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NEW X-RAY AND OPTICAL OBSERVATIONS OF THE X-RAY DISCOVERED QSO-GALAXY PAIR 1E 0104.2+3153[1]

ISABELLA M. GIOIA,[2] T. MACCACARO,[2] AND R. E. SCHILD
Harvard/Smithsonian Center for Astrophysics
P. GIOMMI[3]
EXOSAT Observatory, ESOC, Darmstadt
AND
J. T. STOCKE
Center for Astrophysics and Space Astronomy, University of Colorado, Boulder
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ABSTRACT

New X-ray and optical observations are presented of the QSO-galaxy pair 1E 0104.2+3153, originally discovered as a serendipitous source in the *Einstein Observatory* Medium Sensitivity Survey. Results from an extremely deep *EXOSAT* observation have been used to suggest that the QSO rather than the compact group of galaxies is the optical counterpart of the IPC source. High-resolution (1 Å) spectroscopy of the BAL QSO, which failed to confirm the Ca II H and K absorption features reported in a previous paper, is presented and discussed. The presence of broad absorption lines in the QSO spectrum may indicate that intrinsic absorption is the cause of the nondetection of this source in the soft *EXOSAT* energy band. Optical monitoring of the QSO over a 2 yr period indicates variability. Possible interpretations of this phenomenon are intrinsic luminosity variation or a cessation of a gravitational lensing effect acting at the time of the *Einstein* observation.

Subject headings: galaxies: X-rays — quasars — X-rays: sources

I. INTRODUCTION

The X-ray source 1E 0104.2+3153 was originally discovered as part of a systematic search for serendipitous sources to extend the *Einstein Observatory* Medium Sensitivity Survey (see Gioia *et al.* 1984, and references therein for a detailed description of the survey). In the IPC (Imaging Proportional Counter) field centered on the nearby radio galaxy NGC 383 (3C 31) the serendipitous source 1E 0104.2+3153 was detected at $01^h04^m14^s.5+31°53'25''$. Based upon the IPC data the true identity of 1E 0104.2+3153 was ambiguous due to the presence in the error circle ($\sim 40''$) of a radio-quiet broad absorption line (BAL) QSO only 10″ away from a giant elliptical galaxy at the center of a compact group of galaxies. A detailed analysis of the X-ray and optical properties of this source is given in Stocke *et al.* (1984*b*, hereafter Paper I).

The very small angular separation between the quasar and the galaxy makes this pair one of the closest yet discovered and an interesting candidate for observing gravitational lensing phenomena (see Huchra *et al.* 1985, for an even closer projection). As shown in Paper I, there is a probability greater than 1% that brightness fluctuations of the QSO on a time scale of a few years may occur due to a gravitational lensing effect triggered by a star in the halo of the elliptical galaxy (≡minilensing).

The particular alignment of this QSO-galaxy pair motivated us to monitor the system optically. While the production of multiple images separated by more than 0″.1 is unlikely because of the relative distance of the QSO ($z = 2.027$) and the galaxy ($z = 0.111$), it is possible to observe brightness fluctuations of the quasar due to low-mass stars moving in or out of the QSO beam. Furthermore, we have obtained a high-resolution optical spectrum of the QSO with the purpose of confirming the presence of Ca II H and K absorption lines due to the intervening galaxy as reported in Paper I. These absorption lines are *not* confirmed by this new spectrum, but, rather, a low-contrast broad absorption, apparently physically related to the QSO, is present.

With the aim of improving the accuracy of the location of the X-ray source and of monitoring a possible variation of its intensity, a very long observation has been carried out using the imaging instrument on board the *EXOSAT* satellite (Taylor *et al.* 1981). The Channel Multiplier Array (CMA) with a 10″ positional accuracy (de Korte *et al.* 1981) has the capability to distinguish between the different candidates for the optical counterpart of 1E 0104.2+3153.

In § II we present the reprocessed IPC data and discuss the X-ray identification. In § III new optical data including a high-resolution spectrum of the QSO, and the *EXOSAT* observation are described. The results are given and discussed in § IV.

Values of $H_0 = 50$ km s^{-1} Mpc^{-1} and $q_0 = 0$ are assumed throughout this paper.

II. THE REPROCESSED IPC DATA AND X-RAY SOURCES IDENTIFICATION

The IPC data of the field centered on 3C 31 have been recently reprocessed with an improved detection algorithm providing a better flux and background determination and a smaller 90% confidence error circle (see Harnden *et al.* 1984). Figure 1 shows an X-ray contour map of the field centered on 3C 31: three serendipitous sources were detected at a signifi-

[1] Research reported here used the Multiple Mirror Telescope Observatory which is a joint facility operated by the Smithsonian Institution and the University of Arizona.
[2] On leave of absence from Istituto di Radioastronomia, CNR, Bologna, Italy.
[3] On leave of absence from Istituto di Fisica Cosmica, CNR, Milano, Italy.

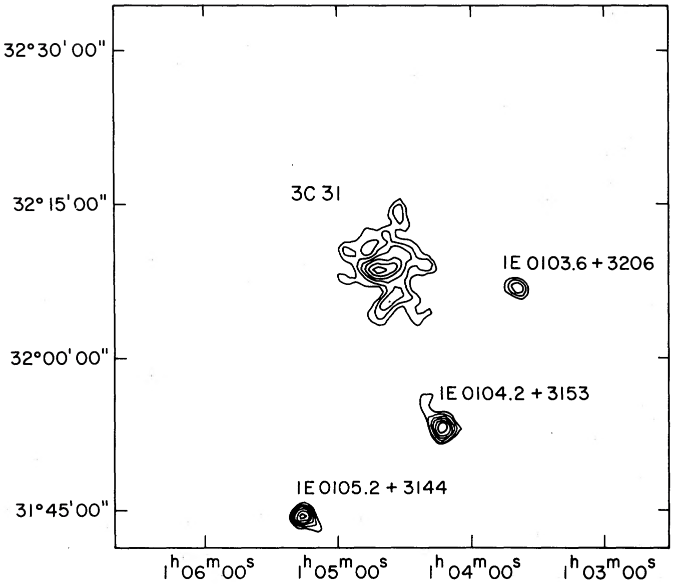

FIG. 1.—X-ray contours of the field centered on 3C 31. The background level is 1.18 counts per cell (32″ × 32″). Contours correspond to 1.01, 1.43, 1.88, 2.37, 2.89, and 3.46 counts above the background.

cance level greater than 4 σ. Their X-ray properties and proposed optical identifications are given in Table 1.

The X-ray flux of 1E 0104.2+3153 was computed in the 0.3–3.5 keV band assuming a power-law spectrum with photon index $\alpha_{ph} = 1.7$ and corrected for absorption through our own Galaxy using a hydrogen column density $N_H = 5.5 \times 10^{20}$ atoms cm^{-2} (Stark *et al.* 1986).

Present in the error circle of 1E 0104.2+3153 (42″ radius) are a large elliptical galaxy at a redshift $z = 0.1115$, which is the brightest member of a small group of galaxies; three compact members of this group; a radio-quiet (<0.5 mJy at 6 cm; Gioia *et al.* 1983 and Stocke *et al.* 1984*a*) broad absorption line QSO at $z = 2.027$, only 10″ away from the center of the elliptical galaxy; and two stars. As discussed in Paper I, the presence of more than one plausible candidate as the optical counterpart of the X-ray source complicates the identification of 1E 0104.2+3153. The two stars (object I = G star and object J = K star in Fig. 1 of Paper I) were ruled out as optical counterparts on the basis of their X-ray–to–visual flux ratios [log $(f_x/f_v) = 0.3$ and -0.4, respectively] which are too high for stars of these spectral types (cf. Vaiana *et al.* 1981). On the other hand, using these same arguments, we concluded in Paper I that both the QSO and the compact group could be the X-ray emitter. We will examine here the two possibilities in turn. The small photon statistics involved (54 net counts) prevent us from discriminating between different spectral shapes or from properly analyzing the angular extent of the X-ray brightness distribution.

The recent study of IPC spectra of quasars in the soft 0.1–4.0 keV energy band by Elvis, Wilkes, and Tananbaum (1985) strongly contrasts with the picture of a single "universal" power-law slope ($\alpha_{ph} = 1.7$) previously shown by the spectra of many active galactic nuclei measured at higher energy bands (see, among others, Rothschild *et al.* 1983; Mushotzky 1984; Worrall and Marshall 1984). The preliminary results of Elvis, Wilkes, and Tananbaum (1985) show the existence of a wide diversity within soft X-ray spectra of quasars with slopes ranging from 1.6 to 3.2 in photon index. Allowing for different power-law spectra and using these extreme values for the spectral indexes, the flux of 1E 0104.2+3153 changes from 4.38×10^{-13} to 4.60×10^{-13} ergs cm^{-2} s^{-1} in the 0.3–3.5 keV energy band.

If the group of galaxies is the correct identification and assuming a thermal bremsstrahlung spectrum with a temperature $kT = 6$ keV and the same absorption column previously used, the flux of 1E 0104.2+3153 is equal to 4.28×10^{-13} ergs cm^{-2} s^{-1}.

The other two serendipitous sources in the IPC field are optically associated with stars. For 1E 0103.6+3206 an HRI (High Resolution Imager) observation confirms the identification of the source with an 11th visual magnitude star (log $f_x/f_v = -3.1$). 1E 0105.2+3144 is only 12″ away from a cataloged F2 star (SAO 54445) with a visual magnitude $m_v = 6.3$ (log $f_x/f_v = -4.7$). For both stellar sources the X-ray fluxes in Table 1 were computed assuming a Raymond thermal spectrum (Raymond and Smith 1977) with a temperature $kT = 0.3$ keV and a hydrogen column density $N_H = 1.0 \times 10^{18}$ atoms cm^{-2}. Using different values for kT (from 0.2 to 0.7) does not change the flux by more than $\sim \pm 5\%$.

III. THE NEW OPTICAL AND X-RAY OBSERVATIONS

a) Optical Photometry

The optical brightness of the QSO image was monitored with the RCA-CCD camera on the 61 cm telescope of the F. L.

TABLE 1

X-RAY SERENDIPITOUS SOURCES IN THE FIELD OF 3C 31

Einstein Source Name (1)	Position of X-Ray Centroid (1950.0) (2)	90% Confidence Error Circle (3)	σ[a] (4)	Flux; Error[b] (10^{-13}) (5)	Count Rate; Error[c] (10^{-3}) (6)	Proposed Optical Identification (7)
1E 0104.2+3153.........	$01^h04^m14^s.5$ +31°53′ 25″.7	42″	6.3	4.37 ± 0.69	14.09 ± 2.24	QSO + galaxy in group
1E 0103.6+3206.........	01 03 38.7 +32 06 57.8	47	4.7	1.40 ± 0.29	8.55 ± 1.80	Star, $m_v = 11.0$
1E 0105.2+3144.........	01 05 15.9 +31 44 53.6	54	5.7	2.56 ± 0.45	15.59 ± 2.76	SAO 54445, F2 star, $m_v = 6.3$

NOTE. Exposure time: 6252 s.
[a] Significance of detection (signal-to-noise ratio).
[b] X-ray flux computed in 0.3–3.5 keV band (see text) and 1 σ error in units of 10^{-13} ergs cm^{-2} s^{-1}.
[c] Count rate in units of 10^{-3} s^{-1} and 1 σ error.

TABLE 2

BRIGHTNESS MONITORING OF THE QUASAR

Date UT	R	*n*
1982 Nov 12	19.20	1
1982 Nov 15	19.18	2
1982 Nov 21	19.13	4
1983 Dec 6	19.36	2
1983 Dec 7	19.50	4
1983 Dec 8	19.42	3
1984 Oct 28	19.22	2
1984 Nov 2	19.12	2
1984 Nov 4	19.17	2
1984 Nov 15	19.35	1
1984 Nov 16	19.30	2
1984 Nov 19	19.25	2

Whipple Observatory. A broad *R* filter was used, and all observations are transformed to the Johnson *R* photometric system. In addition to the original 1982 February data taken to identify the Medium Survey source, we have observations taken in the late autumn of 1982, 1983, and 1984. The brightness of the QSO image was measured relative to a network of field standards. Two of the field stars are labeled as I and J in Figure 1 of Paper I. The third star, here identified as K, is in the lower right-hand corner of the same illustration.

Only one of the three stars has photometry listed in Paper I (star I) and its *R* magnitude is uncertain by 0.05 mag. We have monitored the brightness of stars I, J, and K on 27 CCD data frames extending over 3 yr and have found none to vary above the 2% level. From our combined observations, we determine for star J, $R = 15.95$ and for star K, $R = 16.44$. Note that the 5% uncertainty of the original determination of the magnitude of star I propagates as a 5% uncertainty in the zero point for the three field standards. However the three standards provide a satisfactory basis for brightness monitoring, which is our primary concern. The zero point of the magnitude scale is uncertain by 5%, but magnitudes are internally consistent at the 1% level.

Table 2 gives the brightness monitoring results for 12 nights since the date of the original discovery of the quasar. Since the source is quite faint, the magnitudes have a rather large uncertainty which we estimate from repeated observations to be ~0.10 mag per observation. The field was generally imaged at least twice per night to reduce this error. The number of observations is given in the last column of Table 2. Observations made during a single observing run agree to within the errors of a night's observation, but there are differences in brightness between observing runs. To emphasize this point, we have averaged together the data for each observing run, and show a 1 σ error bar calculated as $[\Sigma(R_i - \bar{R})^2/n(n-1)]^{1/2}$, where *n* is the number of observations in each run. The averaged results are shown in Figure 2. Inspection of Figure 2 suggests that the observed QSO brightness changed over a range of 0.55 mag since the time of its discovery. We have used the χ^2 test to check the statistical significance of this brightness variation. When all the 27 independent measurements are considered we derive a probability $P > 99.99\%$ that the source has varied over a time scale of 2 yr. Inspection of Figure 2 suggests also a possible brightness variation over a much shorter time scale of about 2 weeks. Unfortunately the significance of this variation is only marginal (2.6 σ), and we therefore prefer not to elaborate any further on what would have been an intrinsic brightness variation on a time scale of less than 5 days. Optical monitoring of the quasar is still in progress.

b) The EXOSAT Observation

1E 0104.2+3153 was observed with *EXOSAT* on 1984 August 17. The thin lexan filter which provides the maximum throughput in the 0.05–2.0 keV CMA band was used throughout the observation. On the basis of the measured IPC flux and allowing for different plausible spectral shapes (a thermal bremsstrahlung spectrum with *k*T values ranging from 1 to 8 keV and a power-law spectrum with photon spectral index α_{ph} ranging from 1.2 to 3.0), we expected to collect from ~70 to ~200 net counts above an estimated 50 background counts during the 160,000 s exposure.

Since no X-ray source was apparent, a search was made in the vicinity of 1E 0104.2+3153. No significant excess above the background was found for detect cells ranging from 24″ × 24″ (optimized for point sources given the point spread function of the CMA in the central region of the field of view) to 1′ × 1′, the maximum extent of the X-ray source consistent with the IPC data. Upper limits of 3 σ on the total counts were

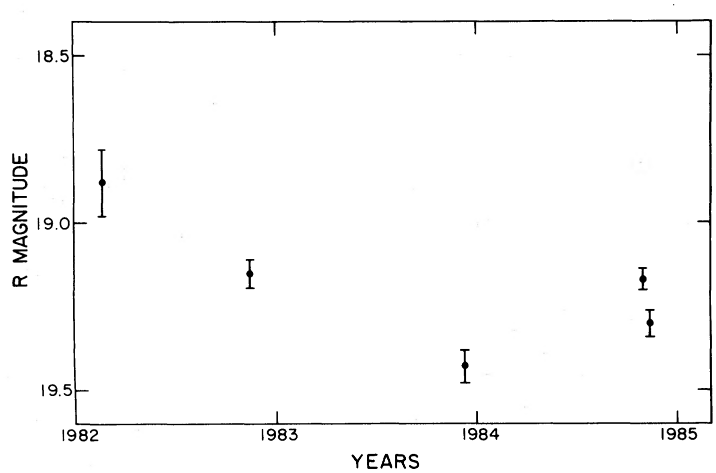

FIG. 2.—Brightness monitoring of the BAL QSO. The data have been averaged together for each observing run as described in the text. The first point comes from a 10 minute exposure taken on the MMT (see Paper I).

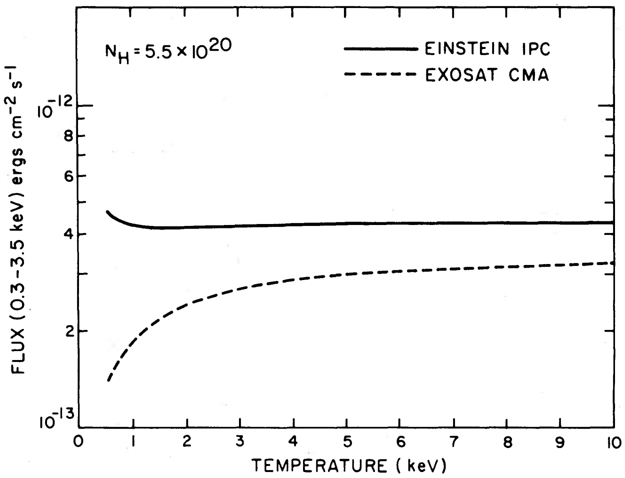

FIG. 3.—The IPC flux and the CMA 3 σ upper limit are plotted as a function of temperature in the case of a thermal bremsstrahlung spectrum assuming only the absorption due to our own Galaxy.

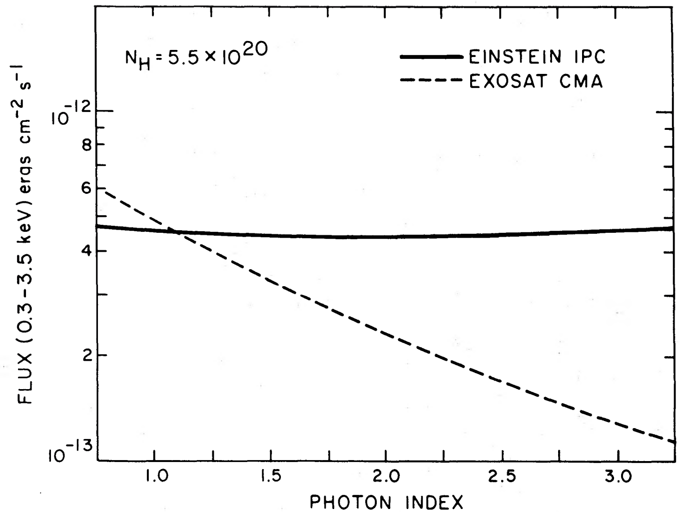

FIG. 4.—The IPC flux and the CMA 3 σ upper limit are plotted as a function of photon spectral index in the case of a power-law spectrum assuming only the absorption due to our own Galaxy.

determined leading to different fluxes according to the assumptions on the spectral parameters.

In Figures 3 and 4 the IPC flux and the CMA 3 σ upper limits (extrapolated to the 0.3–3.5 keV band) are plotted as a function of temperature (in the case of a thermal bremsstrahlung spectrum) and photon spectral index (in the case of a power-law spectrum). In both cases only the absorption due to the interstellar medium in our own Galaxy has been assumed. In the case of the thermal bremsstrahlung spectrum (see Fig. 3), there are no temperatures at which the CMA upper limit becomes consistent with the IPC detection. Therefore, if the X-ray emission detected by the IPC is due to a thermal process, as in the case where the group of galaxies (or a cooling flow within the giant elliptical galaxy) is the counterpart to the X-ray source, the *EXOSAT* observation would imply that the source is variable (see Fig. 3). We can thus rule out the group of galaxies as the correct identification of 1E 0104.2+3153.

The situation is quite different when power-law spectra are considered. In this case, due to the softer *EXOSAT* energy band, the conversion between count rate and flux is a much stronger function of the assumed spectral parameters. Assuming the "canonical" value for AGN spectral slope (i.e., $\alpha_{ph} = 1.7$), and a hydrogen column density of 5.5×10^{20} cm^{-2}, the CMA 3 σ upper limit is a factor of 1.5 below the IPC value. Consistency between the two measurements, however, can be obtained if the same N_H value is used and slopes as flat as $\alpha_{ph} = 1.15$, or flatter, are considered (see Fig. 4). This value for α_{ph} is at odds with the recent results on soft X-ray spectra of QSOs: B. Wilkes and M. Elvis (private communication) find evidence that on average radio quiet QSOs (as in the present case) show a steeper slope ($\alpha_{ph} = 2.2$) when a power-law model is assumed to describe their X-ray spectra.

Alternatively, if we keep the spectral slope of 1E 0104.2+3153 constant, then consistency is reached for hydrogen column density values much higher than those attributable to our own Galaxy, implying the presence of intrinsic absorption at the source. As shown in Figure 5, for a spectral index $\alpha_{ph} = 1.7$ a $N_H = 1.5 \times 10^{21}$ cm^{-2} or more is needed (Fig. 5*a*). Adopting the mean slope for radio quiet QSOs (Wilkes and Elvis 1986) of $\alpha_{ph} = 2.2$, then $N_H \geq 2.3 \times 10^{21}$ cm^{-2} is needed (Fig. 5*b*).

The presence of the broad absorption lines (BALs) in the QSO optical spectrum (see § III*c* and Fig. 6) suggests that intrinsic absorption may indeed be the cause of the *EXOSAT* CMA nondetection of this object. Although Figures 5*a* and 5*b*

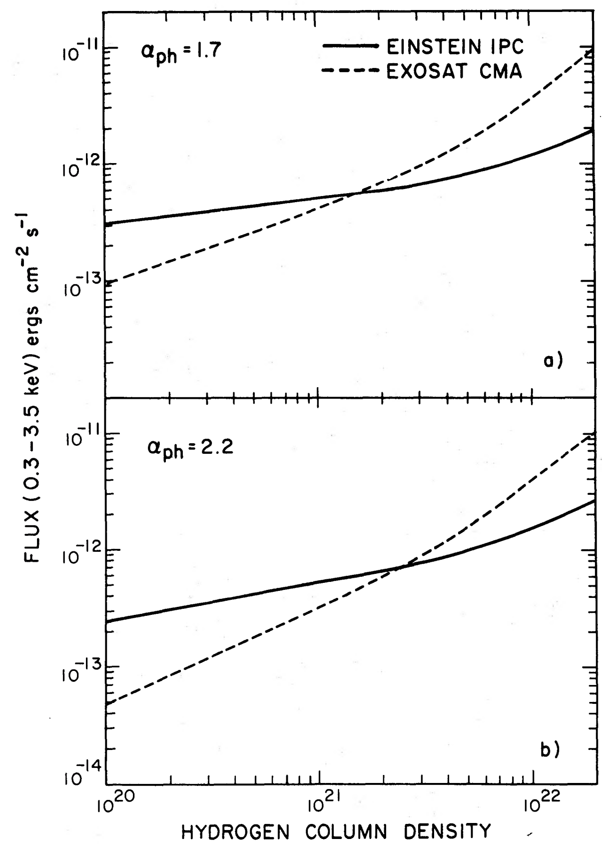

FIG. 5.—The IPC flux and the CMA 3 σ upper limit are plotted as a function of the hydrogen column density in the case of a power law spectrum with photon index $\alpha_{ph} = 1.7$ (Fig. 5*a*) and $\alpha_{ph} = 2.2$ (Fig. 5*b*), respectively. Consistency is obtained between these two observations only for $N_H \geq 2.3 \times 10^{21}$ cm^{-2}, where the limiting value is possible only if the absorbing cloud is perfectly black.

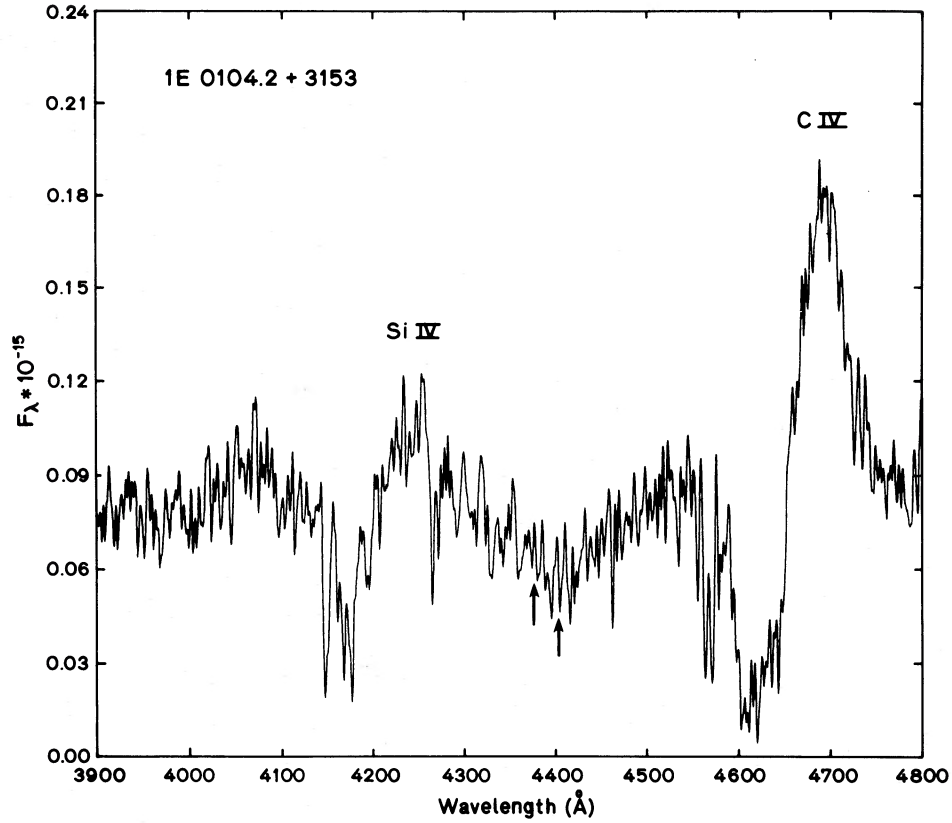

FIG. 6.—The optical spectrum of the BAL QSO taken with the MMT spectrograph in 3 hr integration time and with a resolution of 1 Å over the range 3900–4800 Å.

were constructed assuming that the absorbing column is neutral, the inferred column densities would be very similar for the highly ionized material of a BAL cloud (Weyman and Foltz 1983) for two reasons: (1) the H and He absorption is a major contributor to the total absorption cross-section for energies $\lesssim 0.1$ keV (Morrison and McCammon 1983) where the CMA with 3000 Å lexan filter has a negligible fraction of its effective area; and (2) ionization affects the metal absorptions only slightly because they are almost entirely due to K shell electrons (Kallman and Krolik 1984). Moreover, the individual column densities inferred from the depth of the BAL in several QSOs (Turnshek 1984) suggest a total hydrogen column density of $10^{20.4-21.4}$ assuming metal abundances of 10% solar. Given the effects which could increase these estimates (e.g., observing usually only one ionization state, possible saturation of absorption lines, etc.), the suggested N_H from Figures 5*a* and 5*b* are well within the range expected for BAL QSOs.[4] This suggests that X-ray spectroscopy will allow a detailed study of the X-ray absorption and so will significantly contribute to an understanding of the structure of BAL clouds in QSOs in the future.

c) Optical Spectroscopy

In Paper I we reported the *probable* detection of Ca II H and K absorptions in the QSO spectrum at the redshift of the foreground elliptical galaxy. Despite the wavelength coincidences we considered these absorptions only probable because (1) their statistical significance was only marginally above 3 σ; (2) if real, their equivalent widths would be stronger than any other such systems detected (see York 1982 for a summary), and they would constitute the first such absorptions due to an intervening elliptical galaxy; and (3) the QSO spectrum contains strong, broad absorption lines (BAL) suggesting that other weak absorptions intrinsic to the QSO could be present. Thus we sought to obtain a higher resolution, higher signal-to-noise ratio spectrum of this QSO to confirm these features. A previously published erratum (Stocke *et al.* 1984*b*) has reported that these new data fail to confirm the presence of Ca II H and K absorptions.

Figure 6 presents the results of a 3 hr integration, taken on the night of 1984 October 28, using the MMT spectrograph and 832 l mm^{-1} grating through 1″ circular apertures yielding a 1 Å spectral resolution over the range 3900–4800 Å. Clearly visible are the C IV and Si IV emission linas and their complex associated BAL systems. The predicted positions of the alleged Ca II absorptions are indicated with arrows. Upper limits on the equivalent widths of any unresolved absorption lines at or near the redshifted ($z = 0.111$) positions of Ca II H and K in the foreground galaxy are $W_\lambda < 0.10$ Å at $\sim$4375 Å and $W_\lambda < 0.11$ Å at $\sim$4408 Å, approximately 10 times weaker than the equivalent widths suggested in Paper I. A smoothing of the Figure 6 spectrum to the 10 Å resolution of the previous spectrum does show broad (FWHM $\sim$5 Å), low-contrast features similar to those seen in Figure 3 of Paper I. But the irregular shape of the continuum in that region prevents us from concluding that these features are due to the foreground galaxy.

[4] We note that BAL clouds are seldom black either in the continuum or the emission lines. This increases the N_H estimate needed to explain the X-ray nondetection.

TABLE 3

SUGGESTED ABSORPTION SYSTEMS IN 1E 0104.2+3153

SYSTEM NUMBER	$Z_{abs}(\pm 0.0003)$	WAVELENGTHS OF OBSERVED DOUBLETS C IV	Si IV	VELOCITY RELATIVE TO EMISSION LINES (± 300 km s^{-1})[a]
1: red edge	1.9993	4651.3	4207.3	2750
blue edge	1.9765	4608.1	4148.0	5050
2: red edge	1.9523	4578.3	4114.8	7490
blue edge	1.9420	4554.8	not clearly detected	8540
3:	1.7546	4271.5	[b]	28200
		4265.0	[b]	
4: red edge	1.92($\pm$0.005)	4545.0	4071.0	10790($\pm$500 km s^{-1})
center	1.84($\pm$0.005)	4405.0	3968.0	19100($\pm$500 km s^{-1})
blue edge	1.75($\pm$0.005)	4265.0	[b]	28700($\pm$500 km s^{-1})

[a] Uncertainties in velocity due almost entirely to uncertainty in emission line redshift.
[b] Not in wavelength range observed.

Instead of one or more sharp absorption doublets as might be expected from cold interstellar clouds, a broad, low-contrast absorption trough is present, extending from ~4250 to 4550 Å. The blue end of this trough is uncertain due to the onset of Si IV emission. Albeit unusual in its relatively low contrast and symmetrical shape, this trough probably signifies a BAL since there is an associated weak Si IV trough at the blue end of Figure 6. Indeed, as in several BAL QSOs (Turnshek 1984), the shape of the absorptions makes it difficult to determine the exact position of the continuum.

The wavelengths for the extreme blue and red edges of the strongest absorption features in Figure 6 are listed in Table 3. Since the resolution and signal-to-noise ratio in Figure 6 are not entirely adequate to determine whether these BALs consist entirely of individual absorption doublets, the presence of "contiguous absorption," particularly in the deepest trough, is not clear. The quasar GC 1556+335, which was originally suggested to be a BAL QSO on the basis of a low-resolution spectrum, was found to contain a dense clustering of C IV and Si IV doublets. Based upon Figure 6, higher resolution and signal-to-noise data for 1E 0104.2+3153 could reveal a similar situation for this QSO. For GC 1556+335 Morris *et al.* (1986) found two clumps of absorption doublets which could conceivably be due to two foreground clusters as unlikely as that possibility seems. In 1E 0104.2+3153 the proposed "clusters" would have quite reasonable velocity dispersions of 1000 and 500 km s^{-1} (systems 1 and 2, respectively) but the presence of the low-contrast BAL at even higher velocities (relative to z_{em}) suggests the alternative explanation that these absorptions are the "break-up" of a single BAL cloud (Briggs, Turnshek, and Wolfe 1985). In this way 1E 0104.2+3153 is very similar to the BAL QSO 1303+308 which also exhibits a high degree of structure in the absorption lines (Foltz *et al.* 1986).

IV. RESULTS AND DISCUSSION

The deep *EXOSAT* observation of the X-ray source 1E 0104.2+3153 suggests, at a high level of confidence, that the compact group of galaxies present in the IPC error circle is not the counterpart of the X-ray source. An optical spectrum of the giant elliptical galaxy shows no evidence of nuclear activity as no emission lines are present in the wavelength range 3700–6500 Å. Normal elliptical galaxies are characterized by X-ray luminosities ranging from a few $\times 10^{39}$ to 5×10^{41} ergs s^{-1} (Long and Van Speybroeck 1983). So although we cannot positively rule out the giant elliptical galaxy as the source of the X-ray emission, the very high nonthermal X-ray luminosity (2.5×10^{43}) which would characterize this "normal" and radio-quiet object, makes this possibility very unlikely.

Thus the QSO is the strongest candidate for the optical identification of 1E 0104.2+3153. The *EXOSAT* CMA data imply a substantial decrease in its X-ray luminosity unless (1) the soft X-ray spectrum is unusually and extremely flat ($\alpha_{ph} < 1.2$), or (2) this object exhibits a significant amount of intrinsic absorption ($N_H > 2 \times 10^{21}$ cm^{-2}; quite possible for a BAL QSO). If the luminosity has indeed decreased, then, the variability could be due to a luminosity variation or to the cessation of a gravitational lensing effect acting at the time of the *Einstein* observation. With respect to the former case we note that X-ray luminosity variations on time scales of several months or years is commonly observed in optically and radio selected QSOs (Zamorani *et al.* 1984). Although none of the QSOs in the sample studied by Zamorani *et al.* was found to vary by more than a factor of 2, the X-ray selected QSO EXO 1102.8+2359 ($z = 0.095$) reduced its flux by a factor of 3 in 2 days (Beuermann, Stella, and Sieber 1984).

An alternative interpretation for the X-ray flux variation is due to gravitational lensing. This would imply amplification of the quasar emission at the time of the *Einstein* observation by the presence, along the line of sight, of a star in the halo of the giant elliptical galaxy. In this case an analogous variability should have occurred at optical wavelengths. Unfortunately, no optical images of the region of 1E 0104.2+3153 were taken at the time of the *Einstein* observation (1980 July 30) but the optical monitoring reported herein does show a slow decrease over the last 3 yr.

The *EXOSAT* CMA nondetection seems to rule out the cluster of galaxies as the X-ray emitter. This observation, however, does not provide unambiguous information on the nature of the QSO X-ray emission and several extremely interesting alternatives are still possible and invite further investigation.

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REFERENCES

Beuermann, K., Stella, L., and Sieber, W. 1984, in *X-Ray and UV Emission from Active Galactic Nuclei*, ed. W. Brinkmann and J. Trümper (MPE Report 184), p. 111.
Briggs, F. H., Turnshek, D. A., and Wolfe, A. M. 1984, *Ap. J.*, **287**, 549.
de Korte, P. A. J., *et al.* 1981, *Space Sci. Rev.*, **30**, 495.
Elvis, M., Wilkes, J. B., and Tananbaum, H. 1985, *Ap. J.*, **292**, 357.
Foltz, C. B., Weymann, R. J., Morris, S., and Turnshek, D. A. 1986, in preparation.
Gioia, I. M., Feigelson, E. D., Maccacaro, T., Schild, R., and Zamorani, G. 1983, *Ap. J.*, **271**, 524.
Gioia, I. M., Maccacaro, T., Schild, R., Stocke, T., Liebert, J., Danziger, I, Kunth, D., and Lub, J. 1984, *Ap. J.*, **283**, 495.
Harnden, F. R., Fabricant, D. G., Harris, D. E., and Schwarz, J. 1984, *Smithsonian Ap. Obs. Spec. Rept. 393.*
Huchra, J., Gorenstein, M., Kent, S., Shapiro, I., Smith, G., Horine, E., and Perley, R. 1985, *A.J.*, **90**, 691.
Kallman, T., and Krolik J. 1984, *Ap. J.*, **286**, 366.
Long, K. S., and Van Speybroeck, L. P. 1983, in *Accretion Driven Stellar X-Ray Sources*, ed. W. H. G. Lewin and E. P. J. Van den Heuvel (Cambridge: Cambridge University Press), p. 117.
Maccacaro, T., *et al.* 1982, *Ap. J.*, **253**, 504.
Morris, S. L., Foltz, C. B., Weymann, R. J., Shectman, S., Price, C., Boroson, T. A., and Turnshek, D. A. 1986, *Ap. J.*, submitted.
Morrison, R., and McCammon, D. 1983, *Ap. J.*, **270**, 119.
Mushotzky, R. F. 1984, *Adv. Space. Res.*, **3**, No. 10–12, 157.
Raymond, J. E., and Smith, B. 1977, *Ap. J. Suppl.*, **35**, 419.
Rothschild, R. E., Mushotzky, R. F., Baity, W. A., Gruber, D. E., Matteson, J. L., and Primini, F. A. 1983, *Ap. J.*, **269**, 423.
Stark, A. A., Heiles, C., Bally, J., and Linke, R. 1986, in preparation.
Stocke, J., Foltz, C., Weymann, R., and Christiansen, W. 1984*a*, *Ap. J.*, **280**, 476.
Stocke, J., Liebert, J., Schild, R., Gioia, I. M., and Maccacaro, T. 1984*b*, *Ap. J.*, **277**, 43 (Erratum 1985, *Ap. J.*, **295**, 685) (Paper I).
Taylor, B. G., Andresen, R. D., Peacock, A., and Zobl, R. 1981, *Space Sci. Rev.*, **30**, 479.
Turnshek, D. 1984, *Ap. J.*, **280**, 51.
Vaiana, G., *et al.* 1981, *Ap. J.*, **245**, 163.
Weymann, R. J., and Foltz, C. B. 1983, in *Quasars and Gravitational Lenses, Proc. 24th Liège Int. Ap. Colloq.* (Liège: Institut d'Astrophysique), p. 538.
Wilkes, B., and Elvis, M. 1986, in preparation.
Worrall, D., and Marshall, F. E. 1984, *Ap. J.*, **276**, 434.
York, D. 1982, *Ann. Rev. Astr. Ap.*, **20**, 221.
Zamorani, G., Giommi, P., Maccacaro, T., and Tananbaum, H. 1984, *Ap. J.*, **278**, 28.

I. M. GIOIA, T. MACCACARO, and R. E. SCHILD: Harvard/Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138

P. GIOMMI: *EXOSAT Observatory*, ESOC, R. Bosch Strasse 5, 6100 Darmstadt, FRG

J. T. STOCKE: Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, CO 80309