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TWO ZWICKY COMPACT GALAXIES WITH BROAD EMISSION LINES

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We describe spectrometry of two Zwicky compact galaxies, I Zw 92 and III Zw 77, which have broad emission lines. They are of types Sy 2 and Sy 1, respectively. III Zw 77 has several notable features, including the prominence of [Fe VII], a preference for [Fe II] over Fe II, the presence of Bowen fluorescence lines of O III and (probably) N III, and an atypical Balmer line profile. Its Fe/Ne abundance ratio appears to be approximately solar, in contrast to those of several other Seyferts. Line emission has serious effects on the broad-band color of I Zw 92 and probably other Sy 2's as well. We derive a mass for I Zw 92.

Key words: Seyfert galaxies—spectrophotometry

I. Introduction

The great majority of galaxies known to have Seyfert nuclei were first identified by Markarian and his collaborators (see Weedman (1977) for a recent review). Their objective-prism technique allowed selection of objects with unusually prominent ultraviolet continua, of which approximately 10% have turned out to have broad emission lines. Initially, it was hoped that Zwicky's lists of "compact" objects (Zwicky 1971), selected on purely *morphological* criteria, would also yield a large fraction of Seyfert nuclei. However, despite spectacular examples such as I Zw 1 and II Zw 14 (3C 120), the proportion of broad-lined objects among the Zwicky compacts, ~ 2%, is unfortunately disappointingly small (Sargent 1970). This appears to be a confirmation of Adam's (1977) conclusion that the outer structure of Seyfert galaxies is not necessarily peculiar and that their mean surface brightness is not abnormally high.

Nonetheless, additional broad-lined objects of some interest are to be found among the compact galaxies. Here we report on observations of two prototype Zwicky compacts whose mild Seyfert characteristics first came to our attention during an extensive spectral survey of luminous, blue objects from Zwicky's lists. The two galaxies are I Zw 92 (1439+53) and III Zw 77 (1622+41); both received rather thorough treatment in the early literature on compacts (Zwicky 1966; Takada and Kodaira 1972; Karoji and Kodaira 1972) without, however, clear evidence of their Seyfert character having emerged.

Zwicky (1966) published 5-m photographs of each object. I Zw 92 exhibits a 2″ diameter core embedded in a fainter 7″.5 diameter halo. A faint bridge connects I Zw 92 to a 16th magnitude spiral companion 51″ distant. III Zw 77 is a sharp-edged disk surrounded by a thin, faint halo with a remarkably small diameter ~ 3″. It is isolated in space and possesses no extensions or spiral structure. Zwicky found that both objects have strong emission-line spectra notable for the presence of [Ne V] λ3426. Both also have blue continua and were later included in Markarian's lists as Mk 477 and Mk 699, respectively. In their systematic survey of Markarian galaxies, Denisjuk, Lipovetsky, and Afanasyev (1976) have recently confirmed the broad-lined nature of III Zw 77.

We discuss new spectrometry of these objects below and find that I Zw 92 and III Zw 77 are Seyfert galaxies of type Sy 2 and Sy 1, respectively. The spectrum of III Zw 77 is notable for several unusual features.

II. Emission-Line Spectra

A. *Observations*

Spectrometry of both galaxies was obtained with the Intensified Image Dissector Scanner (IDS) on the 2.1-m telescope of Kitt Peak National Observatory during March 1976. This instrument has been described by Weedman (1976). It was operated with a 6″ entrance aperture and two gratings, one of which covered observed wavelengths λλ3500–5300 at a resolution of 2 Å per channel and the other of which covered λλ6000–6900 at 1 Å per channel. III Zw 77 was observed in the blue on two nights (1976 March 25 and 26) with a total integration time of 2400 seconds. The standard error in the mean of the two blue scans was 0.03 magnitude. I Zw 92 was observed in the blue on 25 March with 800 seconds integration. Both objects were observed on 29 March in the red for 1600 seconds; these scans are inferior to those in the blue because of the higher dispersion and lower throughput of the scanner here. Reduction to absolute fluxes was ac-

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complished by reference to Oke white dwarfs (Oke 1974) using methods similar to those employed with the Lick Observatory IDS (Osterbrock and Miller 1975). Despite some troublesome flexure in the dissector housing, relative mean fluxes in widely separate regions of a scan appear to be accurate to better than 10%; local flux ratios are probably accurate to 5%.

The redshifts of I Zw 92 and III Zw 77 measured from the stronger emission lines are $z = 3.74 \times 10^{-2}$ and $z = 3.37 \times 10^{-2}$, respectively. We do not confirm the 300 km s^{-1} redshift residual reported in III Zw 77 by Denisjuk et al. (1976) between the Balmer and forbidden lines; from our data, any such residual appears to be $\lesssim$ 100 km s^{-1}.

IDS energy distributions reduced to the rest frame are illustrated in Figures 1 and 2. The broad-lined nature of both objects is obvious: I Zw 92 is a Sy 2 with forbidden and permitted line FWHM $\sim$ 600 km s^{-1}, while III Zw 77 is a Sy 1 with broad Balmer lines (FWHM $\sim$ 1000 km s^{-1}) but narrower forbidden lines. Both objects exhibit relatively flat continua, $F_\lambda \sim$ constant, containing only weak stellar absorption features.

Emission-line intensities for each object are given in Table I together with other relevant data. Line ratios for the stronger features are accurate to about 10%. Although Hα in III Zw 77 exhibits a narrow "core" superposed on a broader profile (see below and Fig. 2), the distinction between the two components is not clear for Hβ, so line ratios are listed with respect to the total Hβ strength. No reddening corrections have been made.

B. *The Spectrum of I Zw 92*

I Zw 92 has a typical Sy 2 emission-line spectrum. Apart from the narrower Balmer lines, it is distinguished from the spectra of Sy 1 galaxies such as NGC 4151 (Osterbrock and Koski 1976) primarily by increased strengths of all other lines relative to the Balmer series, most noticeable in [O I], [O II], and [O III]. Identifications range from low ionization features of [O II], [S II], and [N II] to high ionization species like [Ne V] and [Fe VII] (IP $\sim$ 120 eV). He II λ4686 is stronger than He I λ5876, and He I λ4471 is just barely detectable.

Line ratios in I Zw 92 are remarkably similar to those observed in 3C 327, a "narrow-lined" radio galaxy (FWHM $\sim$ 500 km s^{-1}) studied by Costero and Osterbrock (1977). Their values are listed for comparison in Table I, along with the Hβ equivalent widths, fluxes, and luminosities, and M_v for each object. A Hubble constant H_0 = 50 km s^{-1} Mpc^{-1} has been adopted. 3C 327 is an intrinsically bright, strong radio galaxy in which a late-type stellar component dominates the continuum. I Zw 92 is a radio-quiet ($S < 30$ mJy at 5000 MHz (Sramek and Tovmassian 1975)), interacting system which has an early-type stellar population (see below) and four times the Hβ luminosity of 3C 327. That both have such similar line spectra is further evidence of the existence, suggested by several earlier investigators (e.g., Osterbrock and Koski 1976), of a relatively "standard" Sy 2 line spectrum which can arise in a wide variety of objects.

C. *The Spectrum of III Zw 77*

Compared with I Zw 92, the forbidden-line spectrum of III Zw 77 exhibits a general increase in ionization. Normalized to [O III] λ5007, low ionization species like [O II] and [O I] are weaker, while high ionization species such as [Ne III], [Ne V], and [Fe VII] are considerably strengthened. [Fe X] λ6374 also appears to be present (an alternative identification with Fe II is unlikely for reasons discussed in the next paragraph). [Fe VII] is particularly conspicuous in III Zw 77, with six of the seven lines in the available spectral region being clearly detected. (The seventh is λ4699.8, which is expected to be weak and may be present in the blend at λλ4690–4730.) Of the 41 Sy 1 objects studied by Osterbrock (1977), the only one found to have comparable [Fe VII] strengths is the remarkable disturbed system Mk 40 (= I Zw 26, VV 144), which possesses a unique jet-like extension (see Burbidge and Burbidge 1964).

In addition to the Balmer series, here detectable through H9, the permitted lines He II λ4686 and O III λ3444 are prominent. He I is not visible. Most Sy 1 objects exhibit broad blends of Fe II multiplets, the strongest of which occur at λ4570, λ5190, and λ5320. Only λ4570 lies in the observed spectral region for III Zw 77, and, indeed, there is significant enhancement of its continuum between λ4500 and λ4750 (see Fig. 1), some of which is undoubtedly due to Fe II multiplets 37 and 38. However, several other individual Fe II features expected from the appearance of Fe II-rich spectra like that of I Zw 1 (Phillips 1976), are definitely *absent* in III Zw 77. These include λ4178 (multiplets 27 and 28), λ4924 (multiplet 42), and λ6248 (multiplet 74). Overall Fe II emission is therefore not strong in III Zw 77. It is also not clear whether the observed Fe II originates in the broad-lined region (BLR).

Instead of intense permitted lines of Fe II, there are several convincing identifications with forbidden Fe II features. The best of these are [Fe II] λ4245 (multiplet 21F), λ4319 (21F), and λ4815 (20F). Both λ4319 and λ4815 are on the blue wings of Balmer lines. They appear to be real features independent of the H I profile, but their intensities are somewhat uncertain. The structure of the blend at λ4895 indicates the presence of [Fe II] λ4905 (multiplet 20F) as well as [Fe VII] λ4894; and [Fe II] λ4728 (multiplet 4F) may be present in the blend at λ4700. Most strong lines from multiplets 6F

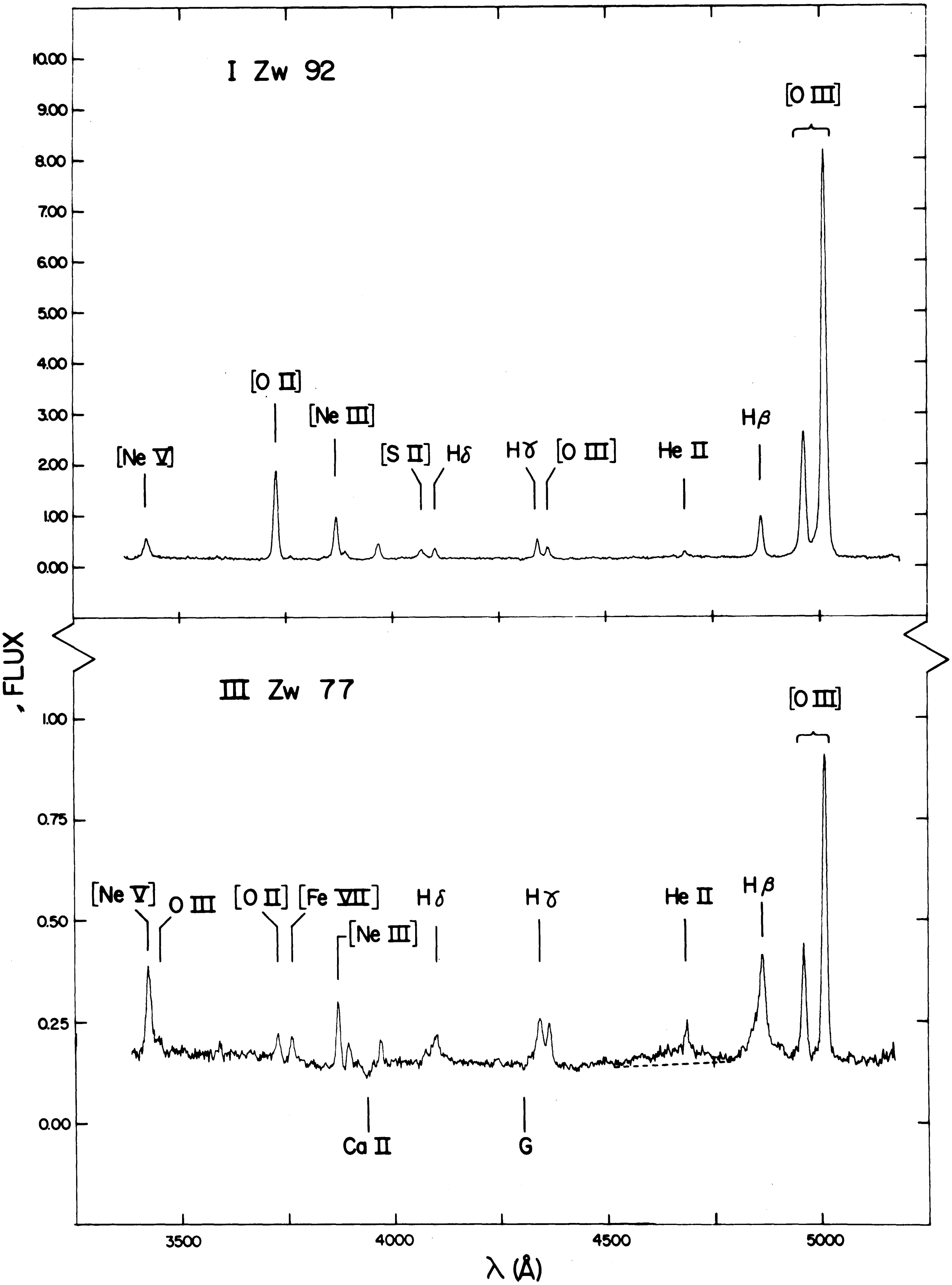

FIG. 1—Blue IDS scans reduced to the rest frame. The ordinate is $F_\lambda \times 10^{14}$, where $[F_\lambda]$ = ergs s^{-1} cm^{-2} $Å^{-1}$. Note the differences in the relative strengths of the forbidden lines between I Zw 92 (Sy 2) and III Zw 77 (Sy 1), as well as the prominent [Fe VII] and O III emission features in III Zw 77. The dashed line for III Zw 77 indicates the probable level of the continuum under the λ4600 blend.

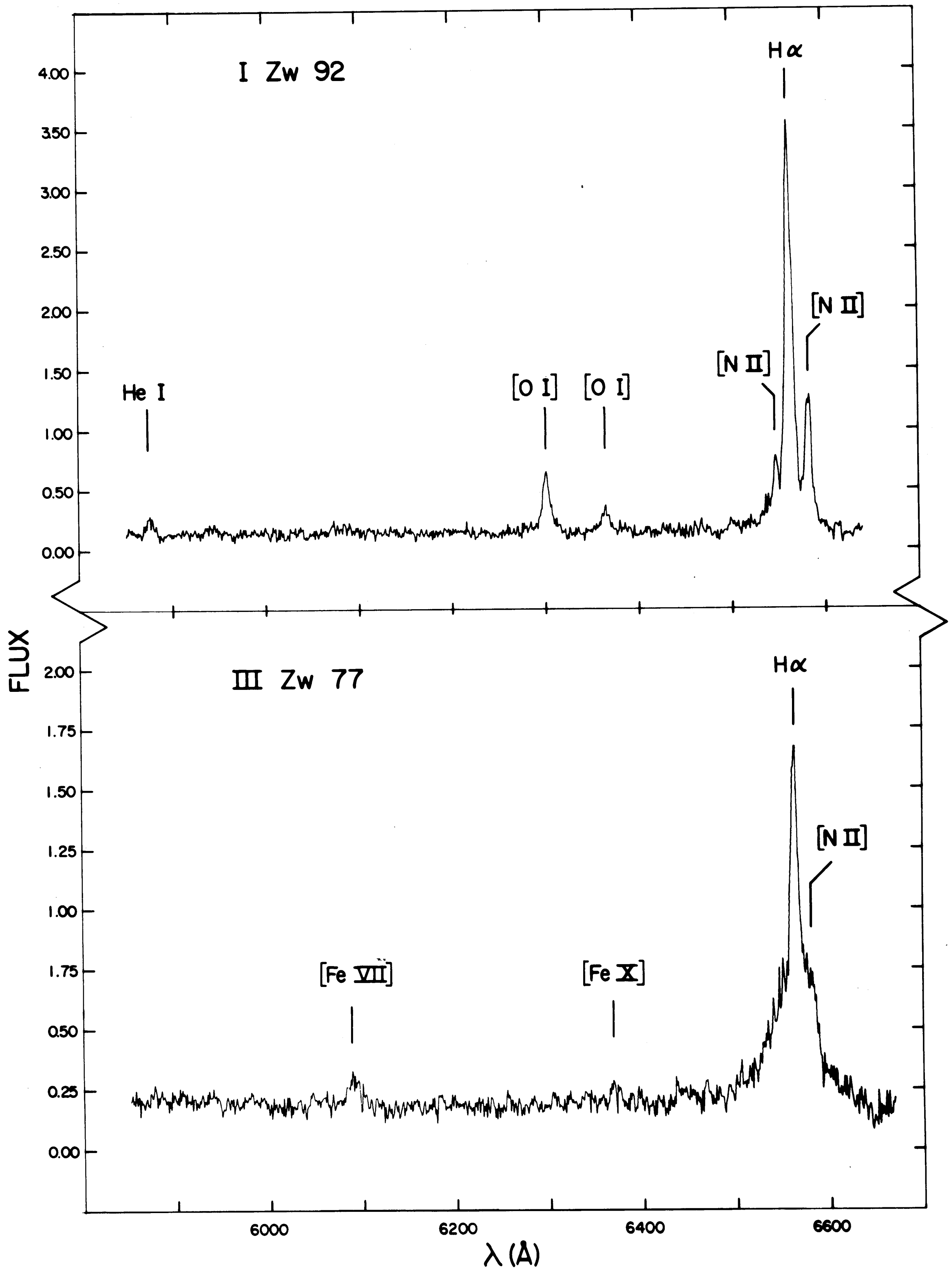

FIG. 2—Red IDS scans, as in Figure 1. Note the narrow core in Hα for III Zw 77 together with the blueward extension of the broad component.

TABLE I

Relative Emission Line Intensities (Hβ = 1.00)

λ (Å) Line	I Zw 92	III Zw 77	3C 327[a)]
3426 [Ne V]	0.67	0.46	1.18
3444 O III	...	0.095	...
3587 [Fe VII]	0.032:	0.031:	...
3727 [O II]	1.81	0.13	1.79
3760 [Fe VII]	0.039	0.12	...
3835 H9	0.027:	0.006:	...
3869 [Ne III]	0.87	0.23	0.80
3889 Hζ + He I	0.18	0.094	0.12
3968 [Ne III] + Hε	0.33	0.081	0.27
4072 [S II]	0.27	0.046	0.24
4102 Hδ	0.19	0.23	0.24
4245 [Fe II]	...	0.024:	...
4319 [Fe II]	...	0.02:	...
4340 Hγ	0.41	0.39	0.43
4363 [O III]	0.25	0.14	0.22
4471 He I	$\lesssim$0.028	...	...
4490 [Fe II]?	...	0.04:	...
4520-4690 blend[b)]	...	0.28	...
4658 [Fe III]?	0.061	...	...
4686 He II	0.17	0.21	0.31
4690-4750 blend[c)]	...	0.087	...
4711 [Ar IV]	0.039:	...	...

TABLE I (Continued)

λ (Å) Line	I Zw 92	III Zw 77	3C 327[a)]
4740 [Ar IV]	0.032:	...	...
4815 [Fe II]	...	0.056:	...
4861 Hβ	1.00	1.00	1.00
4900 [Fe VII] + [Fe II]	0.008:	0.14	...
4942 [Fe VII]	...	0.026:	...
4959 [O III]	3.55	0.49	4.75
4989 [Fe VII]	...	0.026:	...
5007 [O III]	10.57	1.42	14.11
5876 He I	0.10	<0.04	0.17
6086 [Fe VII]	0.11:	0.30	0.24
6300 [O I]	0.47	<0.01:	0.54
6364 [O I]	0.18	...	0.18
6374 [Fe X]	...	0.07:	0.14
6548 [N II]	0.59	0.27:	1.22
6563 Hα	3.34	4.98	4.83
6583 [N II]	1.50	0.81	3.80
EW (Hβ) (Å)	69	46	11
F(Hβ) (ergs s^{-1} cm^{-2})	1.2×10^{-13}	7.2×10^{-14}	3.8×10^{-15}
L(Hβ) (ergs s^{-1})	7.0×10^{41}	3.5×10^{41}	1.8×10^{41}
V[d)] (mag)	14.8	15.4	16.3
M_V (mag)	-22.0	-21.1	-22.7

Notes to Table I

a) Emission line intensities from Costero and Osterbrock (1977).

b) Blend contains Fe II multiplets 37 and 38, [Fe III] λ4658 and probably N III λλ4634, 4641 and 4642. The intensity given does not include He II.

c) Blend probably contains [Fe VII] λ4699, [Fe II] λ4728, and [Fe III] λ4701, which is the strongest [Fe III] feature normally observed next to λ4658 (Meinel et al. 1968). [Ar IV] λλ4711 and 4744 appear to be absent.

d) V magnitude for Zwicky compacts from Sargent's (1970) broad band photometry. Value given is for largest aperture used (∿12" diameter).

and 7F would appear in the λλ4400–4500 region where the continuum level is not well defined. The only strong feature which is expected on the basis of our identifications and the behavior of [Fe II] in η Carinae (Thackeray 1953) and which is clearly absent is [Fe II] λ4277. We suspect that it may be concealed by underlying G-band absorption since the band seems weak for the strength of the Ca II K line (see section III).

Thus, we believe the [Fe II] identifications in III Zw 77 are reasonably secure. The only other Seyfert with known [Fe II] emission is NGC 4151 (Netzer 1974). Although the upper levels of all observed [Fe II] transitions lie within 3.5 eV of the ground state, Netzer's rough calculations indicate that both electron collisions *and* continuum fluorescence can be important in populating them. In company with other forbidden lines, it is presumed that [Fe II] originates in low density ($n_e < 10^7$ cm^{-3}) regions.

The O III λ3444 line, which is the primary feature produced by resonance scattering of He II λ304 in the Bowen fluorescence mechanism, is particularly conspicuous in III Zw 77. This feature has previously been reported only in NGC 4151 (e.g., Netzer 1974), and it is about twice as strong with respect to Hβ in III Zw 77. In novae, symbiotic systems, and other emission-line stars, strong N III features are often associated with strong O III (Underhill 1970). This is attributed to the second stage of the Bowen fluorescence cycle, wherein λ374 photons emitted by return of O III to its ground state are absorbed by the ground state of N III, producing emission near λλ4100 and 4640. We believe that N III fluorescence lines are the reason that the λλ4520–4690 blend in III Zw 77 (after removal of He II λ4686) peaks near λ4640 instead of near λ4570, as it would if Fe II were the only contributor to the blend. There is also marginal evidence that N III λ4100 is present in the [S II]-Hδ blend since the Hδ/Hγ ratio is larger than one would expect from Hγ/Hβ.

The Bowen fluorescence lines are potentially useful indicators of ionization structure, velocity fields, etc. within Seyfert nuclei (Weymann and Williams 1969). They can originate in both the BLR and the lower density, narrow-lined region (NLR). It is not clear from the literature whether the lines are genuinely rare in Seyferts or whether poor instrumental efficiency and low spectral resolution simply make them difficult to detect. The whole issue of the Bowen lines deserves a careful study.

D. *Line Profiles*

Full widths of Hα, Hβ, and [O III] λ5007 for both galaxies are given in Table II. These have been corrected for instrumental smoothing (corresponding to FWHM $\sim$ 600 km s^{-1} at Hβ) determined from He-Ne comparison lines. I Zw 92 has symmetrical line profiles with FWHM $\sim$ 550 km s^{-1} for Hβ and [O III]. Forbidden-line profiles in III Zw 77 are similar to those in I

TABLE II

Emission Line Full Widths (km s^{-1})

	I Zw 92			III Zw 77		
	Hα	Hβ	[O III]	Hα	Hβ	[O III]
Intensity						
0.75	190	290	380	270	560	340
0.50	310	560	550	540	1060	500
0.25	580	830	840	2040	2580	800
0.0	<5000	4200	4300	10000:	5500:	1500:

Zw 92, except the latter has larger FW0I. In both objects, Hα is significantly narrower than Hβ for intensities larger than 25% of maximum. This indicates the contribution of two distinct regions to the Balmer emission, the less turbulent of which appears to have a steeper Balmer decrement.

The Balmer lines in III Zw 77 are about twice as broad as in I Zw 92 and have an asymmetrical profile. Half widths for the red and blue wings separately are given for Hβ in Table III. The blue wing is clearly stronger than the red. This result is interesting, since in every Sy 1 object with an asymmetrical profile studied by Osterbrock (1977), the *red* wing was the stronger. The effect here is not due to blending with adjacent [Fe II] or [Fe VII] features, which are clearly separated from Hβ, and in any case a similar asymmetry is also present in Hα for intensities below ~ 30% of maximum.

It is possible that the abnormal profiles and spectral peculiarities of III Zw 77 are related to the relative mildness of the Sy 1 phenomenon here, since few objects have such small FW0I in the Balmer lines. If Sy 1's evolve into Sy 2's, III Zw 77 may well represent a transitional phase.

E. *The Fe/Ne Abundance in III Zw 77*

Since the Balmer series and [O III] features in both I Zw 92 and III Zw 77 resemble those in other Seyferts, physical parameters deduced from these primary diagnostics using the standard analysis (see, for example, Osterbrock, Koski, and Phillips 1976) are likewise similar to other Seyferts.* For the NLR of I Zw 92, we find $n_e \sim 10^5$, $M_{\rm H\,II} \sim 4.7 \times 10^5\ \mathfrak{M}_\odot$, and $R \sim 7.4\ \epsilon^{-1/3}$ pc, while for the BLR of III Zw 77 if $n_e \sim 10^9$, then $M_{\rm H\,II} \sim 2.4\ \mathfrak{M}_\odot$, and $R \sim 2.8 \times 10^{-3}\ \epsilon^{-1/3}$ pc. Here, ϵ is the filling factor, estimated to be $\lesssim 10^{-3}$ in earlier studies (e.g., Shields and Oke 1975).

In III Zw 77, the [Fe VII] lines also yield a temperature estimate for the most highly ionized zone of the NLR. Using the best-determined strengths, for λ3760 and λ6086, we find from the calculations of Nussbaumer and Osterbrock (1970) that $T_e \sim$ 12,000 K for $n_e \lesssim 10^6$. The λ3760 value has been corrected for the contribution of O III λ3759.9; however, the temperature estimate would be changed significantly (toward higher values) if any foreground reddening were assumed.

Nussbaumer and Osterbrock (1970) have shown that since they arise in the same volume independent of ionization structure, the [Ne V] and [Fe VII] lines yield a good estimate of the Fe/Ne abundance ratio. Unfortunately, the result is very sensitive to the assumed electron temperature. Without reddening corrections, the temperature derived above from [Fe VII] ratios yields N(Fe)/N(Ne) ~ 1.0. However, if we adopt the color excess implied by the BLR Balmer decrement, T_e increases to 20,000 K and yields N(Fe)/N(Ne) ~ 0.2. The solar abundance value is N(Fe)/N(Ne) = 0.89 (Withbroe 1971).

Thus, depending on the reddening, the Fe/Ne ratio in III Zw 77 may be anywhere from approximately solar to about one-quarter solar. We believe a small color excess is most realistic, implying Fe/Ne near solar levels. In this regard, III Zw 77 is distinct from other objects where both [Ne V] and [Fe VII] are present. NGC 1068 (Shields and Oke 1975), 3C 327 (Costero

*The Hα/Hβ/Hγ decrement in I Zw 92 and III Zw 77 could be explained by Whitford-law reddening with $E(B-V)$ = 0.15 and 0.52, respectively. The decrements do not exhibit the large displacement from the reddening line encountered by Osterbrock (1977) in many Sy 1's. However, it is not clear that the anomalous Balmer decrement in most Sy 1's is a product of internal extinction (Stein and Weedman 1976), so in the following, reddening corrections have not been applied to III Zw 77 line strengths unless noted.

TABLE III

Hβ Line Profile for III Zw 77

Intensity	Blue (km s^{-1})	Red (km s^{-1})
0.75	-280	+280
0.50	-600	+460
0.25	-1650	+930
0.0	-3200	+2300

and Osterbrock 1977), and I Zw 92 all have observed [Fe VII]/[Ne V] ratios a factor of three smaller than those of III Zw 77, indicating correspondingly smaller N(Fe)/N(Ne) for a given T_e. In their detailed analysis of the spectrum of NGC 1068, Shields and Oke deduced an Fe/Ne abundance ratio of 0.17 solar.

Better observations of the Fe and Ne features in Seyferts would be very useful, not only in order to understand better the processes which lead to a Seyfert outburst but also because they provide a direct method of determining Fe-peak abundances, which are central to the problem of element enrichment in galaxies (Faber 1977).

III. Continua and Absorption Lines

Continuum energy distributions for I Zw 92 and III Zw 77 obtained from IDS scans and earlier observations at Lick Observatory are given in Table IV. The approximate spectral indices with the 6″ aperture for $\lambda > 4000$ Å are $\alpha \sim 1.5$ and $\alpha \sim 2.6$, respectively, although in neither case is a power law a particularly good fit. Both continua are much bluer than that of a giant elliptical galaxy nucleus. The 6″ energy distribution of I Zw 92 is significantly redder than the 10″ continuum at all wavelengths except $\lambda < 3700$. Comparison suggests reddening amounting to $E(B-V) \sim 0.2$ coupled with Balmer recombination continuum for $\lambda < 3650$ in the nuclear regions.

Absorption-line strengths are listed in Table V for each object together with those for typical Sc and gE nuclei. The 10″ continuum and line strengths of I Zw 92 indicate an early-type stellar population simliar to that of an Sc nucleus. The strengths of the Ca II K line together with continuum dips near 4300 Å and 3800 Å suggest a somewhat later type for the stellar background in III Zw 77. (The G band, as noted above, appears to be weakened by superposed emission lines.) Higher precision data would be required to separate the stellar component from the nonthermal continuum which one expects to be present in Sy 1's (Neugebauer et al. 1976).

It is worth noting that the continuum of I Zw 92 is ~ 0.4 magnitude bluer than the broad-band $(B-V)$ color index (~ 1.0 from Sargent (1970)) would indicate. The broad-band V magnitude is strongly affected by the intense [O III] λ5007 line, which has an equivalent width of 730 Å and is redshifted to a wavelength where the V filter has significant response. Because all Sy 2's tend to have strong [O III] lines, this kind of line contamination is undoubtedly an important contributor to the pronounced color segregation of Sy 2's and Sy 1's (Sy 2's have redder $(B-V)$ color indices) found by Weedman (1973), and the segregation would not appear to be simply related to continuum properties.

IV. The Mass of I Zw 92

IDS scans were also obtained of the spiral companion of I Zw 92. It has a spectrum typical of late-type spirals with [O II] λ3727 and Hβ in emission and the higher Balmer members as well as Ca II H and K in absorption. Its redshift is $z = 3.81 \times 10^{-2}$ and its velocity with respect to I Zw 92 is 210 ± 80 km s^{-1}. Using the simplest assumptions (circular orbit, both objects in the plane of the sky, and equal mass-to-light ratios for the two galaxies), we estimate a mass for I Zw 92 of $\mathfrak{M} \sim 6 \times 10^{11}\ \mathfrak{M}_\odot$. The corresponding mass-to-light ratio is $\mathfrak{M}/L_v \sim 10$ in solar units. These figures are uncertain by probably a factor of three, but they are not atypical of those derived for normal late-type galaxies in binary systems.

V. Summary

These two Zwicky compact galaxies exhibit spectral characteristics which are generally similar to those of other Seyfert galaxies. III Zw 77 has several unusual features, however, including the prominence of [Fe VII], the presence of [Fe X], a preference for [Fe II] over Fe II, the presence of Bowen fluorescence lines of O III and (probably) N III, and an atypical Balmer-line profile. Its Fe/Ne abundance ratio appears to be approximately solar, in contrast to the significantly smaller values encountered in several other Seyferts. The stellar background in both I Zw 92 and III Zw 77 appears to correspond to those of middle-to-late-type spirals. Line emission has serious effects on the broad-band color of I Zw 92 and probably other Sy 2's as well. The mass and $\mathfrak{M}/L_v$ of I Zw 92 appear to be normal.

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TABLE IV

Continuum Energy Distributions*

	I Zw 92		III Zw 77
λ	6"	10"	6"
3400	16.76	16.20	16.85
3600	16.78	16.05	16.74
3800	16.75	15.76	16.79
4000	16.63	15.57	16.65
4200	16.52	15.56	16.55
4600	16.32	15.48	16.36
5000	16.14	15.42	16.11
5800	15.91	15.18	15.58
6600	15.68	15.14	15.42
7400	. . .	15.06	. . .
8400	. . .	14.9:	. . .

* 6" aperture data from KPNO 2.1-m IIDS scans. Values represent 50 Å flux averages (with emission lines removed) converted to magnitudes. Differences in magnitude are accurate to about 0.10 mag. 10" aperture data from Lick Observatory 3-m prime focus scanner, $\Delta\lambda = 20$ Å, with emission contributions not removed. Relative magnitudes accurate to about 0.05 mag. All values given in AB magnitudes, where $AB = -2.5 \log f_\nu - 48.59$, and $[f_\nu] = \text{ergs s}^{-1} \text{ cm}^{-2} \text{ Hz}^{-1}$.

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TABLE V

Absorption Line Equivalent Widths (Å)*

Feature	I Zw 92		III Zw 77	Sc	gE
	6"	10"	6"	10"	10"
Ca II K	1.1	1.6	3.3	3.8	8.3
G band	1.7	1.2	0.4	1.8	3.6
Mg I b	...	1.8	...	2.2	6.9
TiO λ6180	...	1.0	...	0.6	1.0

* 6" aperture observations are total equivalent widths from IDS scans. 10" aperture data are from Lick 3-m prime focus scanner; values listed indicate equivalent width within the measuring bandwidth, which is 16.4 Å for $\lambda < 5000$ and 26.2 Å for $\lambda > 5000$. "Sc" data refer to the nucleus of M33, while "gE" data represent the mean of 3 gE galaxies in the Virgo Cluster (O'Connell 1976).

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