic errors due to the large Galactic N_H (1.4×10^{21} cm^{-2}) for NRAO 140.

most distant quasar for which a high-quality X-ray spectrum has ever been obtained. It is clearly shown that the spectrum is adequately described by a power-law model with a spectral index not much different from the average value ($\alpha \sim 0.8$) for the lower redshift quasar sample (Williams et al. 1992). Based on the sample of 13 radio-loud and radio-quiet quasars observed with *Ginga*, Williams et al. show that radio-loud objects have flatter spectral slope ($\bar{\alpha} \sim 0.7$) than radio-quiet sources ($\bar{\alpha} \sim 1.1$), confirming and revising the soft X-ray results obtained by Wilkes & Elvis (1987). The observed spectral slopes of the present two-radio-loud objects belong to the flatter group, giving further evidence for the Williams et al. interpretation that radio-loud and radio-quiet quasars form different populations.

The above feature implies that the distant quasars probably share similar spectral properties with the low-redshift objects with $z \lesssim 0.5$. Recently, Maccacaro et al. (1991) have found in the *Einstein* EMSS sample a significant evolution of AGN at $z \gtrsim 0.4$. The *Ginga* spectrum of NRAO 140, however, suggests that the spectral evolution of AGN is not as strong as the luminosity or density evolution. If this is truly the case, some models which have been proposed to explain the quasar dominancy of CXB would face serious difficulty. For example, an arbitrary assumption of the spectral evolution, such as the one by Morisawa & Takahara (1989) who predict $\alpha \sim 0.3$ at $z = 1$ in order to account for the CXB spectrum, would not be acceptable any more. Larger samples of the spectra of distant quasars are needed to confirm this.

We also note that the large redshift of NRAO 140 allows us to measure the hard X-ray part of the quasar spectrum, reaching ~ 50 keV with good statistics in the source rest frame. The good agreement with the single power-law model with $\alpha \sim 0.7$ over the whole energy range indicates that the deviation of the quasar spectrum from the power law must be small in the energy range below 50 keV. This is an important new result in modeling the emission mechanism of quasars. Also, models explaining the CXB by invoking, for example, a spectral flattening toward higher energies (Schwartz & Tucker 1988) now seem unlikely from the present results. Close agreement with simple power-law models is also noticed for the high statistical data from 3C 273 (Turner et al. 1990) and from 3C 279 in outburst (Makino et al. 1989) in the energy ranges up to 35 and 45 keV, in the source rest frame, respectively. On the other hand, we note that there must be a break in the power-law spectra of AGN since their superposition would exceed the diffuse gamma-ray background if all quasars have genuine power-law spectra (Rothschild et al. 1983).

VLBI observations of both NRAO 140 and 4C 34.47 indicate superluminal motions (Marscher & Broderick 1982; Barthel et al. 1989), therefore the important issue here is whether the X-ray emission of these objects is beamed or not. Since no information about the structure of the X-ray emitting region is available to us, we need to make rather indirect or model-dependent estimations. The strongest evidence for the X-ray beaming is the detection of fast time variations in excess of the theoretical limit: $\Delta L/\Delta t \sim 2 \times 10^{42}\eta$ ergs s^{-2} with η being the mass-to-light conversion factor (Cavallo & Rees 1978; Fabian 1979). Recent *Ginga* observations have revealed such unusual variations from two quasars: 3C 279 (Makino et al. 1989) and PKS 0558−504 (Remillard et al. 1991). The present sample, however, seem to be rather inactive in this respect. Neither source exhibits significant intensity variations over several years, or during the 1 day long *Ginga* observations. The intensity change is less than $\sim 15\%$ for both objects. However, the lack of variability in a sparse sampling does not rule out the beamed X-ray emission.

Information about possible X-ray beaming can also be derived from emission and absorption features. If the emission is isotropic from the central power house, part of it would hit any surrounding matter giving rise to fluorescent line emission. The continuum spectrum would also be modified through absorption or reflection by the matter. The recent results of iron features in the spectra of Seyfert galaxies are consistent with isotropic continuum emission from the nucleus. The iron line EW is 150–300 eV, and the depth of the iron edge corresponds to $N_H \gtrsim 10^{23}$ cm^{-2} (Pounds et al. 1989; Matsuoka et al. 1990). In the present sample, we can exclude an iron line with EW > 140 eV or an iron *K* edge with equivalent $N_H >$ 22.3 cm^{-2}. It is significant that the X-ray spectra of core-dominant quasars are featureless compared with those of Seyfert galaxies. A more stringent upper limit (EW < 20 eV) has been obtained for the flare spectrum of 3C 279 (Makino et

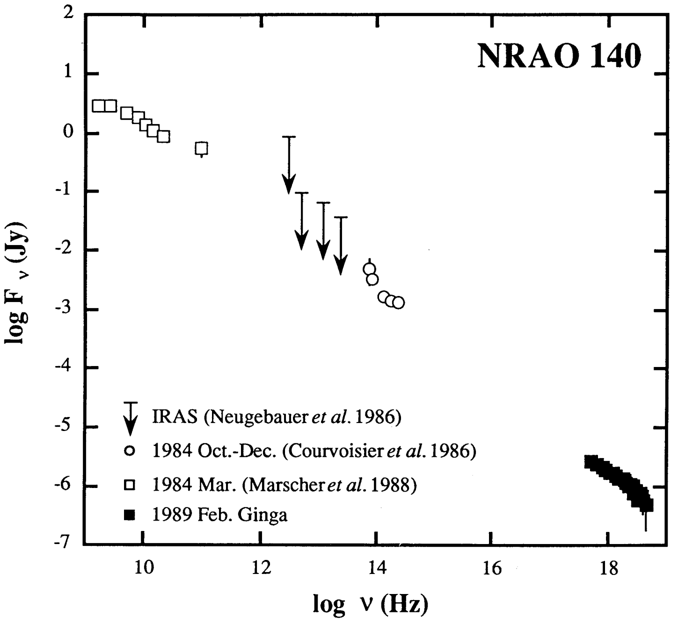

FIG. 6.—Multifrequency spectrum of NRAO 140. The X-ray part shows the best-fit power-law spectrum for the present observation after correction for the interstellar absorption.

al. 1989). This implies that the objects are devoid of surrounding matter and/or that only the continuum emission from the core is somehow boosted by relativistic motion.

Finally, a profile of the multifrequency spectrum provides most useful information for the overall emission mechanism. In Figure 6, we plot the spectrum of NRAO 140 by combining published optical, infrared, and radio results with the present X-ray data. Note that the observations are widely separated in time because contemporary measurements, in other wavelengths, are not available. However in view of the absence of observed high-amplitude variability, the spectrum shown in Figure 6 is considered to be a good approximation of the true shape. It is immediately noted that the X-ray emission exceeds the power-law extension of the IR-optical continuum by a factor of ~ 10. Also, the measured X-ray spectrum is much flatter than the slope defined by the optical and X-ray intensities. This is, again, very similar to the spectrum of 3C 279. Comparison of the spectra of various objects indicates that such an apparent X-ray excess is only noticeable in the spectrum of core-dominent quasars (Makino 1989). In fact, similar plots for radio quiet quasars agree with single power-law spectrum from IR to X-ray sometimes with signs of a blue bump.

The measured 2–20 keV slope of the core-dominant quasars, NRAO 140 and 4C 34.47, is significantly flatter than that of BL Lac objects: strong candidates for X-ray beaming. Worrall & Wilkes (1990) show that the 0.2–3.5 keV spectra of HPQs and FRS QSOs are similar to each other ($\alpha \sim 0.5$), but significantly flatter than that for BL Lac objects which indicate $\alpha \sim 1.0$. Therefore, the present results are consistent with their soft X-ray results.

The observed excess and flatness in the X-ray spectrum of core-dominant quasars can be interpreted in terms of synchrotron self-Compton models, in which X-ray emission is the result of Compton scattering of soft photons by relativistic electrons. The available multifrequency spectra of BL Lac objects (see, e.g., Makino 1989) suggest a rather smooth shape with X-ray spectral slope steeper than the optical-UV extension, often approximated by a parabola in a log-log scale (Landau et al. 1986). Also, measured X-ray spectra of bright BL Lac objects in the energy range 2–30 keV can be described by power-law models of $\alpha \gtrsim 1.5$ with no sign of a hard tail (Ohashi et al. 1989b; Ohashi 1989). These features suggest that the X-ray emission of BL Lac objects is dominated by continuation of the synchrotron component seen in the radio frequency. These differences between core-dominant quasars and BL Lac objects can be explained by a different cutoff energy. Namely, quasars have a lower cutoff energy than BL Lac objects. A simple interpretation is to consider that emission from BL Lac objects are more blueshifted than quasars because of strong relativistic beamings. This is consistent with the feature that BL Lac objects often exhibit very fast time variations (see, e.g., Urry 1986). On the other hand, core-dominant quasars are likely to be relatively less beamed and, therefore, intrinsically high-luminosity objects. To summarize, under the synchrotron scheme, the X-ray emission of core-dominant quasars and BL Lac objects would be distinguished in the following way:

1. Core-dominant quasars appear to be intrinsically luminous objects; their X-ray emission comes from the synchrotron self-Compton process; there is evidence of moderate X-ray and radio beaming (beaming factor δ = several).

2. BL Lac objects are intrinsically low-luminosity objects; the X-ray emission is of direct synchrotron origin; the emission may be boosted by strong beamings over all frequency regions ($\delta \sim 10$?).

In conclusion, *Ginga* observations of two core-dominant quasars, NRAO 140 and 4C 34.47, have shown 2–20 keV spectra, in the observer's frame, of these objects for the first time. No significant intensity variations were seen, and the spectra show no significant iron emission or absorption feature. Similarity in the measured spectra of core-dominant quasars suggest that the emisson mechanism, possibly synchrotron self-Compton emission with moderate beaming, would be common to this type of quasars.

The authors would like to thank all the members of the *Ginga* team who supported the work through observations and data analysis. Useful comments from C. M. Urry and M. Matsuoka are gratefully acknowledged.

REFERENCES

Allen, C. W. 1973, Astrophysical Quantities, 3rd ed. (London: Athlone), 31
Barthel, P. D. 1989, ApJ, 336, 606
Barthel, P. D., Hooimeyer, J. R., Schilizzi, R. T., Miley, G. K., & Preuss, E. 1989, ApJ, 336, 601
Cavallo, G., & Rees, M. J. 1978, MNRAS, 183, 359
Courvoisier, T. J. L., et al. 1986, A&A, 169, 43
Elvis, M., Lockman, F. J., & Wilkes, B. J. 1989, AJ, 97, 777
Fabian, A. C. 1979, Proc. R. Soc. Lond. A, 366, 449
Harris, D. E., et al. 1989, The *Einstein* Observatory Catalog of IPC Sources (Cambridge: Harvard-Smithsonian Center for Astrophysics)
Hayashida, K., et al. 1989, PASJ, 41, 373
Kii, T., et al. 1991, ApJ, 367, 455
Landau, R., et al. 1986, ApJ, 308, 78
Maccacaro, T., Della Ceca, R., Gioia, I. M., Morris, S. L., Stocke, J. T., & Wolter, A. 1991, ApJ, 374, 117
Makino, F. 1989, in Proc. 23d ESLAB Symp. on Two-Topics in X-Ray Astronomy, ed. N. E. White (ESA Sp 296), 803
Makino, F., & the ASTRO-C team, 1987, Astrophys. Lett. 25, 223
Makino, F., et al. 1989, ApJ, 347, L9
Marscher, A. P. 1988, ApJ, 334, 552

Marscher, A. P., & Broderick, J. J. 1982, ApJ, 255, L11
Marscher, A. P., Marshall, F. E., Mushotzky, R. F., Dent, W. A., Balonek, T. J., & Hartmann, M. F. 1979, ApJ, 233, 498
Matsuoka, M., Piro, L., Yamauchi, M., & Murakami, T. 1990, ApJ, 361, 440
Morisawa, K., & Takahara, F. 1989, PASJ, 41, 873
Morrison, R., & McCammon, D. 1983, ApJ, 270, 119
Neugebauer, G., et al. 1986, ApJ, 308, 815
Ohashi, T. 1989, in BL Lac Objects, ed. L. Maraschi, T. Maccacaro, & M. H. Ulrich (Berlin: Springer), 296
Ohashi, T., et al. 1989a, in Proc. 23d ESLAB Symp. on Two-Topics in X-Ray Astronomy, ed. N. E. White (ESA SP 296), 837
Ohashi, T., Makishima, K., Inoue, H., Koyama, K., Makino, F., Turner, M. J. L., & Warwick, R. S. 1989b, PASJ, 41, 709
Petre, R., Mushotzky, R. F., Krolik, J. H., & Holt, S. S. 1984, ApJ, 280, 499
Pounds, K. A., Nandra, K., Stewart, G. C., George, I. M., & Fabian, A. C. 1990, Nature, 344, 132
Pounds, K. A., Nandra, K., Stewart, G. C., & Leighly, K. 1989, MNRAS, 240, 769
Remillard, R. A., Grossan, B., Bradt, H. V., Ohashi, T., Hayashida, K., Makino, F., & Tanaka, Y. 1991, Nature, 350, 589
Rothschild, R. E., Mushotzky, R. F., Baity, W. A., Gruber, D. E., Matteson, J. L., & Peterson, L. E. 1983, ApJ, 269, 423
Schwartz, D. A., & Tucker, W. H. 1988, ApJ, 332, 157
Turner, M. J. L., et al. 1989, PASJ, 41, 345
———. 1990, MNRAS, 244, 310
Turner, T. J., & Pounds, K. A. 1989, MNRAS, 240, 833
Urry, C. M. 1986, in The Physics of Accretion onto Compact Objects, ed. K. Mason et al. (Berlin: Springer), 357
Wilkes, B. J., & Elvis, M. 1987, ApJ, 323, 243
Williams, O. R., et al. 1992, ApJ, 389, 157
Wood, K. S., et al. 1984, ApJS, 56, 507
Worrall, D. M., & Wilkes, B. J. 1990, ApJ, 360, 396
Zeusus, J. A. 1989, in BL Lac Objects, ed. L. Maraschi, T. Maccacaro, & M. H. Ulrich (Berlin: Springer), 3