SEARCHING FOR EMISSION-LINE GALAXIES

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Survey methods for finding emission-line galaxies are reviewed. Observational selection effects are investigated by comparing different surveys and the limitations of the different techniques are discussed. The advantages of Hα surveys for finding low luminosity galaxies and those with low excitation emission spectra are emphasized.

1. INTRODUCTION

Nearly all the emission lines that we see in the spectra of galaxies are formed in hot interstellar gas. Only a few cases are known where the lines formed in stellar atmospheres are strong enough to be seen in an integrated galaxy spectrum - e.g. He II 4686 from the bright but short-lived WR stars in the galaxy Tololo 3 (Kunth and Sargent 1981). Smith (1981) has recently reviewed the methods used to find broad-lined emission objects; we here concentrate on the techniques for finding the more common and quite diverse narrow-lined types. There are a variety of ways in which the gas can be excited in these galaxies, but the discovery problem in all cases is to recognize the emission spectrum in the presence of an (often strong) absorption spectrum that comes from the stars in the galaxy.

The most important emission lines, for discovery purposes, are [OII]3727, Hβ 4861, [OIII]4959,5007, Hα 6563 and [NII]6548,6584. Early photographic spectroscopy (e.g. Humason, Mayall and Sandage 1956) used blue sensitive plates on which Hβ and the [OIII] lines would only be seen if these lines were strong and of low redshift. Early estimates of the frequency of occurrence of emission lines (Mayall 1939, Humason 1947 given in Table 1) refer to the [OII]3727 line and showed that this line

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Table 1. Emission occurrence as function of galaxy type.

Galaxy type	Mayall n	(1939) %	Humason n	(1947) %	H.M.S. n	(1956)* %
E0-7	14	7	77	20	125	11
S0	-	-	48	46	91	30
Sa	10	15	37	78	71	37
Sb	20	52	46	87	93	61
Sc	27	56	25	88	69	64

*[Calculated from Humason, Mayall and Sandage (1956), Table I]

is more frequent in the later Hubble types with their larger ratio of young to old stars. Humason used only spectra that were sufficiently exposed to have shown the [OII] line and used only about half the number (n) of spectra listed in HMS Table 1; he thereby got a significantly higher frequency than is obtained from a simple analysis of the HMS data. Analysis based on a literature search is therefore likely to underestimate emission-line frequencies. Gisler's 1978 literature analysis of 1316 galaxies with velocities less than 15,000 km s^{-1} (obtained with spectral dispersions higher than 500 Å mm^{-1}) is important because it showed the difference in frequency for galaxies in clusters and in the field; for E, E-S0 types he found a frequency of 26% in the field but 0% in clusters, while for Sc and I types he found 88% in the field and 75% in dense clusters.

[OII]3727 is a good indicator of ionized gas in E galaxies because their continua are relatively weak in the ultraviolet. In later types of galaxy, the Hα + [NII] group of lines becomes a rival indicator (see the discussion in Mayall 1956) but historically most surveys for emission-line galaxies have been made in the blue where the photographic plates are fastest. Recently, Keel (1983) searched for Hα + [NII] in the nuclei of an optically complete sample of 93 spirals with B_T < 12.0. All showed emission (five were Seyferts); his high spatial resolution (400-800 pc) allowed the [NII]6584 to be detected even when the Hα emission was swamped with the underlying absorption. Besides such compact sources of emission, there are various diffuse components in later type galaxies (Georgelin, Georgelin and Sivan 1979) that can contribute significantly to an integrated spectrum. Emission in elliptical galaxies is also complex. Gisler and Butcher (1980) searched 54 E type galaxies for Hα with the Kitt Peak video camera using interference filters and found evidence for emission in 40 of them. Only 6 of these 40 had emission in unresolved cores; the remainder had emission that was to some extent distributed - in a few cases completely so.

Clearly survey techniques must be tailored to the type of galaxy that interests us; no universal method will work on all types. For some purposes (e.g. identifying very rare galaxies or studying galaxies for evolutionary effects where a significant look-back time is needed), we are forced to work with galaxies that are so distant that little structural information can be obtained about them. More generally, our understanding of survey material is greatly enhanced if structural information is available. Consider therefore, as a working limit, a galaxy with a diameter (at $\mu_B = 25$) of 5 arcsec; for non-Seyfert Markarian galaxies (mean $\mu_B \sim 21$) this corresponds to apparent magnitude B = 17.75. For the best ground-based observations, its image will contain about 50 pixels, while from space (with adequate signal-to-noise) one might achieve 2000. According to Morgan, Kayser and White (1975), the classification of galaxies requires about 100 pixels. If we use Huchra's empirical diameter vs. M_B relation (which assumes $H_o = 50$ km s^{-1} Mpc^{-1}), we find the following limiting redshifts to go with this resolution: 44,668 km s^{-1} at $M_B = -22$, 17,783 km s^{-1} at $M_B = -20$, 7079 km s^{-1} at $M_B = -18$, 2818 km s^{-1} at $M_B = -16$ and 1122 km s^{-1} at $M_B = -14$. The rare but intrinsically bright active galaxies such as Seyfert type 1, will be somewhat brighter for their diameter than these non-Seyferts. To study these, we need to survey a large volume of space and therefore need a survey with a large redshift range. On the other hand, only a small redshift range will give the spatial resolution needed to survey for the more numerous and diverse types of intrinsically faint galaxies.

2. FINDING EMISSION-LINE GALAXIES BY APPEARANCE

The more active and luminous emission-line galaxies look compact and so compactness has been used as a criterion for finding them. Out of 141 of the bluer Zwicky compact galaxies, Sargent (1970) found 10 Seyferts, 53 with sharp-lined emission, 60 with absorption lines and 3 with continuous spectra. Rodgers, Peterson and Harding (1978) observed compact galaxies from Zwicky's IX list; 24 out of 30 of the bluer galaxies showed emission but only 3 out of 27 of the red ones. Samples of Arakelian's (1975) high surface brightness galaxies (considered to be 50% E - SO types and 25% Sa types) were observed by Arakelian, Dibai and Esipov (1975) and Doroshenko and Terebizh (1975). They found that more than half showed Balmer emission. Fairall (1983 and references therein) selected high surface brightness galaxies with sharp boundaries (to avoid E types) from the ESO Quick Blue and the SRC IIIa-J surveys; 21% of these galaxies show emission.

Table 2. Surveys of Compact Galaxies

Survey	Percentage with redshifts >10,000 km s^{-1}	
	Emission lines	Absorption lines only
Sargent (1970)	25%	60%
Arakelian et al. (1975)	42%	-
Doroshenko et al. (1975)	2%	-
Fairall (1977-1983)	20%	51%
Rodgers et al. (1978)	28%	55%

Compact galaxies are a heterogeneous group but the bluer ones do contain a fair proportion of emission-line galaxies. Table 2 compares

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the percentages of the galaxies in these surveys that have redshifts greater than 10,000 km s^{-1} ; there are less than half as many emission-line galaxies in this redshift range as those with absorption spectra. Most of the emission-line galaxies are narrow-lined ones with only moderate luminosities and one cannot expect to select them by appearance at redshifts greater than 10,000 km s^{-1} as we saw above. The case is quite different for the intrinsically bright broad-lined galaxies; 74% of those found in these surveys have redshifts of more than 10,000 km s^{-1} which is very comparable with the percentage of Markarian galaxies in this redshift range that are Seyfert 1 galaxies and which are purely color-selected.

It is believed that interacting galaxies can induce star-formation and hence be a source of emission-lines from the gas near hot, young stars. It is therefore very interesting that in a spectroscopic survey of 43 galaxies from Verontsov-Velyaminov's 2nd Atlas of interacting galaxies (1977), Barbieri et al. (1979) found 48% definitely and 24% possibly showed emission. My own experience of emission-line galaxies is that amongst the narrow-lined less luminous types, they more often than not have rather irregular images - presumably because much of their light comes from either (a) unresolved multiple systems or (b) young and therefore not dynamically relaxed stellar components.

3. FINDING EMISSION-LINE GALAXIES BY COLOR

The correlation of uv-excess with the presence of emission lines is well known (c.f. The discovery of a planetary nebula in M15 on an ultraviolet plate by Pease 1928). Haro (1956) showed that emission-line galaxies could be found by comparing blue, visual and uv images on a single Schmidt plate and the technique has been used in a variety of ways since (see Kinman and Hintzen 1981 for references). An example from a current survey by Bushouse and Gallagher is shown in Fig. 2. Galaxies with redshifts up to the range 30,000 - 40,000 km s^{-1} have been found this way. A disadvantage is the limited accuracy that can be obtained in estimating colors by visual inspection; also the poorer uv images of single-element corrector Schmidt telescopes can be a problem with fainter images (Savage 1983). A large current survey of this type is that using U, G and R colors with 103a-E emulsion on the Kiso 1.05-m Schmidt (Takase 1980, 1983) where, so far, over 3000 uv-excess galaxies have been found in 1625 square degrees to a limiting photographic magnitude of 17-18. Spectra of 30 of these showed that 80% were emission-line galaxies.

Color can also be judged from low dispersion objective-prism images. The largest survey of this kind is Markarian's using a 1.5° prism on the 1-m Byurakan Schmidt (IIa-F emulsion, 2500 Å mm^{-1} at Hβ); some 1399 galaxies with strong uv continua had been found up to their most recent paper (Markarian, Lipovetskii and Stepanian, 1979). A similar program with the same equipment but a wider range of emulsions is reported by Kazarian (1979). Some 11% of Markarian galaxies are Seyferts according to Huchra and Sargent (1976). Huchra (1977) has studied some 200 non-Seyfert Markarian galaxies in some detail: only 4% of these have redshifts that exceed 10,000 km s^{-1}. A subset of about 100 non-Seyfert Markarian galaxies with bright nuclei (so-called "starburst" nuclei) have recently been studied by Balzano (1983) and these are also relatively nearby objects: 66% have redshifts of less than 5,000 km s^{-1} while only 9% have redshifts greater than 10,000 km s^{-1}. The majority have rather low-ionization emission spectra that are characteristic of the photoionization of gas by the radiation from hot stars. These various color surveys differ both by their color criterion and by their limiting magnitude. Thus Haro galaxies correspond roughly to that two thirds of the Markarian galaxies that has the greatest uv-excess. The Kiso survey goes deeper than the Markarian survey (inter alia) and discovers about ten times more galaxies per unit area of sky.

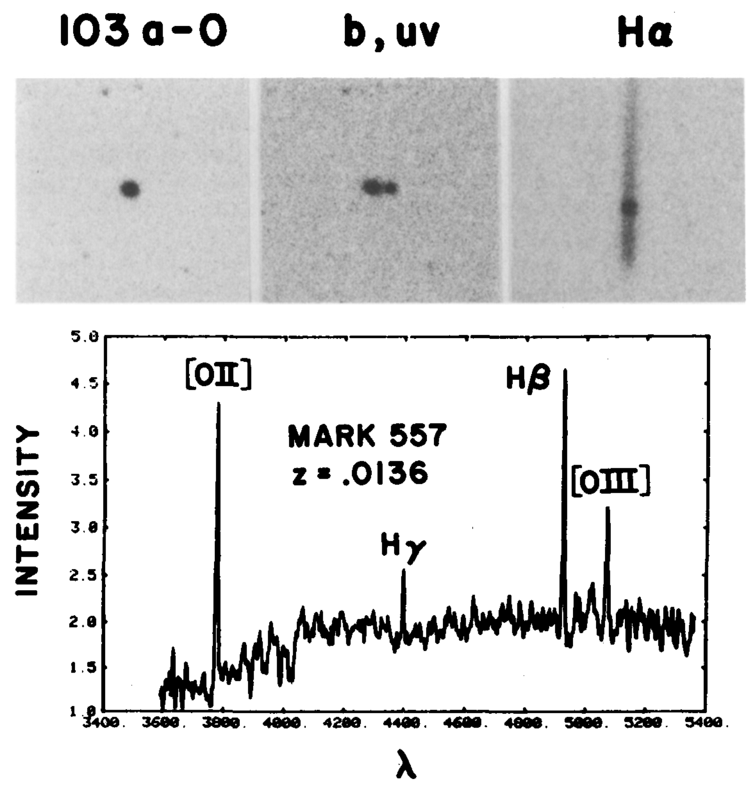

Fig. 1. Markarian 557: (top left) 10-min. unfiltered 103a-O, Palomar 1.2-m Schmidt. (top center) blue-uv, Bolton and Wall (1970). (top right) 180-min. Hα, 0.6-m CTIO Curtis Schmidt (below) 16-min blue scan, IIDS, Kitt Peak 2.1-m telescope.

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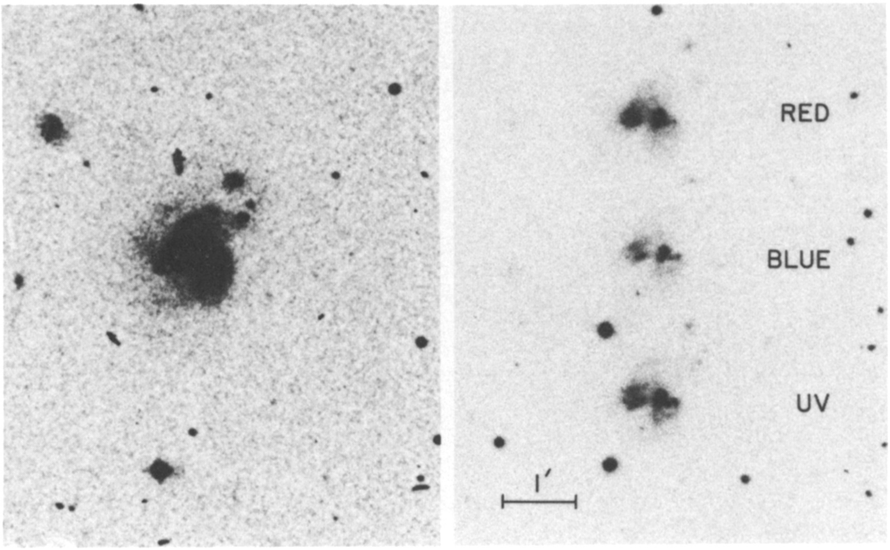

Fig. 2. Arp 299: (left) Palomar Blue Sky Survey to same scale as (right) multiple exp., red (30-min., RG610), blue (30-min., Wr47A), uv (60-min., UG2), IIIa-F, 0.6-m Burrell Schmidt.

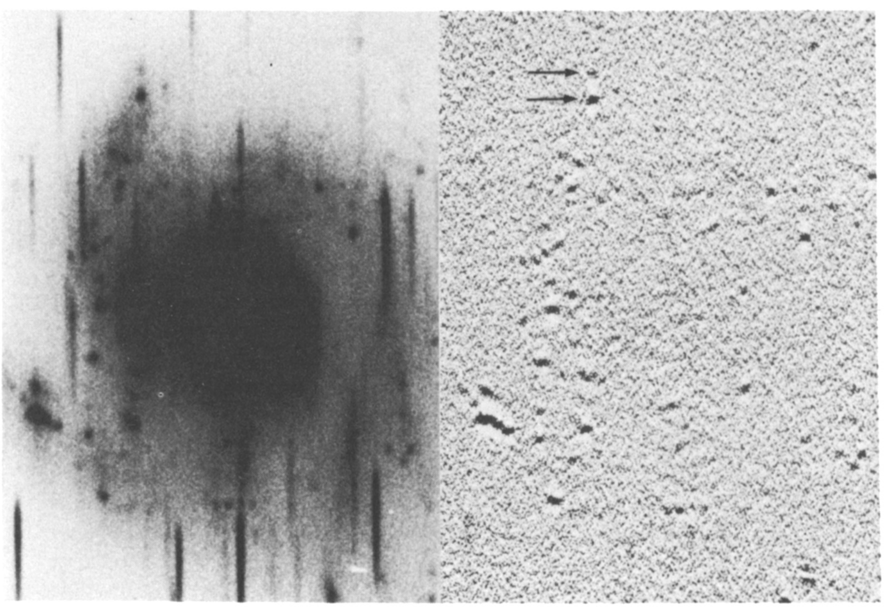

Fig. 3. M 101: (left) 180-min. Hα exp. with 0.6-m Burrell Schmidt. (right) same field after subtraction of field smoothed along dispersion so that only the emission lines remain. The arrows show Hα and [SII] for one H II region.

Table 3. Properties of Galaxies illustrated in Fig. 4.

Object redshift[a]	B B−V U−B	λ4000 break[b]	Mich. color[c]	[OIII]+Hβ flux[d]	 EW[e] line str.[f]	[OII] flux[d]	 EW[e] line str.[f]
ZWG 384.055 +8,295	15.37 +0.77 +0.34	0.8	-	0.1	2	0.1	4
MICH III-295 +5,476	16.99 +0.41 −0.23	1.0	2:	3.2	332 M,m	0.8	75 M,w−
MICH III-296 +5,400	16.72 +0.52 −0.09	0.9	2	3.7	78 W,w	2.2	57 W,w−
HARO 0049.5+01 +13,010	17.68 +0.46 −0.18	0.8	-	0.4	23 confused with star to South on thin prism plate	0.4	+32
MICH III-283 +4,630	17.29 +0.53 −0.23	1.0	2	3.9	219 M,m	1.8	115 M,w
MICH III-286 +1,670	15.31 +0.61 −0.12	0.9	1−2	1.6	20 M,w	1.8	38 W,w−

(a) galactocentric redshift in km s^{-1}.
(b) Ratio: Fλ(3800−4000)/Fλ(4000−4200) at rest wavelength.
(c) Color from Michigan list III: 1 = blue, 3 = red.
(d) Flux in units of 10^{-14} erg cm^{-2} s^{-1}.
(e) Equivalent width in Å.
(f) Line strength on thin prism plate: M = medium, W = weak from Michigan list III; m = medium, w = weak, w− = marginal on author's thin prism plate (90-min., IIIa-J), CTIO Curtis Schmidt.

All plates in Fig. 4 are 3' square, North to top and East to left. The blue-uv exposures were 8 min. with GG 13 for blue and 60 min. with UG 1 for the uv image which is 12 arc sec to the West on a Palomar 1.2-m Schmidt plate by Bolton and Wall (1970): the images would be equally strong for U−B = −0.4, The Hα exposures were 180-min on IIIa-F with an RG2 filter and the 10° prism combination of the CTIO Curtis Schmidt.

4. FINDING EMISSION-LINE GALAXIES DIRECTLY BY THEIR LINES

The most unambiguous way to discover emission-line galaxies is directly from objective-prism spectra of adequate resolution. A curious reluctance to do this until quite recently seems to have stemmed from unduly conservative estimates based on experience with absorption-line spectra (Minkowski 1972). It became apparent in the early 1970's, that about 20% of Markarian's blue galaxies showed emission lines on spectra with a dispersion as low as 2500 Å mm^{-1} at Hβ. This induced Smith (1975)

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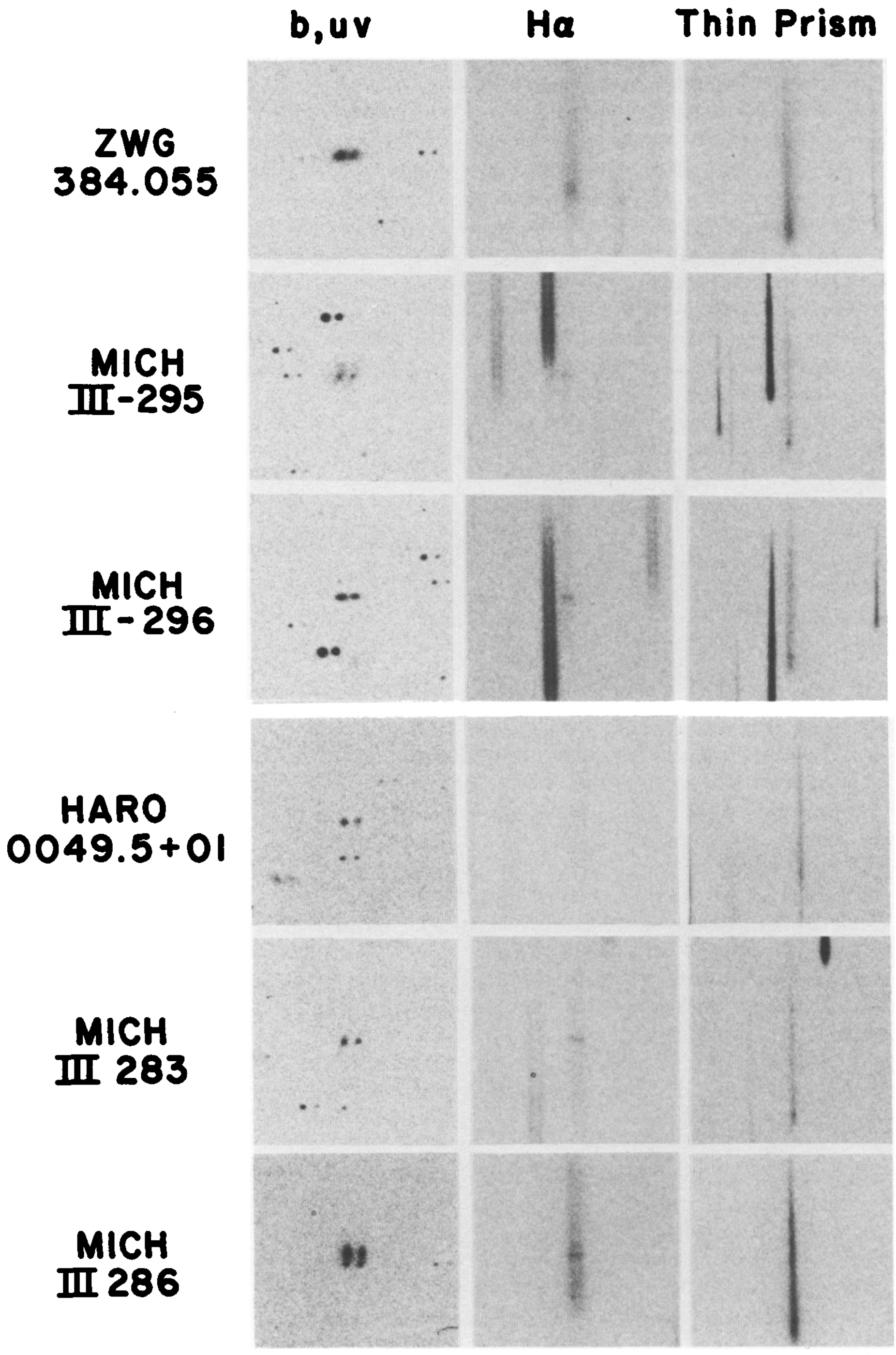

Fig. 4. Comparison of three techniques for finding emission-line galaxies. For details, see text and Table 3.

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Table 4. Distribution of [OIII]/Hβ ratio for diferent surveys.

	Range in [OIII]/Hβ					
	No Hβ	0 - 3	3 - 5	5 - 7	>7	Survey
Number per 100 sq. degrees	10.7	31.2	6.5	1.6	1.6	Kinman (Hα)
	0	4.4	6.4	2.0	3.2	Wasilewski
Percentage	21	60	13	3	3	Kinman (Hα)
	24	46	18	9	2	Balzano
	16	42	33	7	2	Huchra
	18	20	20	20	22	Mich.-Tololo
	0	27	40	13	19	Wasilewski

to start a survey to detect emission-line galaxies and QSO by their lines at a somewhat higher spectral resolution (1740 Å mm^{-1} at Hβ on IIIa-J) using the uv-transmitting 1.8 "thin" prism (Blanco 1974) on the 0.6-m CTIO Curtis Schmidt. He found that both [OII] and the [OIII] - Hβ group of lines could be detected in a 90-minute exposure with a blue continuum magnitude of 17.5-18.0. Several hundred QSO and emission-line galaxies have now been detected in the South galactic cap by this method in the Michigan-Tololo survey (MacAlpine and Williams 1981 and references therein). A similar survey is being carried out in the North using the Burrell Schmidt (Pesch and Sanduleak 1983); their discovery rate of blue and/or emission-line candidates is about 0.5 per sq. degree or about 5 times that of the Markarian survey. Lewis (1983) has taken spectra of 83 of the Michigan-Tololo (MT) galaxies; 69 (83%) of them showed emission lines and of these 35% had redshifts exceeding 10,000 km s^{-1}. A small survey at comparable dispersion (2400 Å mm^{-1} at Hγ) has been made on IIIa-F emulsion with the 1.24-m UK Schmidt by Kunth, Sargent and Kowal (1981). They observed the same field containing Zwicky galaxies that was observed by Rodgers et al. (1978) and found some 23 emission-line galaxies (30% with redshifts greater than 10,000 km s^{-1}) but only two of these were in common with those found by Rodgers et al.

At higher dispersions, the emission-line visibility improves as the continuum is spread out (McCarthy and Treanor 1970, Kinman 1979) although the limiting magnitude of the continuum brightens. Wasilewski (1983) has undertaken such a survey of 825 sq. degrees of the North galactic cap. He used the 4° prism on the Case Burrell Schmidt (400 Å mm^{-1} at Hβ), and with 60 minute exposures on IIIa-J emulsion, discovered 96 emission-line galaxy candidates. His spectroscopic analysis gave redshifts for two thirds of these; only 10% have redshifts greater than 10,000 km s^{-1} but 10-15% are Seyferts. Only about 20% of the Markarian galaxies in his field were rediscovered as emission-line galaxies in this survey, however, possibly because of the low ultra-violet transmission of the 4° prism.

Finally, Kinman (1979, 1983) has undertaken a higher dispersion survey for field emission-line galaxies in Hα. The aim is to achieve a high completeness for nearby (particularly dwarf) galaxies at the expense of detecting the more distant and luminous ones. Both Curtis and Burrell 0.6-m Schmidts have been used with a 10° prism or prism-combination using IIIa-F emulsion and an RG2 filter to limit the waveband to 6400-6850 Å (400 Å mm^{-1} at Hα). Exposures are limited to 180-minutes, not by sky brightness, but by telescope stability and field rotation effects that come from guiding some 6° from the field center. Even though the sensitivity cut-off of the IIIa-F emulsion excludes galaxies with redshifts greater than 12,000 km s^{-1}, over 0.5 galaxies per sq. degree are discovered with this technique and a larger number of the redder Seyfert 2 galaxies are found per unit area of sky than in the Markarian survey. A similar Hα survey is currently being used by Moss and Whittle (1983) to study the nearer rich Abell clusters of galaxies.

5. COMPARISONS OF DIFFERENT SURVEYS

The uneven distribution of galaxies on scales of 10 - 100 Mpc limits the accuracy with which one can compare surveys made in different parts of the sky. Nevertheless it is clear that the compact galaxy criterion, the Michigan-Tololo technique and the blue-uv Haro method pick up the largest percentages ($\gtrsim$ 25%) of distant (redshift >10,000 km s^{-1}) galaxies. The two high dispersion surveys were clearly poor in this respect and the Markarian Survey is intermediate. The overall density (candidates per sq. degree) varies from 0.1 for the Markarian Survey to ten times greater for the Kiso survey. It is clear that besides the redshift cutoff and the limiting magnitude, other factors are involved. Thus the Rodgers et al. and Kunth et al. surveys of the same field have about the same overall density and fraction of distant galaxies, but have only two galaxies in common. As another example, a 1.4 x 0.9 degree field near the Abell clusters 2197-2199 contains 19 Kiso uv-excess galaxies and 14 Hα galaxies but only 11 of these are common to both surveys. All surveys have completeness problems in the sense that a repeat plate or a repeat inspection of the same plate does not give identical results, but little mention is made of this effect. An exception is the Palomar-Green survey for bright quasars (Green 1976); some 47% of this blue-uv survey of 10,714 sq. degrees of sky with the 0.45-m Palomar Schmidt was observed twice. The two side-by-side images on II-a-O film were automatically compared with a PDS scanner: rms errors for B and for U-B colors were estimated to be ±0.27 and ± 0.24 mag. respectively. Comparison of the results for the two independent exposures of the same field showed that on the average 61% of the uv-excess objects were detected on each exposure (Green, 1983). This may be compared with Plaut's (1966) estimate that visual comparison of two 103a-O plates taken with the 1.2-m Palomar Schmidt leads to a 40-50% chance of detecting a 1 mag. difference at 15th magnitude and only about half this chance at 18th magnitude. Clearly uncorrected results from single-pass surveys are subject to sizeable errors and the actual detection limits in any one field are likely to vary from the mean. This is illustrated in Fig. 4 and Table 3 where it is seen that there is some variation in detail in the various estimates of line strengths given in the M-T survey and from a plate taken in good seeing by the author and the actual measured fluxes and equivalent widths for these objects. It is also apparent that the line strengths are a function of the equivalent widths as well as the line fluxes and that the visibility of lines with equivalent widths less than ~30Å is rather marginal. Fig. 4 illustrates both the generalities and singularities that one finds by comparing different survey data. ZWG 384.055 was understandably only found on the Hα survey because its blue emission lines are quite weak and its U-B excess is confined to its core. Rather surprisingly Mich III-295 was missed by Haro because it has a bigger uv-excess than Mich III-296 which he did detect only a few arc minutes away. Haro 0049.5+01 was not detected in Hα because its redshift is too large and not by the M-T survey because of confusion with the star (PHL 6780) to the south and because its lines are probably too weak for the M-T technique anyway.

Table 4 gives the distribution of the excitation parameter (given by the [OIII]4959,5007/Hβ ratio) in different surveys. This shows that the two high dispersion surveys both contain about the same number of the higher excitation ([OIII]/Hβ >3) galaxies but that the blue Wasilewski survey picks out far fewer low excitation objects. The Markarian survey (exemplified by Balzano's "star-burst" subset and Huchra's non-Seyfert subset) gives a similar distribution to that of the nearby galaxies of the Hα survey, but the M-T survey has a higher percentage of high excitation galaxies. Presumably this is because Hα/Hβ>3, and so the blue emission lines are only more conspicuous than Hα for the high excitation objects. Lewis (1983) has, however, discovered some quite low excitation [OIII]/Hβ~0.3 galaxies in the M-T survey with large Hα/Hβ ratios and with [NII]6584 comparable to Hα; he calls these galaxies weak oxygen red (WOR) types. Mark 557 (Fig. 1) may belong to this class. Although reddish [(B-V)=+0.7 and (U-B)=+0.07 in a 24 arcsec aperture], it has a bluer nucleus with [NII]6584/Hα~0.5 and Hα +[NII]/Hβ~13; its [OI]6300 is weak so it is not a LINER type (Heckman 1980). Its strongest blue emission line ([OII]3727) only has an EW of 20Å, so it would be a difficult object for a blue emission-line survey even though it is quite bright (V=14.4). It is hoped that more of these objects will be found in the Hα survey. The galaxy with the lowest known oxygen abundance (I Zw 18) has an [OIII]/Hβ ratio of ~3, galaxies with a much lower oxygen abundance than this could appear to have a lower excitation ratio and have stronger Hα than their blue emission; they may be expected to have a strong uv-excess.

Finally, it is of interest to note the ratio of galaxies with emission to the total number in the field. This data is not often given but is an aid to interpreting the quality of a survey. Takase (1980) finds that the ratio of Kiso uv-excess galaxies to all galaxies is 0.25 in the field but is smaller in clusters; this agrees with Gisler (1978). Table 5 shows the fraction of Zwicky galaxies that have emission in a small sample field of the Hα survey. Most of the nearby and brighter ones show emission because their individual H II regions are resolved and bright enough to be detected by the survey (flux in Hα $\gtrsim 2 \times 10^{-14}$ erg cm^{-2} s^{-1}). For fainter galaxies, the number drops

Table 5: Emission in a sample of Zwicky Galaxies (ZWG)*

Range in m_Z :	12.9	13.0-13.9	14.0-14.9	15.0-15.6	15.7
No. of ZWG :	6	8	22	44	30
No. with emission :	5	4	8	7	2

*Taken from 30 sq. deg. field near NGC 1023

rapidly and for the Zwicky galaxies as a whole, the fraction is ~24% - very similar to that found for the Kiso galaxies.

6. FURTHER COMMENTS

A variety of techniques for finding emission-line galaxies is needed because each can be used to check on the observational selection effects that are present in the others. Some surveys are more effective than others for finding certain classes of galaxy. Thus the M-T and blue compact galaxy surveys are best for finding broad-lined luminous galaxies while the Hα survey is probably the best for finding nearby low-ionization galaxies. New techniques (e.g. the detection of [OII]3727 on uv-filtered high dispersion objective-prism spectra by Moss 1983) are welcome. The [SIII]9069,9531 lines need attention. They can be stronger than Hα if the visual extinction exceeds 3 magnitudes (Hippelein and Munch 1981) and so could perhaps be used to look for Seyfert 1 galaxies (particularly when edge-on).

Most surveys are based on the visual inspection of plates, but more consistent results should be obtainable by automatic means. Particular care is needed however to choose a simple search algorithm. Likely possibilities are uv-excess from a two-color plate or the λ4000 break in an objective prism spectrum or a single strong line such as Hα. With the microphotometry and digitization of plates, one can use simple ways of enhancing the visibility of emission lines as shown in Fig. 3. The field is smoothed along the direction of its dispersion and then this is subtracted from the original field. The extended background is scarcely changed by the smoothing and so this is removed and the emission-lines (which are sharp) remain.

Surveys must be related to each other. Thus work on nearby bright galaxies (Keel 1983, Kennicutt and Kent 1983) needs to be quantitatively related to the spectroscopy of wide-field surveys. At the other extreme, work on distant galaxies (which usually refers to the entire image of the galaxy) has to be compared with work on nearby galaxies at comparable spatial resolution. There is a steep rise in counts of faint galaxies in the j passband at j ~20. Hamilton (1982, 1983) has been trying to explore the nature of these faint galaxies by working on a somewhat brighter sample of uv-excess galaxies. He finds a redshift distribution that peaks at 10,500 km s^{-1} but with a long tail to higher redshifts. Clearly many are quite nearby (and his data agree with an extrapolation of the number found in the Markarian survey), but he only found one Seyfert galaxy out of a sample of sixty. This is an important area of work that will be helped when we know more about the K-terms for these galaxies.

We certainly need more surveys, but there is perhaps an even more pressing need for the spectroscopic and photometric follow-up programs that give value to a survey. Less than half Markarian's galaxies have been observed spectroscopically and still fewer spectrophotometrically so that accurate line ratios are known. Generally this spectrophotometry is not adequate to give information about important faint lines such as [OIII]4386 or [OI]6300. Complexities such as the spectral differences between HII regions and inter HII regions (Hunter 1983) are only just becoming appreciated. This spectroscopic work is essential if the older surveys are to be properly exploited and newer ones appropriately planned. Telescope time is scarce and we should look to ways in which the published results of a wide-field survey can be made attractive to spectroscopists and photometrists. At least part of any survey should be more than one-pass so that completeness estimates can be realistic. Finally one can never emphasize too much the need for good positions (and if possible offsets) and good finding charts.

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