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THE BEHAVIOR OF THE C IV EMISSION LINE IN ACTIVE GALACTIC NUCLEI[1]

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ABSTRACT

The behavior of the C IV 1550 Å emission line strength in variable active galactic nuclei (AGNs) such as Seyfert 1 galaxies and one broad-line radio galaxy (BLRG) is discussed on the basis of low-resolution spectra from *IUE*. The results are compared with those obtained previously for QSO samples.

The variation of individual AGNs indicate that they present matter-bounded conditions when the AGN is in a high-luminosity state. Such behavior is quite well illustrated by the variations seen in the Seyfert 1 galaxy F9, where the transition from photon-bounded to matter-bounded occurs at a transition luminosity of log L_ν (1350 Å) = 29.7 ergs s^{-1} Hz^{-1}. The extrapolation of such behavior for individual AGNs to a statistical sample like the QSOs easily explains the Baldwin relation as the consequence of the fact that the QSO sample represents a luminosity-limited sample in which individual objects behave similarly to variable Seyfert galaxies. The results indicate the existence of a transition luminosity, which appears to be typical for an individual galaxy. An absolute luminosity limit also appears to be present both in the C IV line at log L(C IV) ≈ 45.0 ergs s^{-1} and for the continuum at log L_ν(1350 Å) ≈ 31.7 ergs s^{-1} Hz^{-1}.

Subject headings: galaxies: nuclei — galaxies: Seyfert — quasars — ultraviolet: spectra

I. INTRODUCTION

Since the first paper on the Baldwin effect (Baldwin 1977), which described a possible anticorrelation between the C IV equivalent width (EW C IV) of the doublet line at 1550 Å (multiplet 1) and the continuum luminosity at 1450 Å [L_ν(1450 Å)] for QSOs, various more extensive studies have been made using better selected and more complete samples. The results of Baldwin *et al.* (1978) and Wampler *et al.* (1984) appeared to confirm the existence of the Baldwin relation as a physical relation and suggested that the EW (C IV) could be used as an independent luminosity indicator for high-redshift QSOs. On the other hand, the results of Osmer (1980) on a sample of optically selected QSOs do not support such conclusion and did not show any statistically significant relation between L_ν(1450 Å) and EW (C IV). Jones and Jones (1980) explained the Baldwin relation in terms of observational selection effects, while Murdoch (1983) suggested that the main selection was caused by variability. Netzer (1985) interpreted the Baldwin relation as being caused by the variable contribution of an accretion disk, seen at different inclinations, to the isotropic ionizing continuum which would be seen more clearly at longer wavelengths. On the other hand, the extrapolation to Seyfert 1 galaxies which indicated a breakdown of the Baldwin relation at lower luminosities, has been interpreted by Wu, Boggess, and Gull (1983) in terms of a variation in the covering factor and by Mushotzky and Ferland (1984) as a variation in the ionization parameter under central photoionization modeling.

Since all these studies have been made on statistical samples, only indirect arguments can be used to evaluate and establish the physical reality and nature of the Baldwin relation and the C IV behavior. In this study we have used the large UV variability of Seyfert 1 galaxies (see, e.g., Wamsteker *et al.* 1984) in the expectation that a single galaxy during its variation is likely to show a behavior which is similar to that shown by different objects observed at a single epoch covering a significant luminosity range. This will then allow the study of the actual behavior of the C IV line strength as a function of the continuum luminosity without the unavoidable distance uncertainties. A preliminary report on these results has been given by Colina and Wamsteker (1986). The reality of the Baldwin relation for QSOs will be discussed in the light of the results found for these nearby objects ($z < 0.05$) during their continuum variations.

II. RESULTS

Low-resolution spectra taken with the *IUE* Observatory of the Seyfert 1 galaxies F9, AKN 120, NGC 3783, NGC 5548, NGC 4151, the BLRG 3C382, and the Seyfert 2 galaxy NGC 3393 were used in the analysis below. The data for NGC 4151 were taken from Clavel *et al.* (1986). For NGC 3783 we used only VILSPA spectra between 1978 and 1984, while for the other objects all available *IUE* data between 1978 and 1984 were used. All data were, after normal *IUE* Standard Image Processing System (SIPS) reduction (New Software: Bohlin, Holm, and Lindler 1981), rebinned at 2 Å for convenience reasons and a correction for galactic foreground reddening was applied. The C IV intensity was measured by straightforward integration between the continuum points adjacent to the broad C IV line centered on 1550 Å ($\Delta\lambda$ = 100 Å). The EW (C IV) was always measured with respect to the local continuum. The continuum flux was measured at the continuum

[1] Based on observations obtained at the ESA *IUE Observatory* in Villafranca del Castillo, Spain, and on data from the *IUE* Archive.

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window at 1350 Å. This choice of continuum window has the advantage that no possible intrinsic dependence of the line strength on the continuum is introduced in the measuring process. The absolute continuum luminosity [L_ν(1350 Å)] and the C IV luminosity [L(C IV)] were determined using $q_0 = +1$ and $H_0 = 50$ km s^{-1}. The QSO data from Osmer (1980) and Wampler *et al.* (1984), were adjusted to the same values. The differences introduced by the choice of the continuum window at 1350 Å rather than 1550 Å or 1450 Å, as is the case for the QSO samples, are only small since, as has, for example, been shown by Wamsteker *et al.* (1984), for Seyfert 1 galaxies the slope of the continuum distribution in the 1000–2000 Å range is fairly flat ($\alpha < 1.0$), as seems also indicated to be the case for QSOs (Wills, Netzer, and Wills 1985 and Oke, Shields, and Korycansky 1985).

III. THE LOG L_ν (1350 Å) VERSUS LOG L(C IV) RELATION

In previous studies it was found that the C IV line was directly related to the UV continuum for low-luminosity objects over a range of Δ log L_ν(1350 Å) = 3.5, but for high-luminosity QSOs the C IV line strength appeared to be nearly independent of the continuum luminosity. Many authors have studied the relation between the prominent UV and optical emission lines and the continuum (Wu *et al.* 1983; Shuder 1981; Yee 1980; Baldwin 1977; Baldwin *et al.* 1978; Wampler *et al.* 1984) and have shown that a strong direct correlation with the continuum—either optical or ultraviolet—exists over large ranges of continuum luminosity, e.g., $\Delta \log L_\nu \approx 6$ for the hydrogen lines. The data we discuss here cover, for the first time, the full luminosity range extending from Seyfert 2 galaxies (NGC 4151 at low activity level and NGC 3393) to complete samples of high-luminosity QSOs ($\Delta \log L_\nu = 5$) and are shown in a logarithmic continuum versus a C IV line flux diagram in Figure 1. The overall appearance of this diagram indicates a rather tight relation between L(C IV) and the UV continuum level as measured by L_ν(1350 Å) over the full range of L_ν of 10^{+5}. As can be seen in Figure 1, the relation does, however, appear to flatten somewhat at $\log L_\nu > 29.6$ ergs s^{-1} Hz^{-1}. For $\log L_\nu < 29.6$ one finds,

$$\log L(\text{C IV}) = 16.22 + 0.94 \log L_\nu(1350\ \text{Å}) \quad \text{with} \quad r = 0.98\ . \tag{1}$$

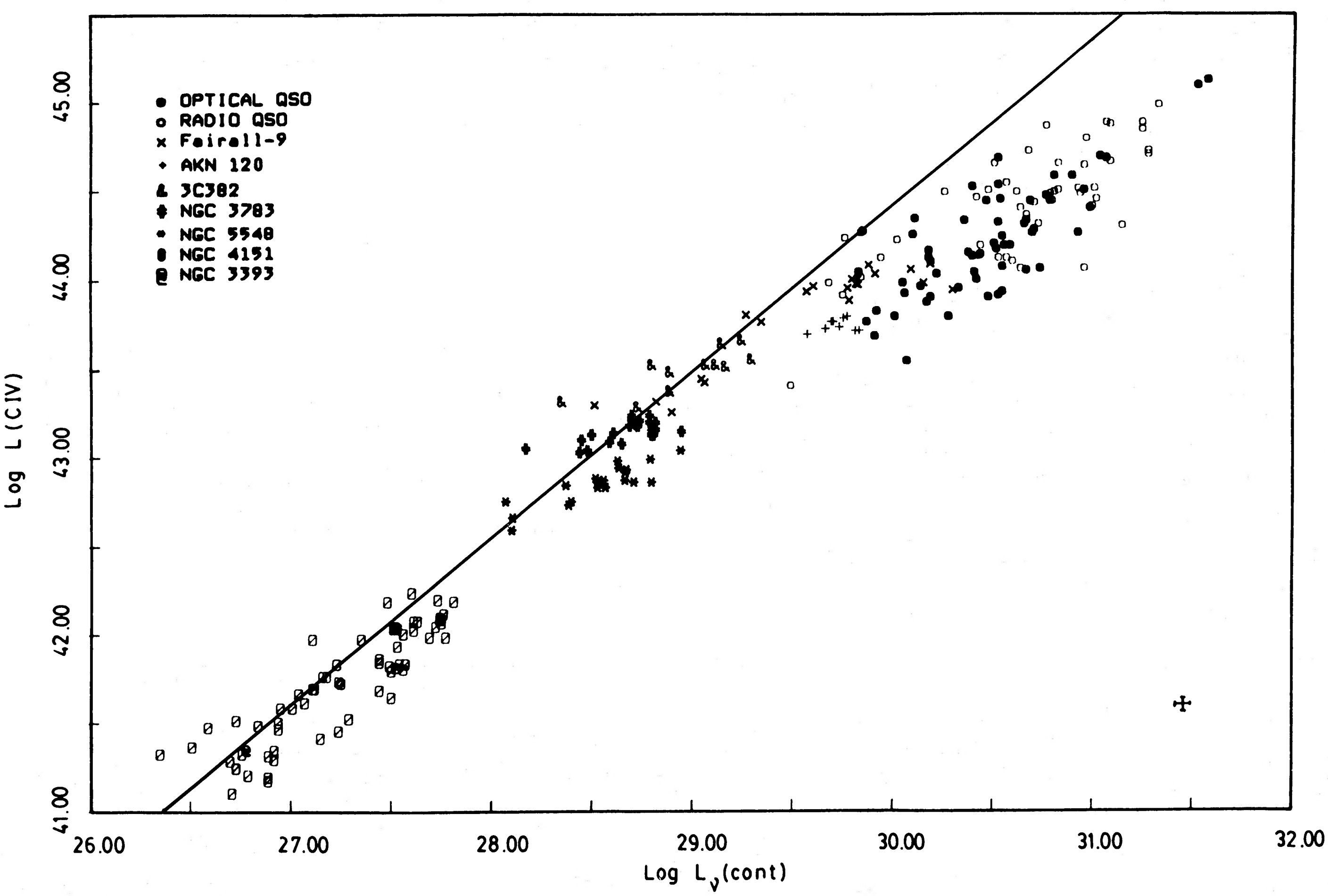

FIG. 1.—This logarithmic diagram shows the relation between the continuum luminosity L_ν(1350 Å) and the luminosity in the C IV emission line (1550 Å) for one Seyfert 2 galaxy, five variable Seyfert 1 galaxies, one variable BLRG, a sample of optically selected QSOs, and a sample of radio-selected QSOs (*see text for details*). A typical 10% error box, which is representative for most of the *IUE* data, is shown. The line corresponding to eq. (1) (*see text*) has been drawn in the figure. The very tight relation between the C IV luminosity and the UV continuum luminosity is striking. The flattening in the relation at high luminosities is caused by the fact that at high luminosities all objects become matter bounded. This is indicated also by the variable objects, which show a similar deviation from unity slope during their individual brightness variations, i.e., although the Seyfert 1 galaxies as a group follow the L(C IV) ~ L_ν(1350 Å) relation quite tightly, most objects do deviate progressively from such a relation during their L_ν variations.

This result agrees with that found earlier by Wu *et al.* (1983) and indicates that over this luminosity range of $\Delta \log L_\nu(1350$ Å$) = 3.5$, similar ionizing conditions prevail. For the complete sample of QSOs and Seyferts together, one finds an equally significant relation with a somewhat less steep slope. The relation for the complete sample in Figure 1 is

$$\log L(\text{C IV}) = 21.02 + 0.76 \log L_\nu(\text{continuum}) \quad \text{with} \quad r = 0.98\,. \quad (2)$$

If one considers only the complete sample of QSOs shown in Figure 1, the resulting relation becomes rather flat, with a slope of 0.58, but the correlation coefficient is considerably less significant at $r = 0.82$. Since both relations (1) and (2) are statistically equally significant, we will below use physical arguments supported by the evidence supplied by the variations in the individual galaxies to show that relation (1) most likely represents the physical conditions in AGNs as a class.

Taken together, the results indicate that for all AGNs considered here (Seyfert's and QSOs) the C IV luminosity is related with the continuum luminosity $L_\nu(1350$ Å). This indicates that the C IV line does behave similarly with respect to the UV continuum as the hydrogen lines behave with respect to the optical nonthermal continuum $L_\nu(4800$ Å) over a luminosity range of 10^{+5}–10^{+6} extending from low-redshift QSOs to liners, as was, e.g., found by Shuder (1981) and Yee (1980). Also the data by Wu *et al.* (1983) on Lyα for Seyfert 1 galaxies indicate a similar relation. The slope for the C IV line in relation (1) (0.94) is within the errors the same as that found for the hydrogen lines (1.06).

Actually, the fact that the behavior of lines with such different ionization potential as C IV and hydrogen is similar with respect to the continuum at 1350 Å and the nonthermal continuum at 4800 Å gives indirect support to the proposed flatter slopes for the nonthermal UV continuum and its extrapolation into the optical as proposed by Wamsteker *et al.* (1984) for Seyfert 1 galaxies and Wills *et al.* (1984) for QSOs, rather than the steep extrapolation of the infrared continuum proposed by, e.g., Malkan and Fillipenko (1983) for such objects. The extrapolation of a steep continuum from the IR to the UV, as proposed by the latter, would be too small to contribute significantly to the ionization needed to produce C IV.

It can be seen from the individual galaxies in Figure 1 that not only does the relation (1) flatten out at the high-luminosity end, but also all Seyferts except NGC 4151 deviate significantly from this relation in their variations. The large variations shown by the high-luminosity Seyfert 1 galaxy F9 are giving a clue toward the interpretation of the results shown in Figure 1. The behavior of the relation for F9 itself is shown in Figure 2. For $\log L_\nu < 29.7$ ergs s^{-1} Hz^{-1}, F9 follows quite closely a $L(\text{C IV}) \approx L_\nu(1350$ Å) relation, while at luminosities higher than this the C IV line strength is constant at $\log L(\text{C IV}) = 44.00 \pm 0.06$ ergs s^{-1} (see also Table 1 for the EW relation). Behavior as shown in Figure 2 can be most easily understood in terms of an abrupt transition from a photon-

TABLE 1

LINEAR REGRESSION ON LOG EW (C IV) VS. LOG L_ν(1350 Å) FOR QSOs AND SEYFERT 1 GALAXIES

Object Type	Zero Point[a]	Slope[a]	r
Radio QSO	32.55	−1.13	0.75
Optical QSO	31.93	−0.89	0.61
F9 $L_\nu > 29.7$	31.84	−1.00	0.91
F9 $L_\nu < 29.7$	(31.81)	(−1.19)	0.41
AKN 120	31.49	−0.96	0.83
3C 382	31.48	−1.01	0.90
NGC 5548	31.16	−1.12	0.85
NGC 3783	31.92	−1.57	0.92
NGC 4151[b]	30.33	−1.29	0.59

[a] Formal errors for these relations are given in Colina and Wamsteker 1985.

[b] Note that the relatively poor correlation found for NGC 4151 is caused mainly by the few points associated with the so-called anomalous epochs (Penston *et al.* 1981).

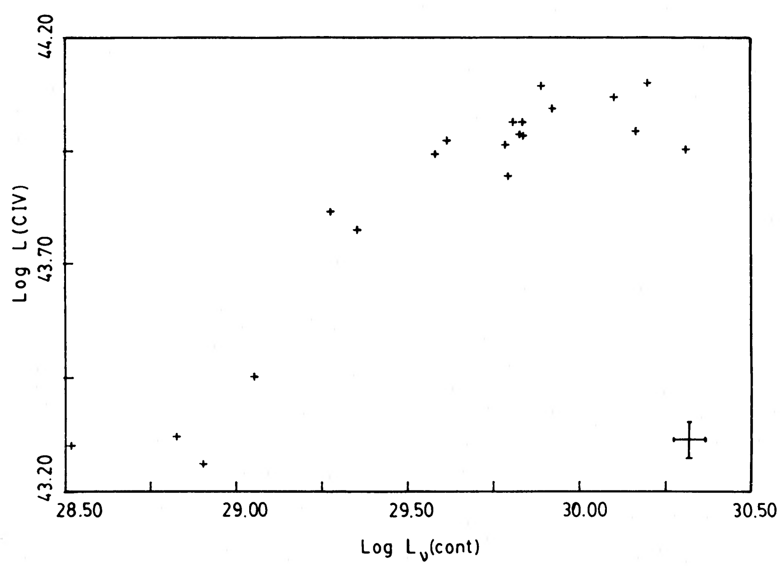

FIG. 2.—The log L(C IV) vs. log L_ν(1350 Å) relation for the highly variable Seyfert 1 galaxy F9 (ESO 113−IG45). These data (enlarged from Fig. 1) show clearly the two different relations followed by an individual Seyfert 1 nucleus during its brightness variations. For $\log L_\nu < 29.7$ ergs s^{-1} Hz^{-1} the C IV luminosity is directly proportional to the UV continuum, while for $\log L_\nu > 29.7$ the C IV luminosity is constant at $\log L(\text{C IV}) = 44.0$. This indicates that for $\log L_\nu(1350$ Å$) > 29.7$ the line emission is matter bounded, while for lower luminosities it is photon bounded. The flattening of the relation shown in Fig. 1 for high-luminosity objects is caused by the fact that such objects are all seen at brightness levels above their transition luminosity.

bounded to a matter-bounded condition at log $L_\nu(1350\ \text{Å}) = 29.7$ ergs s^{-1} Hz^{-1}, i.e., for log $L_\nu(1350\ \text{Å}) < 29.7$ ergs s^{-1} Hz^{-1} the cloud size is larger than the Strömgren radius for C IV while above that luminosity the reverse is true. Under typical broad-line region conditions ($U = 10^{+8}$–10^{+10} cm s^{-1} and $Ne = 10^{+9}$ cm^{-3}) the Strömgren radius is $Rc = 10^{+12}$–10^{+14} cm, which would then represent a typical cloud size. Considering the observed cutoff point, log L(C IV) = 44 ergs s^{-1}, and a typical cloud size of $Rc = 10^{+13}$ cm we obtain a lower limit to the number of clouds present in the BLR of $Nc = 10^{+8}$ and therefore a total amount of gas of $M = 10\ M_\odot$ in F9. This is the same as was found by Wamsteker *et al.* (1985) for F9, from the variations in the Hβ line, under similar assumptions for the conditions in the BLR clouds, which suggest that Hβ and C IV originate in the same region. It is worthwhile to point out here that all estimates of the mass in the BLR depend critically on the assumptions made for Ne. On the other hand, the Ne dependence for the mass estimate made here from C IV is similar to that in the mass estimate derived from the Hβ line by Wamsteker *et al.* (1985). In this respect the similarity of the two mass estimates is important, since it argues against the existence of two different regions with widely different conditions for Hβ and C IV. Some of the lower luminosity Seyferts (e.g., NGC 3783 and NGC 5548) behave in a matter-bounded way at lower continuum luminosities than the transition luminosity shown by F9. This would imply that for each galaxy a specific *transition luminosity* can be found which is characteristic for that object. The conclusion that, e.g., NGC 3783 varies under matter-bounded conditions was also found by Wamsteker and Barr (1985) on the basis of a detailed study of the absorption lines in this galaxy at different brightness states. Further support for matter bounded behavior is found from the relatively small, but quite significant, variations found in the Mg II line (2800 Å) as a function of the continuum brightness in F9 by Gilmozzi *et al.* (1986). The relative insensitivity of the C IV flux to the continuum strength has been suggested to be related to light-travel time delays between the ionizing source and the C IV–emitting gas, which would than be stretched over a range of distances. However, the results for both NGC 4151 and F9 below log $L_\nu < 29.7$, where L(C IV) ~ $L_\nu(1350\ \text{Å})$, are in contradiction with this suggestion, since under such conditions the slopes found for the L(C IV) versus L_ν relation would not be equal to unity and a sharp turnover as seen for F9 (see Fig. 2) would not result.

This behavior shown by these AGNs seems to indicate that *the luminosity of a particular AGN is directly related to the amount of gas available in the galaxy.* If ionizing conditions similar to those in F9 are present over the whole luminosity range, one can interpret the results shown in Figure 1 as a consequence of a decrease in the number of clouds from $Nc = 10^{+9}$ to $Nc = 10^{+6}$ with decreasing transition luminosity. This implies a decrease in the mass of the broad-line region as a function of luminosity corresponding to a mass range from 0.1 $M_\odot$ for low-luminosity Seyfert 1 and 2 galaxies to 100 $M_\odot$ for the high-luminosity QSOs. The flattening observed for the QSOs at high luminosity suggests the presence of an absolute upper limit in the amount of gas present in the C IV–emitting clouds, which under the conditions found above would be at $M_{max} \approx 100\ M_\odot$. The corresponding C IV luminosity appears to be log L(C IV) ≈ 45.0 ergs s^{-1}. If the variation in luminosity with the amount of gas in the BLR is generic in nature, then the variation shown as, e.g., by F9 and as seen for other galaxies which change from Seyfert 1 to Seyfert 2 or reverse, can possibly be considered to represent a self-limiting cycle. Since it is, at our present stage of understanding, not obvious in which way line strength, mass in the BLR, and L_ν are related generically, it is not clear how such a self-limiting cycle would actually proceed. The claims by Gaskell and Sparke (1986) for a few days' delay between the line strength and the continuum luminosity should be considered extremely tentative. The use of a cross-correlation analysis on fairly inhomogeneous data sets in which only a very limited time sampling is available can give rise to statistically significant results which do not, however, have any physical meaning.

Studying the full width at half-maximum (FWHM) of Hβ and C IV as a function of luminosity for AGNs, Joly *et al.* (1985) found that the FWHM versus luminosity relation for C IV was flatter then the linear relation found for Hβ in a statistical sample of AGNs. However, since their C IV sample consists of objects more luminous than the Hβ sample, the conclusion by Joly *et al.* that two physically distinct classes of BLR clouds coexist is far from certain. Such effects could easily be introduced by the fact that most high-luminosity objects (C IV sample) are matter bounded, while the lower luminosity in the Hβ sample are fully photon bounded.

IV. THE LOG L_ν(1350 Å) VERSUS LOG EW (C IV) RELATION

Since the first paper of Baldwin (1977), only one of the further studies discussing the Baldwin relation (Murdoch 1983) has considered the effects of variability on the results obtained. In Figure 3 we show the same results as in Figure 1 but now in the more familiar diagram of log L_ν(1350 Å) versus log EW (C IV). In this figure we have again included many epoch data for the Seyfert galaxies. The same tendency as was found by Wu *et al.* (1983) can be seen: the EW (C IV) relation steepens for the lower luminosity objects. The average value of this for all Seyferts is log EW (C IV) = 2.30 ± 0.15. This led Wu *et al.* to the conclusion that for the low-luminosity objects the EW (C IV) is a constant, suggesting differences in the covering factor between Seyfert galaxies and QSOs. However, a detailed view of the individual Seyfert galaxies during their variations indicates a quite different picture. Each galaxy describes a rather narrow strip in this diagram during its continuum variation. To quantify this behavior we have determined for each galaxy a Baldwin-type relation corresponding to its behavior in the log L_ν(1350 Å) versus log EW (C IV) diagram. The results of the linear regressions determined for each galaxy are given in Table 1. It can be seen that very significant relations are found for each galaxy and that the relations are quite similar to the Baldwin relation, except that for the lower luminosity objects the slope of the relation appears to steepen systematically. These results, together with those presented above in § II, are completely inconsistent with most of the suggested interpretations of such diagrams as the complete coverage for Seyfert galaxies suggested by Wu *et al.* (1983), inverse variations in the ionization parameter as a function of luminosity as suggested by Mushotzky and Ferland (1984), and inclination as suggested by Netzer (1985).

We suggest that the relation originally proposed by Baldwin on a sample which is basically selected on apparent brightness can easily be understood and reproduced by a similarly chosen sample of Seyfert galaxies, i.e., taking into account the variability behavior (above the transition luminosity the ionization is matter bounded) and the fact that the sample used is luminosity limited. It is only because of the unexpected result on the

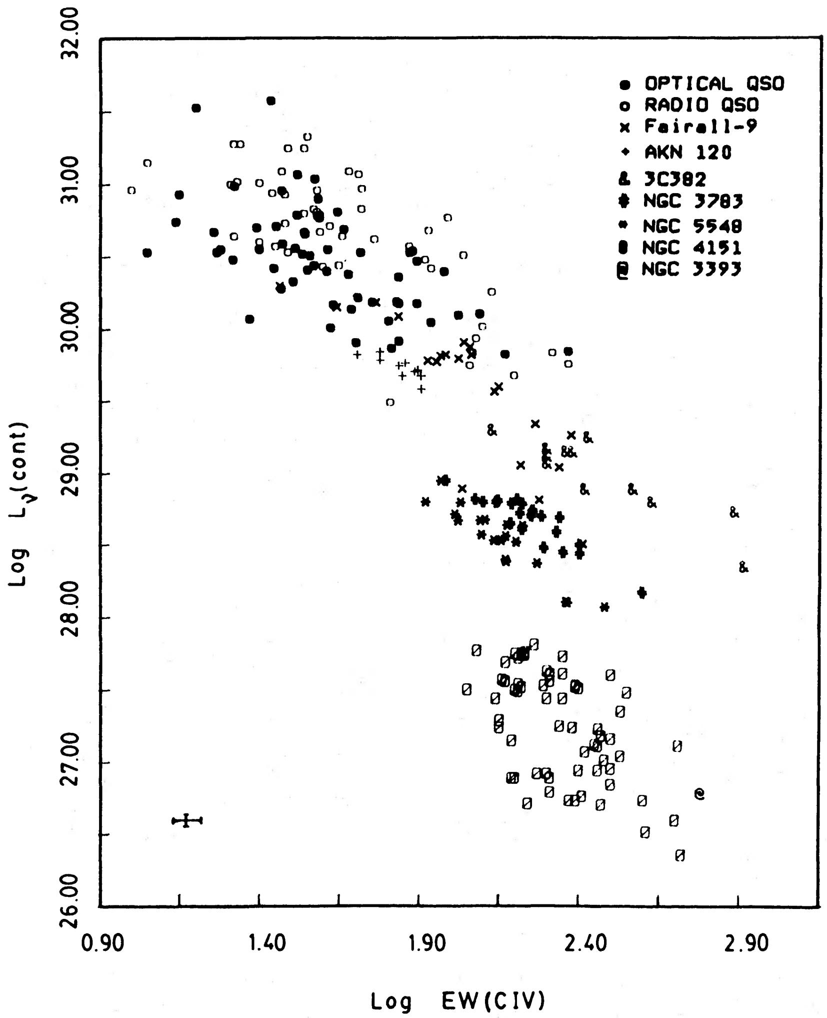

FIG. 3.—This diagram shows the relation log L_ν(const) vs. log EW (C IV) for the same sample as shown in Fig. 1. The lower luminosity Seyfert galaxies and 3C 382 do not, as a group, obviously follow any significant relation. It can, however, be easily seen that individual objects describe a Baldwin-type relation individually (see Table 1 for details). The results (Table 2) on various luminosity-limited samples selected in this diagram will all reproduce Baldwin-type relations. Note (Table 1) that the log EW (C IV) = 0.0 crossings for objects showing matter-bounded variation pass through a small range at log L_ν(const) = 31.7 ± 0.5 ergs s^{-1} Hz^{-1}. These results do not support the concept that one can use log L EW (C IV) as a cosmological candle.

variability behavior of individual Seyfert galaxies—contrary to the class characteristics—that the ad hoc suggestion of Murdoch (1983) to explain the Baldwin relation through variability, is actually confirmed. To illustrate this we give in Table 2 the results of linear regressions through (1) a single, highly variable Seyfert galaxy (F9); (2) A sample of galaxies 28.0 < log L_ν(1350 Å) < 30.3 ergs s^{-1} Hz^{-1}, (3) the result of the QSOs with 29.7 < log L_ν(const) < 31.5 ergs s^{-1} Hz^{-1}. One sees in Table 2 that for each of these samples identical results are

TABLE 2

COMPARISON BETWEEN ORIGINAL BALDWIN RESULTS ON DIFFERENT SAMPLES

Sample	Zero Point	Slope	r	Source
Radio QSO	33.34	−1.57	0.82	Baldwin 1977
	...	−1.66	...	Baldwin 1978
Seyferts	32.40	−1.56	0.67	This work
F9[a]	33.07	−1.69	0.83	This work

[a] All data.

obtained. The conclusion one derives from this is that the behavior of QSOs is *not* fundamentally different from that of Seyfert 1 galaxies and therefore it is not justified to use the Baldwin relation as a cosmological distance indicator for high-redshift QSOs. The fact that Wampler *et al.* (1984) found a statistically significant relation on a complete sample of radio-selected QSOs is then an obvious consequence of the fact that their QSO sample is luminosity limited (note that the luminosity range covered by the Seyfert galaxies in our sample is more than 100 times that covered by both the optical *and* radio selected QSOs; this is valid both in the C IV line luminosity as well as for the continuum luminosity). A similar conclusion is indicated by the results of Table 1 where the extrapolation of all relations with a correlation coefficient $r > 0.7$ to log EW (C IV) = 0.0 appears to end at the same luminosity (log L_ν(1350 Å) = 31.74 ± 0.48 ergs s^{-1} Hz^{-1}). An obvious and natural interpretation of such would be to suggest that the log EW (C IV) = 0.0 luminosity represents the BL Lac objects. Most presently available evidence on the absolute luminosity of BL Lac objects suggest luminosities in the UV less than log L_ν(1350 Å) = 31.7 ergs s^{-1} Hz^{-1}. Recent observations by

Sitko and Junkkarinen (1985), for the BL Lac object OJ 287 have shown that at least Hα, Hβ, [O III] λ5007 did rise out of the continuum when the object became very faint. Because of the poor signal-to-noise ratio, inspection of *IUE* data taken at similar time (SWP 22871 and SWP 24637) do not allow us to determine if the same occurs for Lyα and C IV. On the other hand, the now reliably determined redshift of OJ 287 ($z = 0.306$; Sitko and Junkkarinen 1985) allows us to determine that for OJ 287, $30.1 < \log L_\nu(1350) < 30.8$ ergs s^{-1} Hz^{-1} which remains below the above suggested luminosity limit and is thus not inconsistent with its existence. It would be of great interest to find confirmation of this limit, since the existence of an intrinsic luminosity limit both in the continuum and the C IV line is indicated. Any modeling proposed for the AGNs would have to be able to account for the existence of such limiting conditions.

V. CONCLUSIONS

IUE monitoring of variable Seyfert 1 galaxies has supplied enough data to make a meaningful comparison between the L(C IV) versus L_ν(1350 Å) relation for QSOs and these lower luminosity AGNs. The results of the comparison can be summarized as follows.

1. Although the Seyfert 1 galaxies as a group follow quite well a relation $L(\mathrm{C\ IV}) \sim L_\nu(1350\ \text{Å})$, most galaxies do not vary along such a relation. For most of the objects included in this work the individual AGNs vary much stronger in the continuum L_ν(1350 Å) than in the C IV line flux L(C IV).

2. The extremely large variations found for the galaxy F9 show that above $\log L_\nu = 29.7$ ergs s^{-1} Hz^{-1} the C IV luminosity is constant, while for $\log L_\nu < 29.7$ ergs s^{-1} Hz^{-1} the C IV luminosity is directly proportional to the continuum luminosity.

These two observational results can be understood in a consistent way when most Seyfert 1 galaxies vary under matter-bounded conditions. Of the objects considered here, only NGC 4151 remains in its variations photon-bounded. The following consequences, valid for AGNs as a class, can be derived from the results presented in the above.

a) Seyfert galaxies present in their variability a mixture of states for C IV: photon-bounded below a transition luminosity and matter-bounded above that. Most QSOs in the Osmer (1980) and Wampler *et al.* (1983) samples present matter-bounded conditions and are observed above their respective transition luminosity.

b) This transition luminosity is a characteristic peculiar to each individual galaxy and is most likely related to the total amount of gas available in a galaxy, from 0.1 $M_\odot$ for low-luminosity objects to 100 $M_\odot$ for high-luminosity QSOs under typical BLR conditions. If this is the case then it is quite conceivable that the processes taking place in AGNs represent a self-limiting cycle.

c) The observed flattening in the log L(C IV) versus log L_ν(const) relation for high-luminosity QSOs, together with the constant log EW (C IV) = 0.0 extrapolation luminosity (Table 1), could be considered an indication for the existence of an absolute luminosity limit both in the C IV line strength as well as in the nonthermal UV continuum luminosity.

d) The existence of matter-bounded states indicates that for typical conditions the cloud size is of the order of 10^{12}–10^{13} cm. This could represent the actual cloud size in the BLR but could equally well be seen as the size of a jet at the point of intersection with a cloud of considerably larger dimensions.

e) The Baldwin relation is a natural consequence of the statistical behavior of a luminosity-limited sample of objects which are variable and behave in their variation similar to the behavior shown by the Seyfert galaxies as indicated under equation (1) and can therefore not be used as a reliable distance indicator even for the high-luminosity QSOs.

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