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SPECTRA OF GALAXIES IN THE CASE LOW-DISPERSION SKY SURVEY IN THE DIRECTION OF THE BOOTES VOID

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ABSTRACT

We have observed a sample of 34 galaxies selected from the Case Low-Dispersion Northern Sky Survey in the direction of the Bootes void. Emission-line redshifts were obtained for 33 objects; the spectrum of the thirty-fourth galaxy contains no obvious features. Three of the emission-line galaxies are located within the boundaries of the Bootes void, including one not previously reported. To date, all the galaxies discovered in the void have emission-line spectra. Although more than half the galaxies in our sample are fainter than $M_B = -21.0$ mag, all five of the galaxies that were detected by *IRAS* are brighter than $M_B = -21.5$ mag.

The relative strengths of the emission lines in most of the galaxies, including those in the void, indicate the lines are excited by photoionization due to young, hot O and B stars. Possible causes for the star formation occurring in these galaxies include interaction with nearby galaxies, star formation induced by nuclear activity, and/or recent development of physical conditions required for star formation.

Subject headings: galaxies: clustering — galaxies: emission lines — galaxies: redshifts

I. INTRODUCTION

Low-dispersion, objective prism spectroscopy is a proven technique for surveying large areas of the sky for emission-line galaxies, quasars, and other objects of interest (see Wasilewski [1983] for a more thorough review of the literature). The results of such surveys, when combined with follow-up observations to obtain spectra at higher dispersion, include space densities and distributions, luminosity functions, and a determination of the relative frequency of the various types of objects which display emission lines. With the recent results that emission-line galaxies may be the most visible, if not the only, occupants of the so-called voids between major galaxy concentrations (Kirshner *et al.* 1987), detailed studies of the emission-line galaxies found in surveys made in the direction of the voids have taken on added interest.

As part of an objective prism survey of the northern sky, Sanduleak and Pesch (1982, henceforth SP) published a preliminary list of emission-line objects in the direction of the Bootes void. Spectra of forty-four of these objects were obtained by Tifft *et al.* (1986), and two were found to lie within the void boundaries. In a different survey, Moody *et al.* (1987) found three more emission-line galaxies in the Bootes void. In addition, two previously known objects, Mrk 845 and I Zw 81, are located in the void (Kirshner *et al.* 1987). The size and location of the void were accurately determined by an extensive study of relatively bright galaxies in the region (Kirshner *et al.* 1987). Brosch and Gondhalekar (1984) searched for gas in the Bootes void by looking for absorption lines of appropriate redshift in the ultraviolet spectra of the quasar PG 1351 + 64. While they report the detection of metal lines at the appropriate redshift, the quasar is actually a considerable distance north of the void boundary.

Sanduleak and Pesch have recently completed an objective prism survey of an area in Bootes almost 4 times larger than that covered in their preliminary list (Sanduleak and Pesch 1987, henceforth SP2). More importantly, unlike the SP list, the SP2 survey coincides with the center of the Bootes void. Because of the interest in the number and types of galaxies in the Bootes void, we have undertaken a program to obtain spectra of the SP2 galaxies. We report here the results of our initial observations of a sample of 34 galaxies.

The sample consists of galaxies that satisfy the following criteria: (1) spectra had not, to our knowledge, been previously obtained; and, (2) the galaxies were identified in SP2 as having emission lines. In addition, three galaxies which were detected by *IRAS* were included, even though SP2 did not report the presence of emission lines in the spectra of these objects (see comments, Table 1).

In the following sections we discuss our results for the 34 galaxies. The observations and reduction procedures, including various calibrations, are described in § II. In § III we report the results, including the redshifts and absolute magnitudes determined for 33 of the galaxies. We confirm two of the galaxies in the void reported by Moody *et al.* (1987) and report an additional, previously unobserved galaxy within the void. We investigate the relationship between our redshifts and the estimates in SP2, to determine the predictive value of the SP2 redshift criteria, and discuss the relative strengths of the emission lines and the implications for the source of the ionizing photons. Ionic abundances in the galaxies and possible causes for the indicated star formation are described in § IV. In the final section (§ V), we summarize our conclusions and discuss future work that is needed to answer some of the questions concerning the void galaxies.

II. OBSERVATIONS

The observations were taken 1986 May 8–14 with the image tube scanner on the University of California, San Diego/University of Minnesota 1.5 m telescope, located on Mount Lemmon near Tucson, Arizona. The scanner/grating combination used produce spectra over the wavelength range ~4000–7000 Å with a resolution of 13 Å (defined as the smallest separation of two emission lines that can be resolved). The scanner is a dual aperture instrument. Observations were made with the galaxy in each 4".3 aperture for half the observing time. The sky was observed simultaneously through the other aper-

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TABLE 1

REDSHIFTS FOR OBSERVED GALAXIES

Case No.	Z_0	Std. Dev.	Z	No. Lines	B	M_B	Remarks
368	0.0338	±0.00024	0.0342	6	16	−20.6	
371	0.0396	0.00021	0.0401	5	16	−21.0	
383	0.0126	0.00020	0.0131	3	16	−18.6	
389	0.0019	0.00014	0.0023	8	16	−14.8	
406	0.0351	0.00015	0.0355	7	15	−21.7	
419	0.0114	0.00023	0.0117	7	16	−18.3	
425	0.0074	0.00029	0.0078	4	16	−17.4	
434	0.0085	0.00013	0.0090	4	16	−17.7	
453	0.0077	0.00016	0.0081	9	15	−18.5	
460	0.0225	0.00015	0.0228	7	16	−19.8	
474	0.0446	0.00013	0.0451	6	16	−21.3	
480	0.0100	0.00017	0.0104	6	16	−18.1	
484	0.0267	0.00011	0.0271	2	16	−20.1	
501	0.0899	...	0.0904	1	16	−22.8	
544	0.0072	0.00010	0.0077	7	15	−18.4	
547	0.0432	0.00023	0.0437	6	16	−21.2	$Z=0.0440$[a]
552	0.0856	0.00008	0.0859	2	16	−22.7	
563	0.0324	0.00020	0.0328	7	15	−21.6	*IRAS*
578	0.0279	0.00021	0.0283	3	16	−20.2	
587	0.0120	0.00039	0.0125	4	16	−18.5	
588	0.0302	0.00014	0.0306	8	16	−20.4	W95, $Z=0.0299$[b]
591	0.0357	0.00033	0.0362	4	16	−20.8	
595	0.0266	0.00014	0.0271	4	16	−20.1	
608	0.0106	0.00007	0.0111	7	16	−18.2	
647	0.0305	0.00016	0.0309	7	16	−20.4	
657	0.0527	0.00025	0.0532	9	16	−21.6	$Z=0.0535$[a]
690	0.0148	0.00031	0.0154	6	16	−18.9	
698	0.0734	0.00011	0.0740	2	15	−23.3	*IRAS*, No SP2 Emission-line estimate
699	0.0382	0.00026	0.0388	5	16	−20.9	
700	0.0320	0.00008	0.0324	4	15	−21.5	*IRAS*, No SP2 Emission-line estimate
722	0.0553	0.00012	0.0558	4	16	−21.7	*IRAS*, No SP2 Emission-line estimate
739	0.0721	0.00007	0.0727	2	16	−22.3	
752	0.0202	±0.00013	0.0208	7	14	−21.6	*IRAS?*

[a] Moody *et al.* 1987.

[b] Wasilewski 1983.

ture, making accurate sky subtraction possible. Integration times ranged from 8 to 40 minutes. At least two standard stars were observed each night. Corrections were made for slight differences in the aperture sizes. Wavelength, flat field, and flux calibrations were applied using the standard stars and observations of comparison lamps.

Spectra were obtained for 34 objects in the Case Survey, of which 33 have one or more strong, narrow emission lines. The spectrum for CG 471 did not show any strong lines, but is too noisy to definitely rule out the presence of weak absorption or emission features (Fig. 1).

With the exception of CG 471 all the spectra had strong Hα emission and 27 showed a significant amount of [O III] emission. Emission lines due to Hβ, Hγ, [N II] 6584, and [S II] 6717, 6731 were detected in several spectra. The spectrum of CG 501 has only a single strong emission line. Identification as Hα provides a reasonable redshift for this galaxy. The observed redshifts (Z_0) were corrected for the Sun's motion as follows: $Z = Z_0 + [300 \sin l \cos b]/300{,}000$ (de Vaucouleurs, de Vaucouleurs, and Corwin 1976). The observed redshift (Z_0), standard deviation, corrected redshift (Z), and number of lines used to calculate the redshift for each galaxy are listed in Table 1.

III. RESULTS

a) Galaxies in the Bootes Void

Kirshner *et al.* (1987) have defined the Bootes void as a sphere of radius 62 Mpc (for $H_0 = 50$ km s^{-1} Mpc^{-1}) centered at R.A. = $14^{\mathrm{h}}50^{\mathrm{m}}$, Decl. = +46°, at a distance corresponding to $cz = 15{,}500$ km s^{-1}. The extreme, line-of-sight boundaries of the void thus correspond to the redshift range $z = 0.041$–0.062. There are four galaxies in our sample with redshifts in the void range (Table 1), but because of the assumed spherical shape of the void, only three, CG 474, 547, and 657 are actually located within the void boundaries. Two of the galaxies, CG 547 and CG 657 have been previously reported by Moody *et al.* (1987). Our redshifts are in good agreement with their results (see comments, Table 1). The spectrum of CG 474 is shown in Figure 2. There are now eight galaxies reported within the void, all with emission lines (Moody *et al.* 1987). [One of us (D. W.) has recently found two more emission-line galaxies in the Bootes void, CG 370 and CG 629, but these data will be discussed elsewhere (Weistrop 1987).]

b) Redshifts

The redshifts can be used to calibrate the redshift criteria used in SP2. In Table 2 we show our redshifts as a function of the redshift estimate, low (L, L?) or medium (M, M?) given in SP2. SP2 also estimate some galaxies to have high redshifts (H, H?), but we have not observed any with that classification. Note also that SP2 do not give a redshift class for all galaxies in their sample. There is a definite correlation between the measured redshifts and the SP2 classes, with the apparent exception of the two galaxies with redshift classification L?. The redshift for one of the galaxies, CG 739, is $Z = 0.073$. The only emission lines observed in this object are Hα and [N II],

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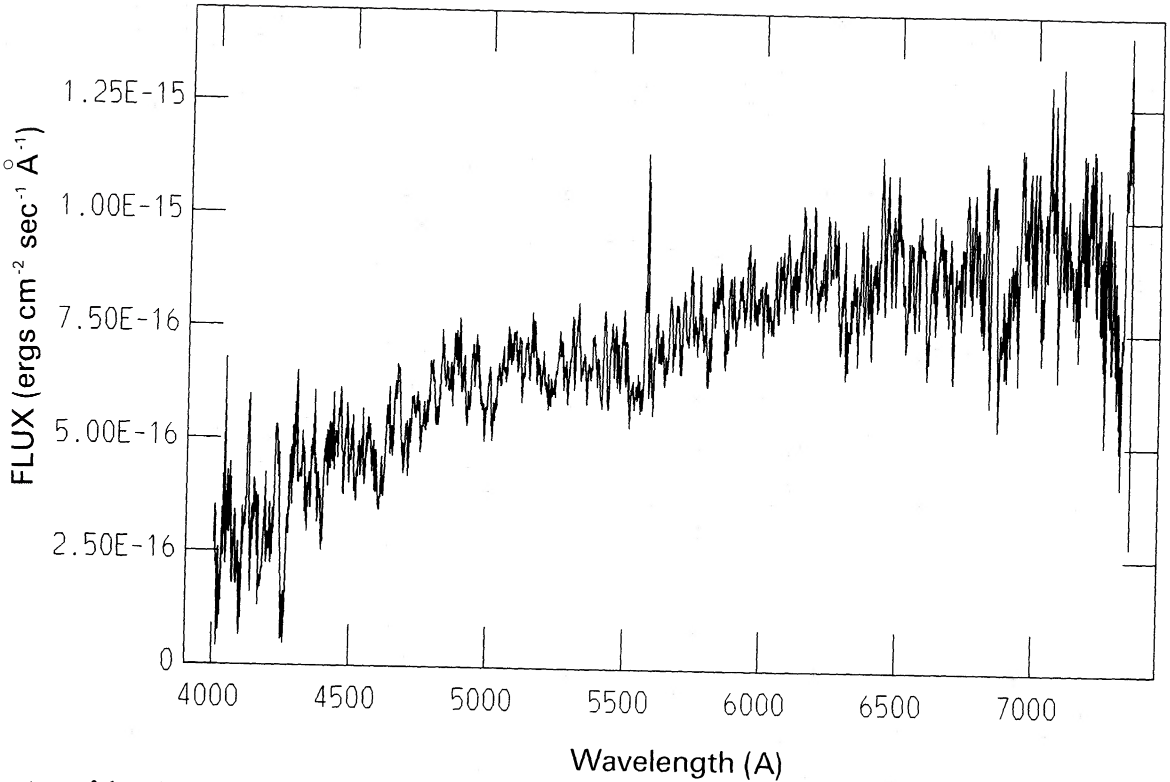

FIG. 1.—Spectrum of the galaxy CG 471. No absorption or emission features in the galaxy are apparent. The feature at 5577 Å is due to incomplete sky subtraction.

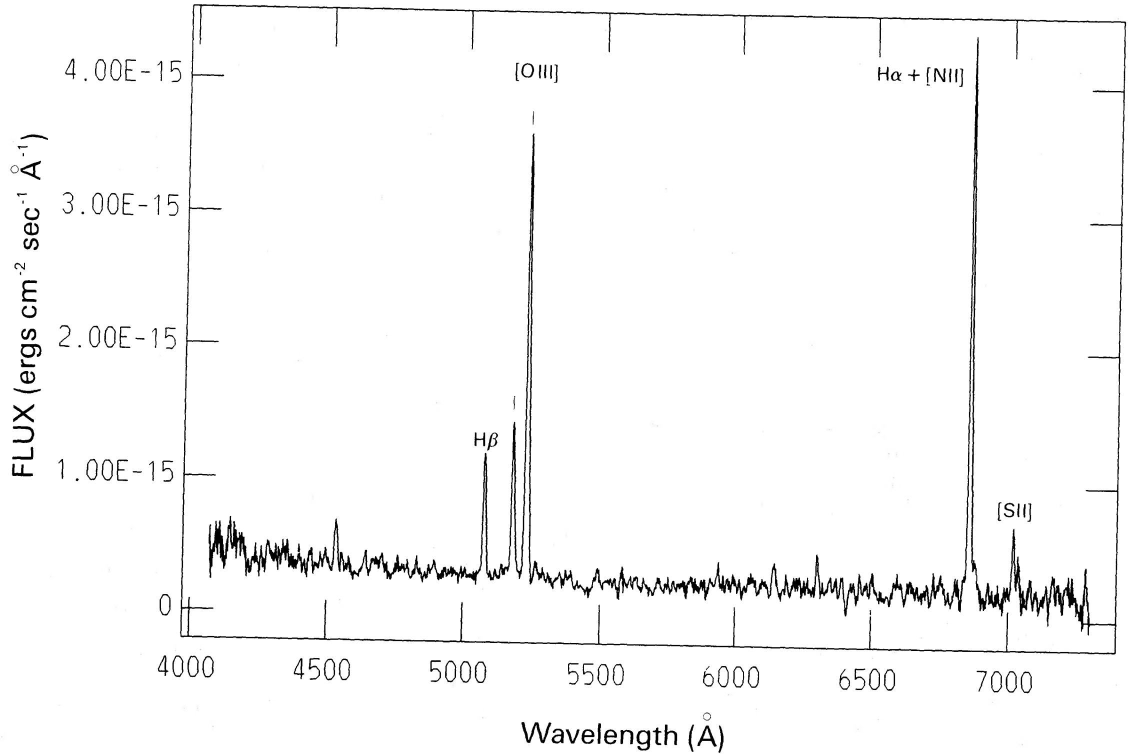

FIG. 2.—Spectrum of CG 474. Several emission lines are identified. The galaxy's redshift places it within the void boundaries.

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TABLE 2

CALIBRATION OF SP2 REDSHIFT CLASSES

SP2 CLASS	OBSERVED DATA			DATA FROM LITERATURE		
	No.	Mean	Std. Dev.	No.	Mean	Std. Dev.
L …………	13	0.0148	±0.0090	11	0.0097	±0.0055
L? …………	2	0.0416	0.0312	4	0.0138	0.0014
L?[a] …………	1	0.0104	…	…	…	…
M …………	7	0.0375	0.0084	19	0.0309	0.0070
M? …………	1	0.0388	…	0	…	…
H …………	0	…	…	7	0.0578	0.0149
H? …………	0	…	…	1	0.0790	…
No class …..	10	0.0491	±0.0250	29	0.0276	±0.0294

[a] CG 739 omitted—see text.

6584. Since these lines are outside the wavelength range observed in SP2, the redshift classification may have been made from a spurious feature. The data for the L? class without CG 739 are also shown in the Table. For comparison, we also list in Table 2 redshifts which have been published elsewhere for galaxies in SP2. The relevant references for these galaxies are given in Table 3. These data show a trend similar to our observations and extend the correlation to the high redshift classes. The standard deviation for the mean redshift of unclassified galaxies indicates that galaxies with a wide range of redshifts are included in this category.

c) *Magnitudes*

The SP2 magnitudes are estimated by eye from the continuum density near 4500 Å and are given to the nearest magnitude (Pesch and Sanduleak 1983). Comparison with published

TABLE 3

DATA FROM LITERATURE

Case No.	Other Names	Redshift Refs.	Magnitude Refs.
330…………	SP2	a	…
334…………	Mrk 283, SP3	a	…
335…………	1401 + 3917	b	b
336…………	Mrk 666	c	…
340…………	Mrk 1369	d	…
351…………	NGC 5480	b, e	b, e
359…………	1Zw 081	f	…
369…………	SP5	a	…
374…………	Mrk 467	d	…
375…………	NGC 5520	b	b
382…………	Mrk 671	c	…
386…………	Mrk 468, SP7	a	l
387…………	NGC 5541	b	b
397…………	SP8	a	…
402…………	Mrk 1490	g	…
403…………	SP9	a	…
405…………	SP10, 1418 + 406	a, h	…
409…………	SP11	a	…
411…………	Mrk 471	b	b, l
421…………	SP12	a	…
428…………	SP13	a	…
437…………	NGC 5633, 1Zw 89	b, e	b, e
442…………	Mrk 472, A1426 + 36	e	l
449…………	SP15, 1427 + 431	a, h	…
467…………	SP17	a	…
476…………	Mrk 474, NGC 5683	e, g	m, n
488…………	NGC 5695, Mrk 686	b	b, m
493…………	Mrk 475	e	…
498…………	Mrk 1386, SP20	a	…
503…………	NGC 5730	b	b
509…………	Mrk 477, 1Zw 92	g	l, m
512…………	Mrk 478	i	m, n
537…………	1444 + 3435	b	b
543…………	SP23	a	…
558…………	Mrk 827, Holm 683A	d	…
559…………	Mrk 828, Holm 683B	d	…
560…………	Mrk 829, VV 324B	b	b
565…………	SP25	a	…
567…………	SP26	a	…
572…………	1Zw 97, A1452 + 42	e	…
576…………	SP27	a	…
586…………	NGC 5804	b	b
590…………	Mrk 833	d	…
593…………	Mrk 834	d	…
598…………	SP29	a	…
623…………	SP30	a	…
624…………	SP31	a	…
626…………	NGC 5860, Mrk 480	b	b, o
631…………	SP33	a	…
636…………	Mrk 845	j	m, n
640…………	1507 + 5229	b	b
641…………	Mrk 846, Reiz 4472	d	…
642…………	1507 + 459	j	…
645…………	SP35	a	…
654…………	1510 + 331	h	…
672…………	NGC 5905	b	b, e
676…………	SP37	a	…
677…………	SP38, Mrk 848	a	…
684…………	SP40	a	…
685…………	SP41	a	…
710…………	NGC 5929, SP45	b, k	b
711…………	NGC 5930	b, k	b
715…………	Mrk 854	g	m
727…………	SP47	a	…
728…………	NGC 5934, 1Zw 113	b	b
729…………	Mrk 481	d	…
730…………	Mrk 482, A1526 + 55	e	l
737…………	NGC 5945	b	b
740…………	SP48	a	…
748…………	Mrk 484	c	o
751…………	SP49	a	…

REFERENCES. (a) Tifft *et al.* 1986; (b) Huchra *et al.* 1983; (c) Balzano and Weedman 1982; (d) Mazzarella and Balzano 1986; (e) de Vaucouleurs *et al.* 1976; (f) Sargent 1970; (g) Veron-Cetty and Veron 1986; (h) Kirshner *et al.* 1987; (i) Weedman 1977; (j) Moody *et al.* 1987; (k) SP; (l) Arakelian *et al.* 1973*b*; (m) Meurs and Wilson 1984; (n) Cheng *et al.* 1985; (o) Arakelian *et al.* 1973*a*.

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data, almost all of which is for galaxies with $B \leq 15$ mag, indicates the SP2 values are generally consistent with other work (see Table 3 for references). Since in most cases the published data are also estimates, no strong conclusions can be drawn.

Using the corrected redshifts in Table 1 and the magnitude estimates in SP2 (repeated in Table 1 for convenience), we estimate the blue absolute magnitudes of the galaxies (Table 1). All the galaxies are at galactic latitude $b > 52°$, corresponding to an interstellar absorption $A_{pg} \leq 0.33$ mag (Holmberg 1975). Since this value is less than the uncertainty in the apparent magnitudes, no correction for absorption is made to the absolute magnitudes. The absolute magnitudes indicate the objects in SP2 are a diverse sample, ranging from extremely bright galaxies with infrared emission bright enough to be detected by *IRAS* (CG 698), to faint objects apparently similar to the dwarf blue emission-line galaxies discussed by Sargent (1972) and Searle and Sargent (1972). The three galaxies in the Bootes void are all relatively bright, with absolute magnitudes between -21 and -22. Since all the galaxies in our sample have apparent magnitudes $B = 16$ or brighter, galaxies at the void distance and fainter than $M_B \sim -21$ would not be detected.

d) *Emission Lines*

To calibrate the line strength estimates in SP2, we compare the measured fluxes of [O III], 4959 Å + 5007 Å to the N1 + N2 line strength criteria in SP2 (Fig. 3). The figure shows the average flux as a function of SP2 class, with the standard deviation for each value indicated. The mean measured flux increases monotonically along the SP2 sequence, although there is considerable overlap between the adjacent classes, especially for the weak fluxes.

Classification parameters for emission-line galaxies, based on ratios of the line strengths, have been discussed by Baldwin, Phillips, and Terlevich (1981) and Veilleux and Osterbrock (1987, henceforth VO). These authors consider three principal excitation mechanisms, photoionization by O and B stars, photoionization by a power-law continuum, and shock-wave heating. We have calculated the line ratios for the 18 galaxies with measurable [O III], Hα, Hβ, and [N II] in their spectra and plotted the results in Figure 4. (While not completely resolved at our resolution, the Hα and [N II] 6584 lines are sufficiently separated to measure the individual fluxes by assuming each line profile is symmetric.) Comparison with the results in Baldwin, Phillips, and Terlevich and VO indicates that all the galaxies in Figure 4 except one fall in the region of the diagram occupied by galaxies with emission lines excited by O and B stars, i.e., "H II region-like galaxies." The single exception is CG 700, which lies just outside the "transition zone" defined by VO as being within ±0.15 (horizontal) units of the boundary between active galactic nuclei and "H II region-like" galaxies. The [S II]/Hα line ratio used in VO places CG 700 well within the region defined by "H II region-like" galaxies, so the significance of the results for the [N II]/Hα ratio is ambiguous for this object. SP2 identify CG 700 as having infrared emission detected by *IRAS*. CG 389 and CG 578 have no detectable [N II] 6584 line but the strengths of the [S II] 6717, 6731 lines were measured. The line ratios for these galaxies fall in the "H II region-like" area of the [O III]/Hβ versus [S II]/Hα diagrams. For at least 19 of the observed

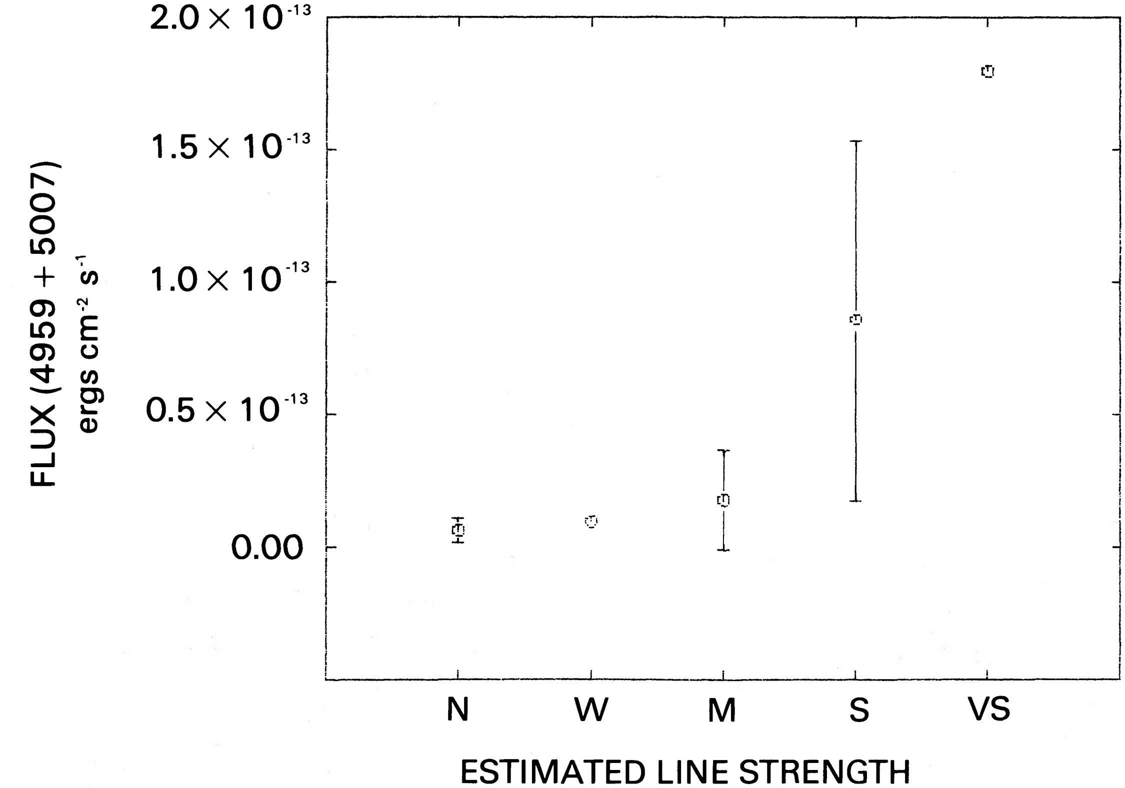

FIG. 3.—Relationship between SP2 line strength estimates for [O III] 4959 Å + 5007 Å and the measured values. The averaged sum of the measured fluxes is plotted as a function of the SP2 estimate: N: no flux; W: weak; M: medium; S: strong; VS: very strong. The length of the lines is twice the standard deviation. The number of galaxies included in each average value follows: N, four galaxies; W, one galaxy; M, 21 galaxies; S, six galaxies; VS, one galaxy.

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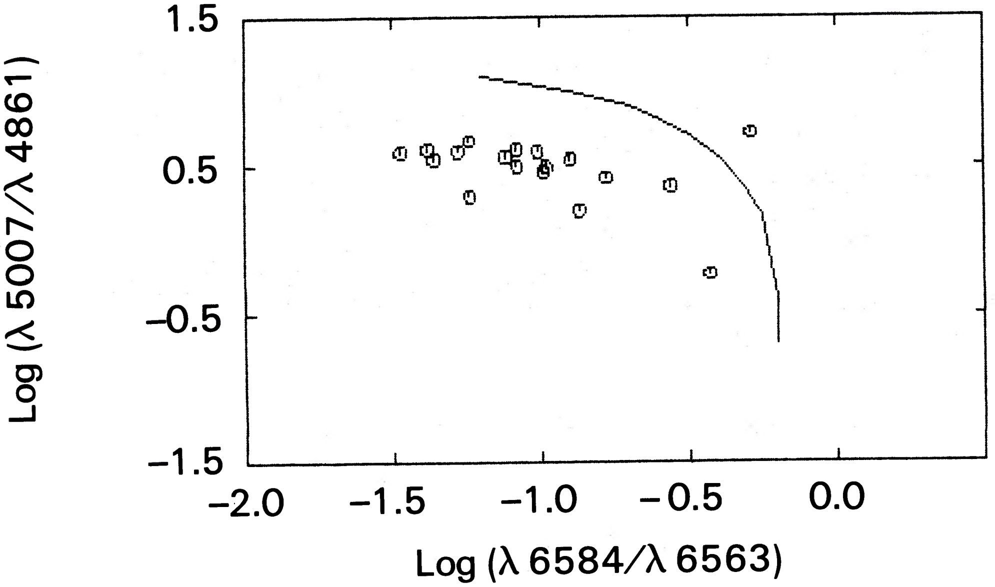

FIG. 4.—The reddening corrected line ratios used to determine the nature of the ionizing radiation. The solid line separates "H II region-like" galaxies from active galactic nuclei.

galaxies (20 if we include CG 700), the excitation mechanism for the emission lines is photoionization due to hot stars. All three galaxies within the Bootes void are included in this group.

IV. DISCUSSION

French (1980) has described the properties of galaxies with the spectra of giant H II regions. The low-luminosity objects (absolute magnitude fainter than $M = -18$ for $H_0 = 50$ km s^{-1} Mpc^{-1}) have oxygen abundances approximately 30% of normal, while the brighter objects (absolute magnitude brighter than $M = -21$) have oxygen abundances 50%–60% of the abundance found in galactic H II regions. We estimate the chemical abundances in the "H II region-like" galaxies in the Case sample by calculating the ionic abundances of O^{++} and N^{+}, assuming $T = 10^4$ K and an electron density of $N_e = 10^3$ cm^{-3}. The temperature and electron abundances could not be determined directly from the emission-line ratios because the required weak lines, e.g., [O III] 4363 or [N II] 5755, were, in most cases, not detected in our spectra. Fortunately, the ionic abundances are relatively insensitive to the assumed value of the electron density. The values adopted for the temperature and electron density are consistent with those determined by French (1980), Our results are shown in Figures 5 and 6, where the ionic abundances of N^+ and O^{++} have been plotted as a function of absolute magnitude. For comparison, we also show the ionic abundances found by French, with absolute magnitudes converted to $H_0 = 50$ km s^{-1} Mpc^{-1}. The distribution of relative abundances of O III is similar for the two samples, scattering around a value of 10^{-4}, even though the French sample contains intrinsically fainter galaxies than ours. The distributions of the N II abundance are similar, with a sharp increase in N II found for the brightest galaxies. The abundances of N II found here are slightly higher than those in French's galaxies for galaxies at all magnitudes, although the difference may not be significant.

Three possible scenarios for the dwarf H II region-type galaxies have been discussed: (*a*) the initial mass function consists almost entirely of massive stars, (*b*) the galaxies are young ($<10^9$ yr), and (*c*) the galaxies are observed during one of several intermittent stages or "flashes" of star formation (Searle, Sargent, and Bagnuolo 1973, henceforth SSB). The massive star hypothesis is ruled out because the presence of so many rapidly evolving stars predicts enhanced metal abundances, which are not observed. SSB predict flashing galaxies brighter than $M = -17$ will be extremely rare, if "flashes" in individual regions of the galaxy are uncorrelated. However, recent results clearly indicate that intrinsically bright "H II region-like" galaxies are not rare (see Balzano 1983; Wasilewski 1983; Veron and Veron-Cetty 1986, and our Table 1). If the same mechanisms are relevant for the bright and faint "H II region-like" galaxies, the SSB analysis suggests that either the bright galaxies are young, or simultaneous star formation over wide areas of the bright galaxies is being induced.

French (1980) reiterates the argument against "flashing" in the bright galaxies, but suggests that the high-luminosity galaxies in his sample are not necessarily young, either. French's bright galaxies appear to be either interacting or have close companions and he considers it likely that the apparent bursts of star formation are induced by interaction with nearby galaxies. In an investigation of galaxies with "star-burst nuclei," Balzano (1983) suggests that these galaxies experience recurrent episodes of star formation which may be correlated with interactions with nearby galaxies. Wasilewski (1983) also finds a significant fraction of the emission-line galaxies he observed to be peculiar, and possibly interacting. It has also been suggested that starbursts at the centers of galaxies may be induced by the presence of active galactic nuclei, defined for this purpose as nuclei with energy input from nonstellar sources (Keel 1985). Heckman (1986) finds that the "H II region-like" spectra are strongly correlated with hot, possibly young stellar populations, and that such nuclei are ubiquitous in late-type galaxies and rare in early-type galaxies. His conclusions could suggest that many of the emission-line galaxies identified in the Case survey are late-type spirals or irregulars.

With a few exceptions (Moody *et al.* 1987), there are no morphological data for the Case galaxies, so it is unknown what fraction of the galaxies have bright, conspicuous nuclei,

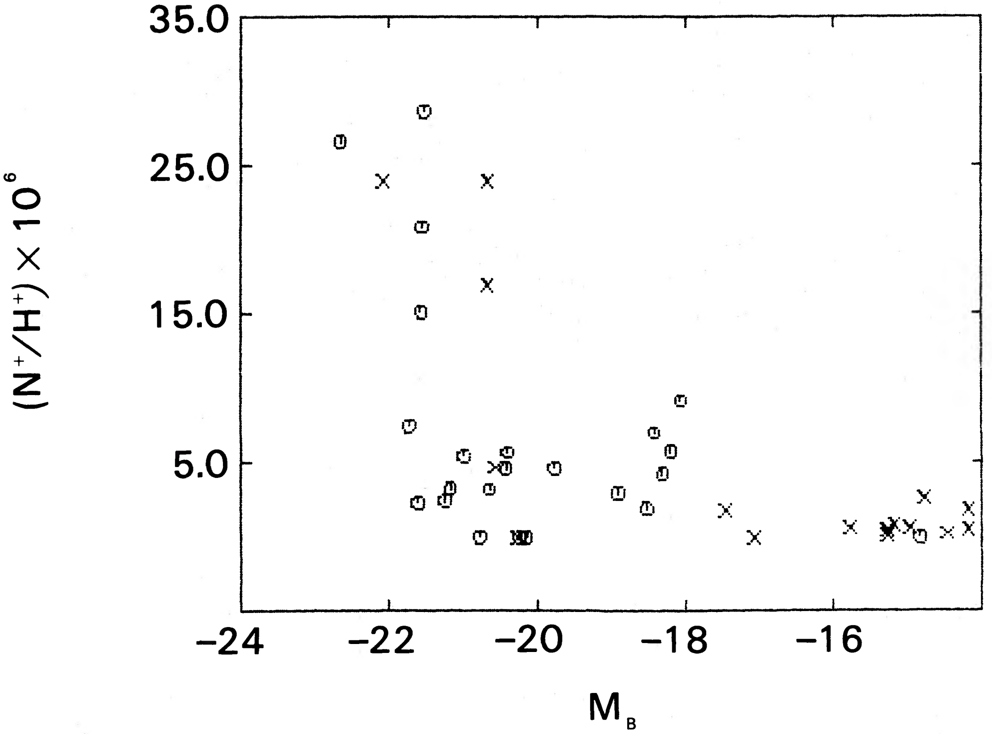

FIG. 5.—Abundance of N II as a function of absolute magnitude for this sample (*circles*). French's results for " H II region-like " galaxies are shown for comparison (*crosses*).

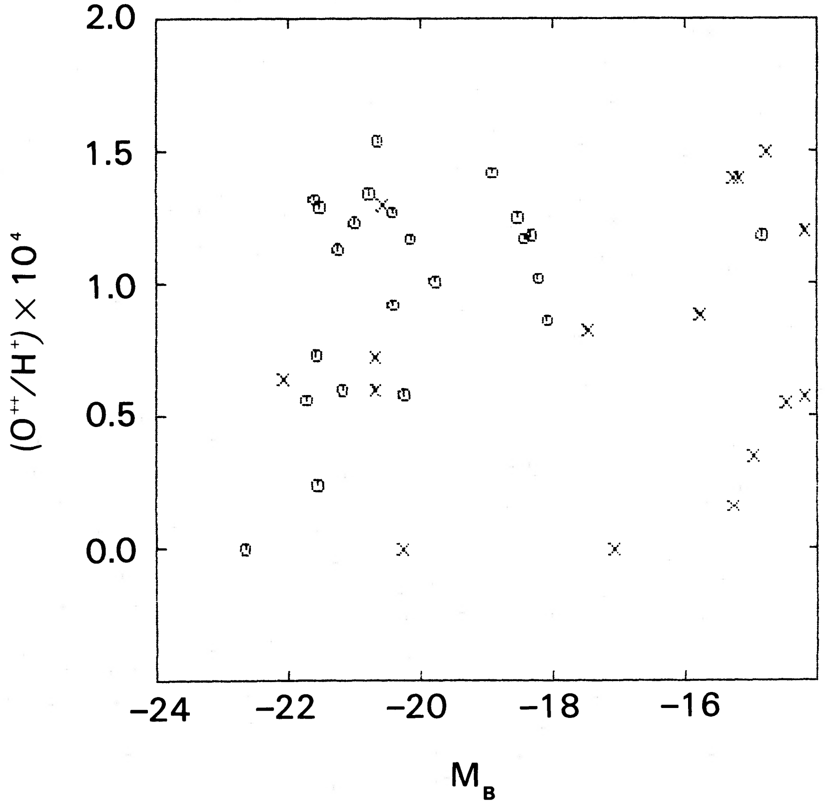

FIG. 6.—Same as Fig. 3, for O III abundance

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whether the emission lines arise exclusively in the nuclei, or whether the galaxies are morphologically early or late types. Our observations were obtained with the aperture centered on the galaxies, most of which appeared to be amorphous blobs on the viewing screen. The emission lines therefore arise in the inner regions of the galaxies. Our 4".3 diameter aperture corresponds to 0.1 kpc at $z = 0.001$, 1.2 kpc at $z = 0.01$, and 11 kpc at $z = 0.1$.

We have examined on the Palomar Sky Survey the area around the 20 galaxies for which the emission lines are excited by hot, young stars. The three objects in the Bootes void are all relatively isolated, with no nearby galaxies. The interacting hypothesis does not appear to be a viable one for these galaxies. For the 17 galaxies not in the void, one, CG 647, is in the same line of sight as another galaxy, and five are isolated. For the remaining 11, there are very faint objects within 1′ which cannot be definitely classified as stellar or diffuse and are not obviously interacting with the Case galaxies. Many of these objects are probably unrelated stars or galaxies in the same line of sight. In these cases, deeper imaging and/or redshifts are required to establish whether any of them are in fact interacting. The signal-to-noise ratio of our spectra is not high enough to distinguish the broad faint wings on the emission lines which signal the presence of nonstellar nuclear activity.

V. SUMMARY AND CONCLUSIONS

Spectra were obtained for 34 galaxies in the fourth list of the Case Low-Dispersion Northern Sky Survey (SP2). We have measured redshifts and emission-line strengths for 33 of the galaxies. Most of the galaxies have "H II region-like" spectra. The sample includes objects with a wide range of absolute magnitudes. Our data are combined with previously published redshifts to define the relationship between redshift and redshift classification given by SP2. We also determine the correlation between the estimate of the line strengths given by SP2 and the measured line strength for [O III] 4959 Å + 5007 Å.

Based on the relative line strengths for 20 of the galaxies, the excitation mechanism for the emission is hot O and B stars. Assuming the temperature and electron density of these galaxies are similar to those found in other "H II region-like" galaxies, the data suggest that the galaxies are underabundant in oxygen. A similar result has been found for other samples of "H II region-like" galaxies (French 1980). For most of the galaxies in the sample, we cannot distinguish between the scenarios (1) the galaxies are experiencing induced episodes of star formation, due perhaps to interaction with nearby galaxies, or the presence of nonstellar nuclear activity, or (2) they are young.

SP2 indicate that at least four of the galaxies have been detected by *IRAS*: CG 563, CG 698, CG 700, CG 722, and perhaps CG 752. Emission lines were observed in all of these galaxies, although the SP2 objective prism survey did not indicate the presence of lines in three of them. All five of the galaxies have absolute magnitudes $M_B = -21.5$ mag or brighter, with CG 698 the brightest at $M_B = -23.3$ mag. This result is consistent with the suggestion of Vader and Simon (1987) that there may be a deficiency of low-optical luminosity *IRAS* galaxies compared to the field galaxy luminosity function. The emission-line ratios for CG 563 and CG 752 indicate these galaxies are excited by hot, young stars, while the line ratios for CG 700 are ambiguous, as discussed previously. No conclusions can be drawn concerning the remaining two objects. Vader and Simon (1987) find essentially all of the *IRAS* galaxies they observed to have spectra characteristic of "H II region-like" galaxies.

Three of the galaxies, CG 474, CG 547, and CG 657, are located within the Bootes void. These objects are similar to those found previously in the void, bright galaxies with relatively strong emission lines. There are now published redshifts for eight galaxies within the void boundaries. This number is clearly a lower limit, since thus far search techniques have emphasized emission-line objects, and redshifts have not been obtained even for all of those. The emission-line strengths of these three all indicate the lines are excited by hot, young stars and the oxygen abundance in these galaxies may be low. All three of these galaxies appear isolated on the Palomar Sky Survey red prints. Since the interacting hypothesis is not viable for these objects, they are either undergoing episodes of star formation induced by nuclear activity or some other cause, or they are young.

The age of the galaxies in the void clearly has implications for our understanding of the physical conditions there. If all the galaxies in the void contain predominantly young stars, this may suggest that the void is a region of lower mass density than those parts of the universe where widespread star formation in galaxies occurred earlier. Alternatively, there may be other conditions required for star formation which are only recently present in the void.

The recent results of de Lapparent, Geller, and Huchra (1986) and others have revealed the frequent occurrence of voids in the large-scale distribution of galaxies. The existence of these voids and the density of matter within their boundaries restrict models of galaxy formation and the origin of the large-scale distribution of matter in the universe. Models invoking cold, dark matter (White *et al.* 1987), explosions to sweep out material (see Saarinen, Dekel, and Carr [1987] and references therein), or scenarios describing the large-scale structure as a remnant of the inflationary epoch of the universe (Kofman, Linde, and Einasto 1987) must not only account for the concentration of galaxies between the voids, but also for the low, but nonzero, density of galaxies within the voids.

Future work on the galaxies on the Bootes void includes at least two approaches. First, observations of the Case galaxies in the direction of the Bootes void, including those objects not identified as having emission lines, should be continued. These investigations will help to better determine the density of galaxies in the void, although selection effects due to magnitude and color are still severe. Second, spectra with improved signal-to-noise ratio are needed for galaxies located in the void, to better determine the emission-line strengths and abundances of the elements in these objects. These data will help define the physical conditions in the void, and the constraints they place on models of the large-scale structure of the universe.

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