EMISSION-LINE OBJECTS FROM A PRELIMINARY UKST OBJECTIVE PRISM SURVEY

M. Kalafi

Department of Physics, Faculty of Science, University of Tabriz, Islamic Republic of Iran A. SAVAGE
Royal Observatory, Blacford Hill, Edinburgh EH8 3HJ, Scotland

Abstract

A visual search has been made of four fields using United Kingdom 1.2m Schmidt Objective Prism plates with a reciprocal dispersion of 1180 Å/mm at Hβ. Such plate material is ideally suited to searches for emission-line galaxies. We present a catalogue of 53 emission-line objects, which comprises 45 galaxies, where individual HII regions are resolved in 16 bright galaxies; 8 are emission line stellar objects, including one low and one high redshift quasar. One field has a surface density of emission-line galaxies a factor of four higher than any of the other three fields, but the same density of galaxies with resolved HII regions.

1. Introduction

The commissioning of the medium dispersion prism (1180 Å/mm at Hβ) provided an opportunity to try a new method of searching for bright low redshift quasars ($B < 16.0$, $z < 2.0$) by virtue of their emission lines. This approach is needed, in addition to normal search techniques, since some low redshift quasars do not exhibit a strong ultraviolet excess [21]. This may imply that the northern Palomar-Green (PG) bright quasar survey [13] may be incomplete in certain redshift ranges. Indeed Schmidt and Green (1983) themselves draw attention to this point and suggest that it may lead to a 15% incompleteness. If such a selection effect could be shown to exist, at a higher level, then it would go some way in explaining the steep slope of the number counts at these bright magnitudes. Pilot plates for this investigation were initially requested for areas where more than one PG quasar would be recorded on one UKST plate. The original test plates were of an exceptionally high quality and many strong narrow-lined emission objects were found. Comparison with direct plate material confirmed these not as stellar but as galaxies.

With this change of emphasis it is important to recognise the strongest emission lines seen in galaxies. These are [OII] 3727, Hβ 4861, [OIII] 4959, 5007 and the blend of Hα 6563 and [NII] 6548, 6584. The relative strengths of the principle emission features change with galaxy type. [OII] is a good indicator of ionised gas in E galaxies, because their continua are relatively weak in the uv. In later types of galaxies, the Hα and [NII] groups of lines become a rival indicator. These constraints may now determine not only the choice of dispersion but also the emulsion. Once such emission-line galaxies have been found, subsequent work with large telescopes shows that these objects exhibit a rich variety of physical properties [15], which allows investigations into physical conditions, chemical abundances and rates of star formation and the evaluation of evidence for and against evolutionary relationships among different classes of objects. Thus this preliminary study was extended to cover four fields to establish whether this is a viable method for a southern survey for active galaxies compared with similar surveys by Fairall

Keywords: Emission-fine Objects, Active galaxies

[1] and MacAlpine and Lewis [6].

Additionally the wealth of plate data which exists for these four fields provides a sound basis for a more systematic investigation than the visual search for emission-line objects described here. The survey quality J and R plates which exist for each of these fields have been scanned by the COSMOS measuring machine [18] and a complete magnitude limited sample of galaxies is being compiled. The prism plate spectra are being analysed using the Joyce-Loebl microdensitometer to determine absorption-line redshifts for the early type galaxies in this complete sample and to detect weaker emission features than can be seen visually. The main aim of this paper is to draw attention to the suitability of the medium dispersion prism to emission line galaxy surveys in contrast to the low dispersion prism which is better suited to quasar surveys. A secondary aim is to draw attention to the anomalous field.

2. Observational material

The original field (F718 1300-1000) used for this investigation was selected because it contained two PG bright quasars. A variety of plate material was taken because at that time we were not sure of the limiting magnitude of the prism plates for a given exposure time, nor whether we would need widened plate material to detect emission lines. Fortuitously similar dispersion material had already been acquired on IIIa-F emulsion allowing us to extend this preliminary investigation to include a comparison of the IIIa-F and IIIa-J emulsions.

A preliminary visual inspection of this plate material produced 40 emission-line objects from the widened IIIa-J plate, about 20 of which were also visible on the IIIa-F plate. This investigation indicated that dispersion 3 widened spectra on IIIa-J emulsion produced a surface density of emission galaxies a factor of 5 higher, in exposure times three times shorter than the southern survey undertaken on the Tololo Schmidt [6].

However, there were some unanswered questions. We were still not very sure of the limiting magnitudes of the plates. Also the number of emission galaxies found on the IIIa-J plate was far higher than that found by independent searches on other IIIa-F plate material [7]. Additionally a pilot project was initiated on the UKST to duplicate the PG bright uvx survey in the Southern Hemisphere, using direct B and U plates. As most of the objects found in this type of survey would be white dwarfs we also needed to know if this prism material could be used to distingush white dwarf spectra from other stellar spectra.

Consequently, plate material was acquired in three further fields. Field 197 (0200-50) and the other well-studied Bolton-Savage Field 2203-1855 since both these fields have photoelectric sequences [20,9] and have known bright quasars [11], with substantial existing data banks of plate material. The third field F345 2232-40 has also been searched for quasars [8,12] but has in addition been the subject of a search for bright uvx stars by Kelly and Kilkenny [2] and contains a number of classified white dwarf stars.

Details of all the plate material used in this investigation are given in Table 1. For each field both the widened IIIa-J and unwidened IIIa-F plate were searched visually for emission-line objects by each one of the authors independently and dispersion 1 plates used as a further check. All objects found were then inspected on the direct plate material to determine the morphology. In some cases only emission lines were visible on the prism material, continuum was too faint to be detected. These objects are catalogued in Table 2, and a description of this catalogue appears in Section 3

3. Catalogue of objects

Table 2 is a catalogue of all the emission-line objects found in the four fields. Column 1 contains our object name following the recommended IAU system. Columns 2 and 3 contain the 1950.0 optical positions which are accurate to better than 2 arcsec in each coordinate. These were measured on the ROE Packman machine following standard procedures and reduced using the STARLINK VAX standard CHART package utilising only PERTH 70 standard stars. All the objects from one plate were measured at once relative to the standard stars and the overall sky residuals from about twenty reference stars were about 2 arcsecs rms. Galaxies have been morphologically classified on the extended De Vaucouleurs system in 1959 by Dr Robert J. Smyth except for the fainter galaxies which have been classified on the coarser scale of Kirshner et al. [4]. These classifications are detailed in Column 4. The magnitudes, Column 5, for the early-type bright galaxies have been estimated using a fly-spanking technique comparing the images of galaxies with photoelectric photometry in Abell 1060 [16,17] from a long exposure J plate with the unknown galaxy images on similar plate material. Magnitudes could not be estimated for the late

Table 1
UKST plate material used in this investigation

Plate Number	Field	RA 1950.0	Dec	Exp mins	Width µm	Emulsion & filter
·J 1891	197	02 00 00	-50 00 00	60	-	IIIa-J+395
UJ 2618P (1)	"	"	"	60	50	IIIa-J
UJ 9615P (3)	"	"	"	45	120	IIIa-J
YR 8064P (3)	"	"	"	35	40	IIIa-F+455
R 7525	718	13 00 00	-10 00 00	25	-	IIIa-F+630
J 9187	"	"	"	60	-	IIIa-J+395
UJ 9035P (3)	"	"	"	10	25	IIIa-J
UJ 9036P (3)	"	"	"	30	275	IIIa-J
YR 7832P (3)	"	"	"	15	35	IIIa-F+455
J 1749	Savage N1	22 03 00	-18 55 00	60	-	IIIa-J+395
UJ 6526P (1)	"	"	"	45	25	IIIa-J
UJ 9609P (3)	"	"	"	45	120	IIIa-J
YR 8061P (3)	"	"	"	25	25	IIIa-F+455
J 3585	345	22 32 00	-40 00 00	70	-	IIIa-J+395
UJ 4512P (1)	"	"	"	60	30	IIIa-J
UJ 9618P (3)	"	"	"	45	120	IIIa-J
VR8052P (3)	"	"	"	40	25	IIIA-F+495

spirals and irregulars. Catalogued magnitudes have been used from the Second Reference Catalogue of Bright Galaxies [22] or the ESO/Uppsala Survey (1982) where they are given. For the stellar objects and fainter compact galaxies magnitudes have again been estimated using a fly-spanking technique but this time using the stellar photoelectric sequence of Tritton et al. [20]. The notes and tables contain additional information, alternative names if found in the NGC catalogue and an estimate of the relative strengths of the principle emission lines [OII] 3727, [OIII] 5007, 4959, Hβ 4861 and Hα 6563. The catalogues of Fairall [1] and MacAlpine and Lewes [6] have been searched but the only region of overlap is that of a catalogue of Fairall; none of our objects in this area had been found by him.

4. Results

a) The limiting magnitude

The limiting magnitude for stellar objects on the widened, exposure IIIa-J prism plates, was determined in two ways. Firstly, the photoelectric sequences of Tritton et al. [20] and Savage [12] were inspected on the relevant plate material for the stars which just had a spectrum visible. Secondly thirty confirmed quasars from the same two fields with B magnitudes brighter than 18.5 were checked on the plates. The faintest sequence stars visible were B ~ 18.5 and quasars with B magnitudes brighter than 18.0 were easily visible. The limiting magnitude is about B ~ 18.25 for stellar objects.

b) Detectability of emission line quasars

In the field where there are two PG bright quasars both are easily visible on all plates showing very obvious emission lines and would have been detected in a visual search, however both of these quasars are brighter than B=16.0 and have redshifts $z < 0.3$. For the two fields where there are the thirty confirmed quasars with B magnitudes brighter than 18.5 and with redshifts ranging up to 2.555 the results are very disappointing but not unexpected given the broad width of emission lines at $z \sim 2.0$. Only 19 of the quasars were visible and of those only 6 had discernable but extremely broad emission features. None were rediscovered in the visual search for emission line objects. Given the very low surface density of the bright quasars [0.013/ square degree to B=16.0; half a quasar per UKST plate] and the difficulty in detecting the broad emission features in the fainter higher redshift quasars this prism dispersion is unsuited to quasar surveys.

c) Visibility of White Dwarfs

Kelly and Kilkenny [2] have spectrally classified all stars earlier than F0 and brighter than 16.0 magnitude in Field 345. Their lists contain two objects confirmed to be white dwarfs and two suspected white dwarfs. Although these objects show very long continuous spectra on the prism plate material no absorption features are visible. The known brighter white dwarfs in the lists of Savage [9], which have been confirmed by AAT spectroscopy, were also checked. Again no absorption features were detected.

d) Emission-line galaxies

Forty-five emission-line galaxies were found in a total of 150 square degrees giving a density of 0.3 galaxies per square degree. However, 25 of these galaxies were found in F718 a density four times higher than each of the other three fields. There is no question that the plate material is superior for F718, if anything the magnitude limit is brighter than for the other three fields since the spectra were widened to 275 μm compared with 120 μm for the plates of other fields. The appearance of the spectra on all four fields is comparable and the plate material is some of the best we have ever seen. The surface density from the less populated fields of 0.1/square degree is comparable to the densities from the Curtis Schmidt [15] field where quasars could be detected whose continua were as faint as $20^{m}.0$ [8] whereas we can only just detect quasars with continua as faint as $18^{m}.5$. Thus, with our improved resolution we are selecting galaxies with a brighter limiting magnitude but intrinsically weaker emission features.

For 16 of the galaxies the emission comes from one or more distinct regions, probably an HII region, in the galaxy. This is noted in Table 2. Amongst our catalogue of 5O galaxies we found two interacting pairs, about 5% of the total, comparable to the numbers of pairs of interacting HII regions found by Shaver & Chen [14]. The majority of the galaxies in this sample are spirals later than Sab or irregulars. Only 4 galaxies are noted as elliptical or lenticular.

e) Comparison of IIIa-J and IIIa-F emulsions

The unwidened IIIa-F plates reach a fainter limiting magnitude ($R \sim 18^{m}.5$) than the widened III a-J plates, however in all fields the emission features were more easily visible on the IIIa-J prism spectra and in many cases emission features could not be detected on the IIIa-F material. One or two extra galaxies were visible on one IIIa-F prism plate but in all cases the objects were below the magnitude limit of the IIIa-J plate material.

Conclusions

(1) We have found one forty square degree area which has an anomalously high number of emission-line galaxies (F718), a factor of 4 higher than the densities found in the other three fields. This may be directly attributable to the greater number of bright galaxies obviously present in that field.

(2) Our pilot survey has confirmed the statement of Kinman [3] that such objective surveys are ideal for the unambiguous selection of emission-line galaxies. At the dispersions we have available with the UKST we are selecting galaxies with a brighter limiting magnitude but intrinsically weaker emission features than the Curtis-Schmidt survey.

(3) The IIIa-J is the best emulsion to use for such surveys at the highest dispersion which we currently have available because of the marked variation in the sensitivity response of the IIIa-F emulsion with wavelength [10] and the increased sky brightness at these longer wavelengths. These factors limit the detectability of emission features regardless of the variation of the relative strengths of emission features with galaxy type.

(4) The best method of attack for finding bright quasars and white dwarfs is that of multi-colour photometry. The pilot UKST project for a southern Palomar-Green type survey is a more efficient approach for finding bright uvx objects, as such a program requires only short exposure plates and thus is not so dependent on good seeing and dark nights as the program outlined here.

Table 2

Name	RA (1950.0)	Dec (1950.0)	Morphology	Magnitude
0141–515	01 41 42.9	–51 30 55	Galaxy Sab: sp	14.75
0145-530	01 45 48.2	-53 00 39	No685 SAB(r)c	11.97
0146-487	01 46 48.2	-48 46 07	Star dMe	15.50*
0149-477	01 49 57.0	-47 44 21	Star ?	16.50*
0155-524	01 55 46.6	-52 29 33	Galaxy SB:c?	14.25
0206-485	02 06 17.0	-48 35 12	Galaxy Sbc	16.00
0209-499	02 09 01.4	-49 56 00	197-G27 Sbc	13.00
0213-516	02 13 10.6	-51 39 59	197-G33 Scd	(-)
1247-112	12 47 01.7	-11 15 18	Galaxy G	4.80*
1247-073	12 47 41.4	-07 23 45	Galaxy SP	
1247-105	12 47 52.9	-10 34 56	DDO151 SB:(s:)cd	14.65
1248-129	12 48 25.8	-12 57 57	Galaxy	(-)
1249-131	12 49 35.4	-13 08 27	Galaxy Sa:+comp	15.50+16.00
1249-095	12 49 58.5	-09 30 18	Galaxy Sab	14.50
1251-118	12 51 19.6	-11 50 05	DDO153	(-)
1254-121	12 54 02.4	-12 11 49	Galaxy Sbc pec?	15.50
1254-104	12 54 26.9	-10 29 30	Galaxy so^{+}:	13.25
1254-118	12 54 50.1	-11 50 21	Galaxy	(-)
1255-104	12 55 02.7	-10 27 24	Galaxy SBcd	14.50
1255-093	12 55 10.2	-09 21 47	Galaxy Scsp	12.00
1258-078	12 58 45.7	-07 48 01	Galaxy S(r)	15.25
1259-111A	12 59 27.0	-11 06 35	Galaxy SBb?	13.75
1259-111B	12 59 54.2	-11 10 07	Galaxy	16.50*
1300-085	13 00 07.9	-08 33 45	Galaxy EL	14.80*
1300-078	13 00 24.4	-07 48 59	Galaxy SA(rs:)c	12.00
1301-100	13 01 37.6	-10 04 15	NGC4939 SAB(s)bc	14.6
1302-129	13 02 11.6	-12 55 27	Galaxy SP?	14.00
1304-118	13 04 04.7	-11 48 20	Galaxy	17.25*+17.25*
1304-129	13 04 45.0	-12 56 00	Galaxy	17.25*
1306-085	13 06 03.5	-08 32 29	Galaxy SAO:	16.00
1309-117	13 09 20.2	-11 47 56	Galaxy Sbd?	(-)
1310-108	13 10 28.1	-10 51 48	Galaxy	14.50*
1310-122	13 10 57.8	-12 12 23	Nonstellar	(17.50*+17.50*)
2150-215	21 50 42.8	-21 33 47	Galaxy SP?	16.50*
2155-174	21 55 34.2	-17 24 56	Galaxy Sab	12.75

*: uncertain quantity

Name	Note
0141-515	Only [OIII] 5007, 4959/Hβ4861 visible IIIa-F plate.
0145-530	*2 individual HII regions in Hα6563 visible IIIa-F plate.
0146-487	Bands and Hα visible IIIa-F plate.
0149-477	Sharp emission feature IIIa-J.
0155-524	Strong [OIII]/Hβ on both IIIa-J and IIIa-F.
0206-485	*Individual HII region. [OIII]/Hβ stronger than [OII] 3727 IIIa-J.
0209-499	[OIII]/Hβ just visible IIIa-F.
0209-516	Strong [OIII]/Hβ IIIa-J. Hα and [OIII] Hβ look equal on IIIa-F.
1247-112	[OIII]/Hβ equal to [OII] III a-J. Hα stronger than [OIII]/Hβ IIIa-F.
1247-073	*Probably individual HII region. [OIII]/Hβ stronger than [OII] IIIa-J. Hα stronger than [OIII[/Hβ IIIa-F.
1247-105	*Individual HII region. [OIII]/Hβ and [OII] equal IIIa-J. Hα only IIIa-F.
1248-129	Hα stronger than [OIII]/Hβ IIIa-F.
1249-131	Strongest [OIII]/Hβ and greater than [OII] IIIa-J. 6 other fainter lines. visible. Hα very much stronger [OIII]/Hβ IIIa-F.
1249-095	[OIII]/Hβ weaker than [OII] IIIa-J.
1251-118	*2 individual HII regions. Only [OIII]/Hβ IIIa-J. Hα equal [OIII]/Hβ IIIa-F.
1254-121	Hα very much stronger than [OIII]/Hβ IIIa-F.
1254-104	Maybe [OIII]/Hβ just visible IIIa-J.
1254-118	*Probably individual HII region. [OIII]/Hβ stronger than [OII] IIIa-J. Hα weaker than [OIII]/Hβ IIIa-F.
1255-104	*Individual HII region. Only [OII] IIIa-J. Only Hα on IIIa-F.
1255-093	*Individual HII region. [OIII]/Hβ stronger than [OII] IIIa-J. Hα very much stronger than Hβ IIIa-F. Nucleus may have features.
1258-078	[OIII]/Hβ very much stronger than [OII] IIIa-J. Only Hα IIIa-F. 4 or 5 other emission features. Individual HII region visible?
1259-111A	Strong [OIII]/Hβ IIIa-J. Hα equal [OIII]/Hβ IIIa-F. Other features?
1259-111B	[OIII]/Hβ stronger [OII] IIIa-J. Hα stronger [OIII]/Hβ IIIa-F. No continuum.
1300-085	[OIII]/Hβ stronger [OII] IIIa-J. Hα stronger [OIII]/Hβ IIIa-F. 2 other features.
1300-078	[OIII]/Hβ stronger [OII] IIIa-J. Many other lines visible.
1301-100	[OIII]/Hβ stronger [OII] IIIa-J. Hα stronger than [OIII]/Hβ IIIa-F.
1302-129	[OIII]/Hβ just visible IIIa-J. Possible Hα IIIa-F.
1304-118	*Pair HII regions. Strong [OIII]/Hβ IIIa-J. Hα less [OIII]/Hβ IIIa-F. No continuum visible.
1304-129	[OIII]/Hβ stronger [OII] IIIa-J. Hα stronger [OIII]/Hβ IIIa-F. No continuum.

1306-085	[OIII]/Hβ nearly equal [OII] IIIa-J. Hα stronger [OIII]/Hβ IIIa-F.
1309-117	[OIII]/Hβ much stronger [OII] IIIa-J. Hα weaker [OIII]/Hβ IIIa-F.
1310-108	Strong [OIII]/Hβ IIIa-J. Hα stronger [OIII]/Hβ IIIa-F.
1310-122	Strong [OIII]/Hβ IIIa-J. Hα equal [OIII]/Hβ IIIa-F.
2150-215	Strong [OIII] Hβ IIIa-J. Hα and [OIII]/Hβ equal IIIa-F.
2155-174	[OIII]/Hβ stronger [OII] IIIa-J. One other feature visible. Hα stronger [OIII]/Hβ IIIa-F.

Name	RA (1950.0)	Dec	Morphology	Magnitude
2207-169	22 07 28.6	-16 54 20	N7218 S(r:)6	B_T= 12.55
2210-219	22 10 54.4	-21 58 54	601-G31 Irr	(-)
2212-162	22 12 07.6	-16 16 32	Galaxy ?	(-)
2212-187	22 12 39.9	-18 46 42	Galaxy G+G	17.25*17.25*
2214-185	22 14 11.1	-18 31 11	Star	17.25*
2214-183	22 14 57.8	-18 19 59	Galaxy ?Sp:	18.50*
2215-429	22 15 18.3	-42 55 00	Star? pec?	(-)
2216-369A	22 16 49.1	-36 57 45	Galaxy? ?	14.50*
2216-369B	22 16 52.6	-36 58 40	Galaxy EL	13.00
2219-417	22 19 01.3	-41 43 32	Star	16.50*
2230-411	22 30 57.3	-41 11 31	N7307SAB(s)c:pec	12.84
2231-414	22 31 46.0	-41 24 00	Galaxy SP	14.00
2231-373	22 31 48.5	-37 22 16	Galaxy S^-	16.50*
2235-382	22 35 37.2	-38 15 28	Galaxy S^++G	17.50+1
2240-401	22 40 23.3	-40 07 49	N7368SAB(rs)cd	12.50
2240-384	22 40 41.4	-38 27 05	Quasar	17.25*
2245-373	22 45 59.3	-37 20 07	Star	16.50*
2246-389	22 46 56.6	-38 56 28	Quasar	17.50*

Name	Notes
2207-169	*Individual HII region [OII]? only visible IIIa-J. Maybe six individual regions showing Hα.
2210–219	*3 Individual HII regions. Strong [OIII]/Hβ IIIa-J. Maybe features IIIa-F.
2212-162	*Individual HII region. [OIII]/Hβ stronger [OII] IIIa-J. Hα and [OIII]Hβ equal IIIa-F.
2212-187	Compact HII region? Strong [OIII]/Hβ IIIa-J. Hα and [OIII]/Hβ equal IIIa-F.
2214-185	Two narrow emission features.
2214-183	Strong [OIII]/Hβ IIIa-J.
2215-429	Strong [OIII]/Hβ IIIa-J. Hα and [OIII]/Hβ equal IIIa-F.

2216-369A	[OIII]/Hβ? IIIa-J. Hα and [OIII]/Hβ equal IIIa-F.
2216-369B	Strong [OIII]/Hβ IIIa-J. Hαweaker [OIII]/Hβ IIIa-F.
2219-417	Peculiar spectrum, no obvious emission features?
2230-411	*Individual HII region. [OIII]/Hβ and [OII] just visible IIIa-J. Hα equal [OIII]/Hβ IIIa-F.
2231-414	*2 Individual HII regions. [OIII]/Hβ stronger [OII] IIIa-J. Hα stronger [OIII]/Hβ IIIa-F.
2231-373	Compact HII region. Strong [OIII]/Hβ IIIa-J. Hα stronger [OIII]/Hβ IIIa-F and features broad.
2235-382	*Individual HII regions. Strong [OIII]/Hβ IIIa-J. 3 regions showing Hα. IIIa-F?
2240-401	*Individual HII region. [OIII]/Hβ stronger [OII] IIIa-J. 3 regions Hα stronger [OIII]/Hβ IIIa-F.
2240-384	[OIII]/Hβ stronger [OII] III a-J. Very strong [OIII]/Hβ no Hα visible IIIa-F.
2245-373	Weak [OII]? IIIa-J.
2246-389	Known F345 QSO. Osmer & Smith (1980). Two broad features visible IIIa-J & IIIa-F. Found independently as scanning.

References

1. Fairall, A.P., Mon. Not. R. Astr. Soc., **2 1 0**, 69 (1984).
2. Kelly, D. B. and Kilkenny, D: SAAO Circulars No. **8**, 85 (1984).
3. Kinman, T. D.,: Astronomy with Schmidt-type telescopes, p.409, edited by M. Capaccioli (1984).
4. Kirshner, R. P., Oemler, A. Jr. and Schechter, P. L., A. J. 83 1549 (1978).
5. Lauberts, A.,: The ESO/Uppsala Survey of the ESO (B) Atlas. European Southern Observatory (1982).
6. MacAlpine, G. M. and Lewis, D. W., Ap. J. Suppl. Ser. 36, 587 (1978).
7. Morgan, M., Private communication, (1986).
8. Osmer, P. S. and Smith, M. G., Ap. J. (Suppl) **4 2**, 333 (1980).
9. Savage, A. Ph. D. Thesis, Univ. of Sussex, (1978).
10. Savage, A.: Astronomical photography p.89, edited by M. E. Sim & K. Ishida (1984).
11. Savage, A. and Bolton, J. G.,: Mom. Not. R. Astr. Sco. 188 (1979).
12. Savage, A. and Clowes, R.: Unpublished data.
13. Schmidt, M. and Green, R. F.,: Ap. J. **2 6 9**, 352 (1983).
14. Shaver and Chen, J-S., ***Astron. Astrophys.*** (in press).
15. Smith, M.G.,: Ap. J., **2 0 2**, 591 (1975).
16. Smyth, R. J. & Stobie, R. S.,: Mon. Not. R. Astr. Soc., **1 9 0**, 631 (1980).
17. Smyth, R. J.: Ph. D. Thesis, Univ. of Edinburgh (1980).
18. Stobie, R. S., Smith, G. M., Lutz, R. K. and Martin, R.,: Proceedings of the international workshop in image processing **4 8**, edited by G. Sedmak, M. Capaccioli and R. J. Allen (1979).
19. Therlevich, R. and Melnick, J.,: Mom. Not. R. Astr. Soc., 213, 841, (1985).
20. Trtton, K. P., Savage, A. and Morton, D. C.,: Mon. Not. R. Astr. Soc. **2 0 6**, 843 (1984).
21. Usher, P. D., Warnock, A., and Green, R. F.,: Ap. J. 269, 73 (1983).
22. De Vaucouleurs, G., De Vaucouleurs, A., and Corwin, H. G., Jr.,: Second Reference Catalogue of Bright Galaxies, Austin. Univ. of Texas Press (1979).