Mon. Not. R. astr. Soc. (1981) 197, 893–919

The *Ariel V* (3A) catalogue of X-ray sources – II. Sources at high galactic latitude ($|b| > 10°$)

I. M. McHardy, A. Lawrence*, J. P. Pye and K. A. Pounds *X-ray Astronomy Group, Department of Physics, University of Leicester, Leicester LE1 7RH*

Received 1981 March 20

Summary. This paper forms the second part of the *Ariel V* 3A catalogue and covers all the sky outside the galactic plane ($|b| > 10^0$). It is based on all the data collected by the Sky Survey Instrument on the *Ariel V* satellite during its 5½ yrs in orbit. It covers 90 per cent of the high latitude sky down to ~ 0.8 SSI count s^{-1} and contains 142 sources. The main difference from the 2A catalogue is the far greater number of identifications with stars, and, to a lesser extent, with active galaxies. The number of identifications with clusters of galaxies has hardly changed. We suspect that many of the unidentified sources will eventually be identified with cataclysmic variables.

1 Introduction

This paper presents the X-ray sources detected at high galactic latitudes ($|b| > 10^0$) by the Sky Survey Instrument (SSI) on the *Ariel V* satellite during its 5½-yr life (~ 30 000 orbits) from launch in 1974 October to re-entry in 1980 March. It is essentially a revised and extended version of the much-referenced 2A catalogue (Cooke *et al.* 1978a, hereafter 2A), and forms the second part of the *Ariel V* 3A catalogue. Details of the experiment and methods of data reduction are contained in the first, low galactic latitude, part of the catalogue (Warwick *et al.* 1981, hereafter Paper I), and in previous publications (e.g. 2A; Villa *et al.* 1976), and so are not discussed in detail here. Minor differences from the methods of analysis of Paper I are discussed in Section 2 and a discussion of the effects of noise, source confusion and sky coverage on the catalogue is given in Section 3. The list of sources is presented in Section 4. A comparison with previous X-ray catalogues, including 2A, and a discussion of the identification content of the catalogue are given in Section 5.

2 Data analysis

The method of production of the lines-of-position (LOPs) from which each error box is derived is well described in 2A and Paper I, and so is not repeated here. However, we emphasize that we have worked exclusively on the summed-orbit records. This may lead to appar-

* Present address: Center for Space Research, MIT, Cambridge, Massachusetts 02139, USA.

ent differences when comparing our fluxes and variability statements with more detailed SSI studies of variable sources. We take this approach to give some degree of uniformity to all our quoted fluxes, each source having been treated in exactly the same way, and because a more detailed study is beyond the scope of this paper. Where such a study has been performed, reference is given to it in the catalogue.

Three classes of variability code are used in the catalogue: steady, irregular and transient. Transient sources are those which are not usually detectable by the SSI, but which occasionally exhibit short ($\lesssim$ days) and violent flux increases, as detected on the summed orbit records. To appear in the catalogue the source must, of course, have been detected at the 3σ level on at least three occasions. We therefore exclude from the catalogue any transients which show up well in the single orbit data but which do not last long enough to be significant on three separate summed orbit records. A separate study of these sources is, however, in progress. The division of the remaining sources into 'steady' or 'irregular' follows Paper I, i.e. those with a formal probability <1 per cent that the X-ray light curve could result from a steady source are classed as irregular. It is possible that some of the weaker 'steady' sources might turn out to be 'irregular' if examined in more detail.

All the sources listed in Table 1 are line-of-position sources; we do not make use of the Point Summation Technique (PST) in this paper.

3 Completeness and reliability of the survey

In this section we discuss variations in limiting flux of the high galactic latitude survey over the sky, 'sky coverage', validity of the survey acceptance criteria and uncertainties in assignment of source fluxes. Several effects can give rise to spurious sources. These include (a) intersections of spurious $>3\sigma$ LOPs, each LOP occurring because of random photon counting fluctuations in the data and (b) apparent sources arising from spatial fluctuations in X-ray sky brightness, i.e. chance groupings of weak sources which, together, have the flux of a stronger source. These effects are discussed in Sections 3.2 and 3.3 below. As pointed out by Warwick & Pye (1978) in the case of the 2A catalogue, the complexity of the *Ariel V* survey procedure is such that a Monte Carlo simulation method (Murdoch, Crawford & Jauncey 1973; Warwick & Pye 1978) appears to be the only way of determining flux errors and sky coverage with sufficient precision to use the catalogue for detailed analyses such as source count distributions and luminosity functions. Our aim here is simply to discuss the expected magnitude of various effects.

3.1 SKY COVERAGE

The non-uniform manner in which the satellite spin-axis was moved has produced variations in the sky coverage of the survey. The sky coverage as defined here, is the flux, at any given location, for which the probable number of $>3\sigma$ detections is just three, taking into account all useful data sets and the effects of photon counting statistics (*cf.* 2A). The fluxes down to which 20, 80 and 90 per cent of the survey area, i.e. $|b|>10^\circ$, has been scanned are 0.5, 0.7 and 0.8 SSI count s^{-1} respectively. The 20 and 80 per cent contours are mapped in Fig. 1(b). The high concentration of the *Ariel V* spin-axis pointing directions in the galactic plane which was determined by the other, on-axis, experiments has produced the high coverage seen near the galactic poles and along the great circle passing through the poles and cutting the plane at $l \sim 20^\circ$ and 200°.

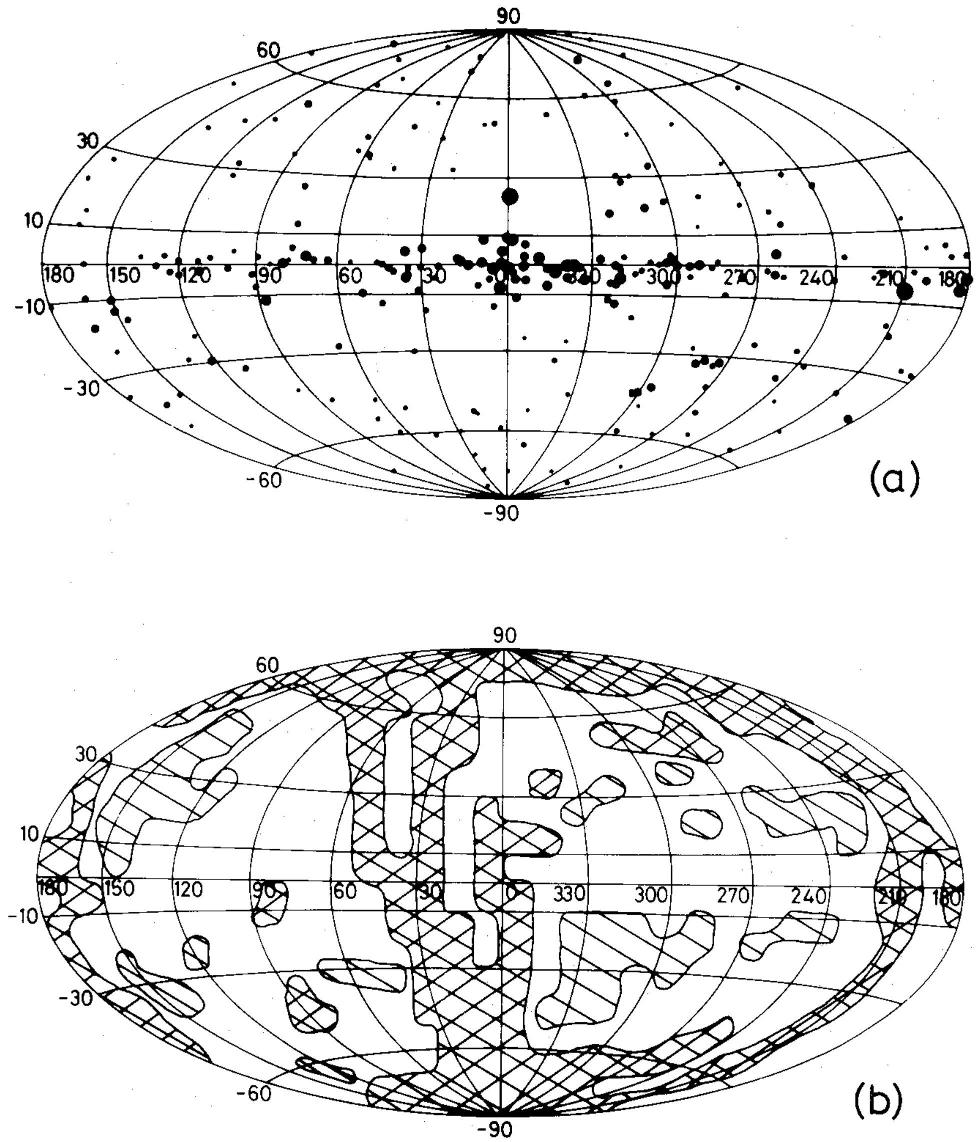

Figure 1. (a) The 3A catalogue of 250 X-ray sources plotted on an Aitoff projection of the sky in galactic coordinates (*l, b,* degrees). The sizes of the symbols representing the sources are proportional to the logarithm of the average source flux for steady and irregular sources, and the maximum flux for transient sources. (b) Sky coverage map showing the source flux for which the probable number of $> 3\sigma$ sightings is just three (see Section 3.1). The region covered to better than 0.5 SSI count s^{-1} is double hatched, that covered to worse than 0.7 SSI count s^{-1} is single hatched and the remaining region is left blank.

3.2 SPURIOUS SOURCES FROM PHOTON COUNTING FLUCTUATIONS

Given the SSI collimator FWHM of about 1° along the spin plane, we expect ~ 0.5 peaks at $> 3\sigma$ per data set due to photon counting statistics, and since the 3A catalogue is compiled from about 550 data sets (summed-orbit records), we expect, from the results of a Monte Carlo simulation, ~ 3 single point intersections of three lines generated from such random peaks, and < 1 four line intersection. Investigation into the credentials of the 3A sources shows, however, that none rely for their existence solely on three 3σ lines; hence we do not expect any spurious sources in the 3A catalogue due to the above process.

3.3 SPURIOUS SOURCES AND FLUX ERRORS FROM SOURCE CONFUSION FLUCTUATIONS

Spatial fluctuations are present in the X-ray sky brightness as measured by a finite instrument beam, due to chance groupings of weak sources. Such sources mostly have individual fluxes between the survey limit and the flux level corresponding to a source surface density ~1 source per beam area (e.g. Scheuer 1974). These fluctuations, often referred to as source confusion fluctuations (e.g. Condon 1974), can (a) give rise to spurious sources, i.e. there is a finite chance that some fluctuations will exceed the survey flux limit and (b) contribute to the 'noise' on the measured fluxes of genuine sources. We consider the two effects as follows:

(a) Calculations based on both the detailed confusion fluctuations distribution (Condon 1974; Scheuer 1974) and on the approximate correction formula of Mills & Slee (1957) lead to $\lesssim 1$ or $\lesssim 0.1$ spurious sources expected in the survey above a flux of 0.2 or 0.4 SSI count s^{-1} respectively. Hence we do not expect any spurious sources in the 3A catalogue from this effect.

(b) The contribution of confusion noise (Condon 1974; Scheuer 1974) to the overall flux error of a source is small compared with that due to photon counting statistics, viz:
FWHM of confusion fluctuations distribution for a single data set ≈ 0.2 SSI count s^{-1}.
FWHM of photon counting (Gaussian) distribution for a typical 30 or 60 orbit data set (*cf.* Paper I, Table 1) ≈ 0.66 or 0.45 SSI count s^{-1}, respectively.

3.4 FLUX ERRORS FROM PHOTON COUNTING NOISE

The true flux of a source will be subject to Poissonian photon counting errors in the observations. Positive fluctuations can thus lead to a source, of true flux less than the nominated survey limit, being catalogued. Since the source count distribution ($\log N$–$\log S$) has a negative slope this will lead to a net increase in the measured number of sources above a given flux threshold (*cf.* Murdoch *et al.* 1973). While the 3A catalogue will be influenced by this effect and a detailed evaluation is beyond the scope of this paper, it does not affect the reality of the sources. Also, Mills, Davies & Robertson (1973) have shown that requiring multiple detections of a source before it is accepted (as in the present catalogue) greatly reduces the flux uncertainty.

We conclude by noting that the measured flux of 2A sources is overestimated, due to the effects mentioned in Section 3.3. and 3.4 above, by ~ 0.1 SSI count s^{-1} below 2.5 count s^{-1} (Warwick & Pye 1978), and we expect this figure still to be appropriate for 3A.

4 The catalogue

The final list of 3A high galactic latitude X-ray sources, fulfilling all required criteria, is presented in Table 1, whose arrangement is as follows:

Ariel name. A 3A designation implies a source from this catalogue. This name supersedes the earlier A and 2A designations. The name is truncated to minutes of time in right ascension and the first decimal place in declination in degrees. 1950.0 coordinates are used throughout this paper.

Alternative names. Other X-ray designations. Up to three other names are given, always including where applicable, the 2A (Cooke *et al.* 1978a), 4U (Forman *et al.* 1978) and common (e.g. Sco X-1) names. MX designations are from Markert *et al.* (1976). References to other designations (e.g. H) are given either in this column or in the 'other information' column (see below). H designations refer to sources detected by experiments on the *HEAO-1* satellite, mainly by the A2 experiment. For additional designations of galactic sources the reader is referred to Bradt, Doxsey & Jernigan (1979a).

Position. Position of maximum probability density for the source location, in degrees of right ascension (RA), declination (Dec) and galactic coordinates (l, b) rounded to two decimal places.

Error box. RA and Dec of the corners of a rectangle enclosing an elliptical approximation to a 90 per cent confidence contour for the source location.

Area. Area within the 90 per cent confidence contour, in square degrees.

Flux and variability code. The flux values in SSI count s^{-1} and the variability codes are assigned as follows:

Variability Code	Flux Quotation
S = Steady source	Weighted mean of *all* flux measurements, $\pm 1\sigma$ error.
I = Irregular source	Weighted mean of *all* flux measurements, $\pm 1\sigma$ error; typical minimum flux, $\pm 1\sigma$ error; typical maximum flux, $\pm 1\sigma$ error. Includes sources seen by the SSI to be periodic (e.g. HER X-1) and those seen to exhibit flaring where emission was also observed by the SSI outside of the flares (e.g. 3A 1102 + 385 = Mkn 421).
T = Transient source	Most stringent non-detection, $\pm 1\sigma$ error; typical maximum flux, $\pm 1\sigma$ error. Includes flaring sources where emission was not observed by the SSI outside of the flares.

All flux determinations and variability code assignments were made from the summed-orbit records.

Identification. Suggested identifications obtained as described in Section 5 and previous identifications as referenced in the 'other information' column. The identification code expresses confidence in the identification as follows:

**** = Almost certain: there is substantial supporting evidence (referenced in the 'other information' column) which generally falls under one or more of the following categories: (a) correlated X-ray/optical or X-ray/radio variability; (b) the X-ray emission has been spatially resolved e.g. sources proposed as clusters of galaxies; (c) the object is inside a very precise (dimension ~ few arc seconds) X-ray error box.

*** = Very likely: the object is inside a very small (dimensions $\lesssim 1$ arcmin) error box (referenced in the 'other information' column).

** = Probable: the object is inside or very close to a small ($\lesssim 0.1\ deg^2$.) 3A error box or inside a larger 3A box and has supporting evidence.

* = Possible: positional coincidence only.

Other information. Includes the key references for the identification and, where they exist, references to published SSI light curves. By 'Seyfert' we mean a 'Seyfert type I' galaxy, and by 'Hexelg' we mean any other type of high excitation emission line galaxy. It is probable that almost all of the latter are, in fact, Seyfert type II galaxies.

In Table 1, there are four entries indicated in the 'other information' column as 'probably >1 source'. These are 3A 0709 + 443, 3A 1148 + 719, 3A 1306 – 015 and 3A 1422 + 481. Here, we have been unable to obtain a self-consistent solution for the location of a single point source, though the SSI data do not otherwise show evidence for more than one source near these positions. In the latter three cases, the presence of two or more sources has subsequently been confirmed by the *HEAO A-2* (2–60 keV) experiment (F. E. Marshall, private

Table 1. *Ariel V* SSI – high galactic latitude catalogue.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	FLUX CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A0004+725	4U0000+72	1.07 72.52	119.61 10.22	359.89 72.67	1.99 72.78	2.19 72.38	.13 72.28	.200	.46 .08			S	CTA 1 *	SNR [D]
3A0020-260		5.11 -26.03	43.47 -83.48	4.59 -25.87	5.43 -25.71	5.55 -26.21	4.72 -26.38	.303	.26 .04			S		A22 (D=6,R=3,BMI) V. NEAR ERROR BOX
3A0039-095	2A0039-096 4U0037-10	9.86 -9.54	115.34 -72.00	9.98 -9.68	9.63 -9.59	9.69 -9.38	10.04 -9.47	.062	1.30 .08			S	A85 ****	CLUSTER OF GALAXIES [B]
3A0040+409	2A0039+411 4U0037+39	10.19 40.93	121.33 -21.64	10.91 40.46	9.27 41.09	9.47 41.40	11.12 40.76	.387	.79 .10			S	M31 ****	NORMAL SPIRAL GALAXY [C]
3A0041+330	2A0042+323 4U0042+32 [A]	10.39 33.02	121.20 -29.55	10.47 32.80	10.11 33.14	10.26 33.25	10.62 32.91	.060		0.00 .32	13.40 1.40	T	STAR ***	[A] V=19.2 X-RAY RISETIME < 1 DAY [E]
3A0042-738	SMC X-2 [A]	10.67 -73.83	303.61 -43.56	12.46 -73.99	8.45 -74.06	8.41 -73.70	12.34 -73.63	.322	.46 .20			S	OB STAR ***	[A] V=14.8
3A0044-410		11.16 -41.09	306.46 -76.28	10.79 -40.66	11.83 -41.11	11.54 -41.51	10.48 -41.06	.331	.22 .06			S		
3A0049-726	SMC X-3 [A]	12.47 -72.67	302.91 -44.73	17.52 -72.26	7.69 -73.22	7.47 -72.94	17.17 -72.01	.768	.80 .15			S	OB STAR ***	[A] V=15
3A0103-232	REPLACES 2A0102-222 2A0102-242	15.79 -23.28	161.63 -84.78	15.73 -23.55	15.54 -23.18	15.82 -23.06	16.01 -23.42	.091	.33 .05			S		MCG-04-03-050 & MCG-04-03-051 IN ERROR BOX
3A0116-736	2A0116-737 4U0115-73 SMC X-1[A]	19.00 -73.66	300.38 -43.61	19.29 -73.72	18.60 -73.66	18.67 -73.60	19.35 -73.65	.011	4.74 .18	.04 .50	20.60 1.30	I	SK 160 ****	[A] STAR V=13.3

[A] : BRADT ET AL.1979A.
[B] : JONES ET AL.1979.
[C] : VAN SPEYBROECK ET AL.1979.
[D] : SIEBER ET AL.1979.
[E] : WATSON & RICKETTS 1978.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A0120-591	2A0120-591 4U0106-59	20.09 -59.11	295.44 -57.83	19.52 -58.94	20.70 -58.99	20.66 -59.27	19.47 -59.22	.140	.65 .07			S	FAIRALL 9 ***	= ESO113-IG45 SEYFERT GALAXY [D,E]
3A0121-353	2A0120-353 4U0115-36	20.50 -35.32	263.46 -79.41	20.31 -35.39	20.42 -35.19	20.62 -35.27	20.52 -35.46	.030	1.05 .05			S	NGC526A ***	HEXELG [A,E]
3A0121+338		20.49 33.81	130.77 -28.29	20.85 34.16	20.71 33.41	20.11 33.49	20.25 34.23	.296	.54 .10			S		
3A0142-681		25.64 -68.10	295.51 -48.51	30.20 -68.55	20.44 -67.92	20.75 -67.45	30.32 -68.07	1.411	.21 .08			S		
3A0205-390		31.29 -39.08	254.24 -70.32	30.37 -39.24	31.93 -38.57	32.16 -38.89	30.60 -39.56	.423	.44 .08			S		
3A0210-745	2A0207-746	32.53 -74.57	295.91 -41.70	34.47 -74.32	30.92 -75.10	30.13 -74.83	33.67 -74.07	.333		0.00 .50	6.90 .80	T		
3A0223+197		35.82 19.75	151.37 -37.62	35.66 19.32	35.46 20.05	35.99 20.18	36.19 19.44	.308	.88 .37			S		
3A0234-526	2A0235-526	38.71 -52.65	272.33 -57.99	38.16 -52.79	38.79 -52.28	39.27 -52.50	38.65 -53.01	.182	.45 .07			S		STARS ETA HOR (A5, V=5.3) & EH PER (M, V=14.0-14.8) IN BOX
3A0250+061	2A0252+060	42.73 6.19	168.82 -45.32	42.65 5.71	42.33 6.54	42.78 6.71	43.10 5.89	.326	.29 .07			S		
3A0251+414	2A0251+413 4U0253+41 MX0255+41	42.98 41.41	146.44 -15.54	42.81 41.27	42.88 41.60	43.09 41.58	43.01 41.24	.043	2.12 .09			S	AWM7 ***	CD GROUP, CONTAINS NGC1129 [B,C]

[A] : GRIFFITHS ET AL.1979A.
[B] : SCHWARTZ ET AL.1980A.
[C] : SCHWARTZ ET AL.1980B.
[D] : RICKER 1978.
[E] : MARSHALL ET AL.1981.

1981MNRAS.197..893M

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	LII BII	ERROR BOX RA DEC	RA DEC	RA DEC	RA DEC	AREA	FLUX AV ERR	MIN ERR	MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A0256+129	2A0255+132 4U0254+13	44.05 13.00	164.48 -39.18	43.98 12.84	43.96 13.12	44.11 13.14	44.14 12.85	.036	1.64 .07			S	A399/A401 ****	ERROR BOX LIES BETWEEN CLUSTERS. BOTH EMIT [K]
3A0311-227	2A0311-227	47.95 -22.76	212.88 -57.45	48.05 -22.67	48.00 -22.89	47.84 -22.87	47.89 -22.64	.026	1.25 .05			S	STAR ****	AM HER TYPE [B,F] V=14.5
3A0316-442	2A0316-443	49.05 -44.28	252.69 -56.13	49.32 -44.15	49.09 -44.48	48.78 -44.37	49.01 -44.04	.071	.62 .06			S	CLUSTER **	
3A0316+414	2A0316+413 4U0316+41	49.20 41.41	150.58 -13.16	49.11 41.40	49.23 41.47	49.28 41.43	49.16 41.36	.005	17.60 .18			S	PERSEUS CL ****	= A426 [J] CLUSTER OF GALAXIES
3A0322+277	H0324+28	50.73 27.72	159.96 -23.65	50.45 27.03	50.40 28.41	50.89 28.42	50.93 27.04	.460	.58 .16			S	UX ARI ***	RS CVN SYSTEM [A,E] V=6.5
3A0327+438	A0327+43	51.95 43.83	150.90 -10.02	51.84 43.30	51.87 44.53	52.07 44.53	52.03 43.30	.140		0.00 .40	4.90 .28	T	GK PER ****	OLD NOVA [C]
3A0335+001	4U0336+017	53.76 .10	185.42 -41.60	53.55 -.31	53.56 .51	53.96 .51	53.96 -.32	.262		0.00 .60	15.90 1.50	T	HR 1099 ****	RS CVN SYSTEM [G,H] V=6.0
3A0336+098	2A0335+096 4U0344+117	54.07 9.83	176.31 -34.98	54.19 10.22	54.20 9.46	53.95 9.45	53.93 10.21	.156	.96 .07			S	CD GROUP ***	[D]
3A0338-169		54.68 -16.97	207.18 -40.56	54.47 -17.52	54.43 -16.46	54.87 -16.45	54.91 -17.50	.361	.18 .08	0.00 .24	7.20 1.60	I		
3A0342-536	2A0343-536 4U0339-54	55.59 -53.66	264.81 -48.88	56.06 -53.64	55.28 -53.95	55.02 -53.73	55.81 -53.42	.111	.70 .08			S	CA0340-538 **	CLUSTER OF GALAXIES [I]

[A] : SWANK & WHITE 1980.
[B] : GRIFFITHS ET AL.1979C.
[C] : KING ET AL.1979.
[D] : SCHWARTZ ET AL.1980A.
[E] : WALTER ET AL.1978A.
[F] : WHITE ET AL.1980.
[G] : WHITE ET AL.1978.
[H] : WALTER ET AL.1978B.
[I] : PYE & COOKE 1976.
[J] : GORENSTEIN ET AL.1978.
[K] : ULMER & CRUDDACE 1981.

1981MNRAS.197..893M

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	FLUX CODE	IDENT OBJECT CODE	OTHER INFORMATION
3AØ352+3Ø9	2AØ352+3Ø9 4UØ352+3Ø [A]	58.Ø4 3Ø.92	163.Ø5 -17.13	58.11 3Ø.91	58.Ø1 3Ø.86	57.96 3Ø.94	58.Ø6 3Ø.98	.ØØ7	6.4Ø .11	1.1Ø 1.8Ø	12.8Ø 1.1Ø	I	X PER ****	[A] O STAR V=6.Ø-6.7
3AØ41Ø+1Ø2	2AØ411+1Ø3 4UØ41Ø+1Ø	62.71 1Ø.26	182.53 -28.31	62.62 9.97	62.59 1Ø.49	62.8Ø 1Ø.5Ø	62.83 9.99	.Ø85	1.26 .Ø8			S	A478 ****	CLUSTER OF GALAXIES [B]
3AØ43Ø-615	2AØ43Ø-615 4UØ427-61	67.67 -61.57	272.16 -4Ø.14	67.15 -61.7Ø	67.94 -61.3Ø	68.19 -61.41	67.4Ø -61.81	.Ø65	1.34 .Ø8			S	SERS 4Ø/6 **	CLUSTER OF GALAXIES
3AØ43Ø+Ø48	4UØ432+Ø5 2SØ43Ø+Ø52	67.66 4.89	19Ø.73 -27.58	67.38 4.58	67.58 5.29	67.93 5.19	67.73 4.48	.2Ø3	.64 .1Ø			S	3C12Ø ***	SEYFERT GALAXY [C,F]
3AØ431-133	2AØ431-136 4UØ431-12	67.83 -13.36	2Ø9.58 -36.48	67.73 -13.68	67.68 -13.Ø6	67.89 -13.Ø4	67.95 -13.66	.Ø98	.92 .Ø6			S	A496 **	CLUSTER OF GALAXIES
3AØ433-327	4UØ429-31?	68.3Ø -32.71	233.68 -41.75	68.Ø8 -33.56	67.87 -31.84	68.43 -31.79	68.66 -33.51	.648	.38 .Ø8			S		
3AØ5ØØ+236		75.Ø4 23.64	179.Ø4 -1Ø.8Ø	75.17 24.32	75.31 22.99	74.89 22.95	74.74 24.29	.386	.43 .Ø8			S		
3AØ512-4Ø1	2AØ512-399 4UØ513-4Ø MXØ513-4Ø[A]	78.14 -4Ø.19	244.62 -35.Ø3	78.28 -39.97	78.29 -4Ø.43	77.94 -4Ø.44	77.93 -39.98	.1ØØ	1.69 .11	.16 .6Ø	4.6Ø .56	I	NGC1851 ****	[A] GLOBULAR CLUSTER
3AØ521-72Ø	2AØ521-72Ø 4UØ52Ø-72 LMC X-2[A]	8Ø.44 -72.Ø3	283.11 -32.65	8Ø.36 -71.94	8Ø.75 -72.Ø3	8Ø.53 -72.12	8Ø.14 -72.Ø3	.Ø14	7.29 .15	5.2Ø .7Ø	8.5Ø .4Ø	I		[A,G]
3AØ527-329	2AØ526-328	81.8Ø -32.9Ø	236.82 -3Ø.69	81.92 -32.71	81.94 -33.1Ø	81.61 -33.11	81.6Ø -32.72	.Ø86	.93 .Ø8			S	STAR ***	CATACLYSMIC VARIABLE V=14 [D,E]

[A] : BRADT ET AL.1979A.
[B] : JONES ET AL.1979.
[C] : SCHNOPPER ET AL.1977.
[D] : SCHWARTZ ET AL.1979B.
[E] : CHARLES ET AL.1979.
[F] : MARSHALL ET AL.1981.
[G] : GRIFFITHS & SEWARD 1977.

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A0529-660	2A0532-664 4U0532-66 LMC X-4[A]	82.33 -66.04	275.95 -32.92	82.98 -66.44	81.14 -65.82	81.53 -65.64	83.36 -66.25	.171	1.05 .14	0.00 .48	4.10 .36	I	O STAR ****	[A,F] V=14
3A0532-053	2A0532-056 4U0531-05 [A]	83.20 -5.36	208.95 -19.36	83.14 -5.52	83.12 -5.19	83.24 -5.18	83.27 -5.51	.032	2.00 .07			S	ORION TRAP ****	[A]
3A0539-641	2A0539-642 4U0538-64 LMC X-3[A]	84.95 -64.16	273.63 -31.96	85.06 -64.25	84.71 -64.19	84.81 -64.08	85.16 -64.15	.015	6.35 .16	0.00 .68	16.50 .68	I	B STAR ****	[A,F] V=16.9
3A0540-697	2A0540-698 4U0540-69 LMC X-1[A]	85.20 -69.75	280.17 -31.46	84.95 -69.67	85.47 -69.71	85.39 -69.82	84.86 -69.77	.017	5.59 .12	1.08 .40	9.12 .64	I	B STAR ****	[A,F] V=12.0
3A0550-076	2S0549-074 H0550-075 [E]	87.55 -7.70	213.19 -16.55	87.50 -8.13	87.37 -7.31	87.60 -7.27	87.74 -8.10	.170	.90 .08			S	NGC2110 ***	HEXELG [B,G]
3A0551+467	2A0551+466 4U0558+46	87.91 46.72	165.51 10.62	87.80 46.43	87.64 46.94	88.03 47.00	88.18 46.49	.108	.75 .08			S	MCG8-11-11 ***	SEYFERT GALAXY [C,G]
3A0557-383	4U0557-38	89.41 -38.40	244.66 -26.13	89.08 -38.73	89.17 -38.03	89.67 -38.06	89.58 -38.77	.221	.79 .11	0.00 .64	3.00 .64	I	SEYFERT **	[H]
3A0609+491	2A0608+497	92.44 49.14	164.74 14.42	92.26 48.48	92.16 49.78	92.62 49.79	92.71 48.49	.342	.53 .07	0.00 .32	1.96 .28	I		EMISSION LINE STAR X AUR (Me, V=8.0-13.6) NEAR BOX
3A0624-546	2A0626-541 4U0627-54	96.19 -54.64	263.41 -25.44	96.57 -54.36	96.30 -54.99	95.79 -54.92	96.07 -54.29	.152	.99 .11			S	CLUSTER(S) *	COMPLEX REGION [D]
3A0634-762		98.57 -76.29	287.54 -27.43	97.33 -76.49	98.08 -75.96	99.75 -76.09	99.06 -76.62	.188	.41 .08			S		

[A] : BRADT ET AL.1979A.
[B] : BRADT ET AL.1978.
[C] : GRIFFITHS ET AL.1979B.
[D] : PRAVDO ET AL.1979.
[E] : MARSHALL ET AL.1979.
[F] : GRIFFITHS & SEWARD 1977.
[G] : MARSHALL ET AL.1981.
[H] : FAIRALL, PRIVATE COMMUNICATION.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A0709+443	2A0710+456	107.43 44.36	173.31 22.27	107.65 44.76	107.92 44.07	107.20 43.92	106.93 44.61	.298	.44 .08			S		PROBABLY >1 SOURCE. MKN376 NO LONGER IN ERROR BOX
3A0729+103		112.38 10.31	208.33 13.65	112.60 10.78	112.44 9.66	112.07 9.69	112.23 10.84	.317	.32 .06			S		
3A0736+493	2A0738+498	114.18 49.34	169.19 27.95	113.57 48.63	114.24 50.04	114.72 49.94	114.03 48.54	.389	.46 .06			S	MKN79 ***	SEYFERT GALAXY [A,F]
3A0906-095	2A0906-095 4U0900-09	136.66 -9.59	239.43 24.71	136.58 -9.74	136.54 -9.44	136.73 -9.41	136.78 -9.72	.049	1.82 .09			S	A754 **	CLUSTER OF GALAXIES
3A0922-314	2A0922-317 4U0923-31	140.52 -31.45	259.52 13.24	140.48 -31.29	140.70 -31.51	140.52 -31.64	140.30 -31.42	.046	1.67 .11			S		HEAO A-3 ERROR BOX, NO OBJECTS BRIGHTER THAN V=18 [E]
3A0943-140	2A0943-140 4U0937-12?	145.84 -14.03	249.66 28.84	145.75 -13.79	146.05 -13.98	145.87 -14.25	145.57 -14.05	.093	1.43 .11			S	NGC2992 ***	HEXELG [B,F]
3A0945-306	2A0946-310 4U0945-30	146.42 -30.65	262.74 17.31	146.51 -31.04	146.10 -30.34	146.28 -30.26	146.69 -30.96	.110	1.41 .10			S	MCG-5-23-16 ***	HEXELG [C,F]
3A0950+694	2A0954+700 4U1004+70	147.50 69.48	142.00 40.70	148.63 69.61	147.36 69.05	146.28 69.34	147.54 69.91	.270	.96 .13			S	M82 **	HEXELG [B] 3A BOX ALSO INCLUDES M81
3A1006+475		151.72 47.51	169.37 52.67	151.12 47.21	151.83 48.05	152.34 47.85	151.62 47.02	.290	.21 .07			S		
3A1021+203	A1021+198 H1019+203 [D]	155.40 20.33	216.74 55.70	155.00 19.84	155.34 21.00	155.75 20.90	155.40 19.73	.368	.53 .08			S	NGC3227 ***	SEYFERT GALAXY [A,F]

[A] : GRIFFITHS ET AL.1979B.
[B] : GRIFFITHS ET AL.1979A.
[C] : SCHNOPPER ET AL.1978.
[D] : MARSHALL ET AL.1979.
[E] : SCHWARTZ ET AL.1979B.
[F] : MARSHALL ET AL.1981.

1981MNRAS.197..893M

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1030-346		157.54 -34.65	273.14 19.80	158.82 -36.55	155.86 -32.62	156.17 -32.46	159.14 -36.39	1.400	.58 .11			S	NGC3281 **	HEXELG [D,F]
3A1035-272	2A1033-270 4U1033-26	158.76 -27.25	269.73 26.59	158.52 -26.75	159.21 -27.53	158.93 -27.72	158.24 -26.94	.256	.82 .10			S	A1060 **	CLUSTER OF GALAXIES
3A1057-224	2A1058-226 4U1057-21	164.48 -22.40	271.92 33.43	164.76 -23.27	163.79 -21.71	164.13 -21.53	165.10 -23.08	.579	.56 .12			S	A1146 *	CLUSTER OF GALAXIES
3A1102+385	2A1102+384	165.54 38.56	179.57 65.09	165.30 38.51	165.61 38.77	165.77 38.66	165.46 38.39	.047	1.05 .07	0.00 .40	7.68 .48	I	MKN421 ***	BL LAC OBJECT [A,E,F]
3A1139-377	2A1135-373 4U1136-37	174.75 -37.73	288.05 22.83	174.30 -37.26	175.47 -37.99	175.24 -38.22	174.07 -37.49	.278	1.31 .14			S	NGC3783 ***	SEYFERT GALAXY [B,F]
3A1140-480		175.10 -48.06	291.33 12.99	174.44 -48.13	175.15 -47.63	175.73 -47.99	175.01 -48.50	.293	.42 .11			S		
3A1141+198	2A1141+199 4U1143+19	175.30 19.82	235.42 72.74	175.67 20.18	175.23 19.29	174.88 19.45	175.32 20.33	.271	.79 .10			S	A1367 ****	CLUSTER OF GALAXIES [C]
3A1146-118	4U1147-12?	176.62 -11.86	279.83 47.92	175.87 -12.47	176.76 -11.17	177.16 -11.43	176.27 -12.73	.552	.31 .09			S		A1391 (D=6, R=2, BMI) ON EDGE OF BOX
3A1148+719	2A1150+720	177.08 71.98	129.54 44.65	178.31 71.76	175.46 71.92	175.60 72.19	178.49 72.02	.190	.86 .08			S		PROBABLY >1 SOURCE A1382 & STAR YY DRA NEAR BOX
3A1200+278		180.24 27.86	207.72 79.35	179.83 27.23	180.27 28.71	180.60 28.63	180.16 27.15	.410	.30 .06			S		

[A] : HEARN ET AL.1979.
[B] : DOWER ET AL.1980.
[C] : JONES ET AL.1979.
[D] : McHARDY ET AL.1981.
[E] : RICKETTS ET AL.1976.
[F] : MARSHALL ET AL.1981.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	LII BII	ERROR BOX RA DEC	RA DEC	RA DEC	RA DEC	AREA	FLUX AV ERR	MIN ERR	MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1208+396	2A1207+397 4U1206+39	182.02 39.67	155.06 75.08	182.10 39.65	181.96 39.61	181.93 39.68	182.07 39.72	.007	3.14 .06	0.00 1.32	10.68 3.12	I	NGC4151 ****	SEYFERT GALAXY [E,H,I]
3A1218+303	2A1219+305	184.64 30.39	187.01 82.70	184.77 30.44	184.69 30.26	184.49 30.33	184.58 30.51	.029	.93 .05			S	BL LAC OBJ ***	[J,K,N]
3A1226+023	2A1225+022 4U1226+02	186.54 2.37	289.70 64.38	186.36 2.41	186.61 2.54	186.72 2.35	186.46 2.22	.047	1.88 .08	0.00 1.48	3.52 .32	I	3C273 ****	QUASAR [B,C,K]
3A1228+125	2A1228+125 4U1228+12	187.16 12.59	284.15 74.44	187.14 12.66	187.22 12.57	187.17 12.52	187.09 12.61	.006	6.13 .10			S	VIRGO CL ****	[G,O]
3A1237-049	4U1240-057 H1238-049 [F]	189.46 -4.95	297.81 57.54	188.99 -4.84	189.85 -4.72	189.90 -5.09	189.04 -5.21	.261	1.22 .24			S	NGC4593 ***	SEYFERT GALAXY [D]
3A1246-411	2A1246-410 4U1246-41	191.56 -41.11	302.44 21.49	191.41 -40.98	191.73 -41.03	191.68 -41.21	191.36 -41.15	.032	2.64 .13			S	CEN CL ****	CLUSTER OF GALAXIES
3A1250-289	2A1251-290 4U1249-28 [A]	192.51 -28.95	303.27 33.65	192.38 -28.87	192.65 -28.89	192.63 -29.03	192.36 -29.01	.027	2.07 .09			S	EX HYA ****	DWARF NOVA [A,L] V≈11.5-13.7
3A1254-171	A1254-16 H1256-171 [F]	193.73 -17.15	305.02 45.42	193.20 -17.16	194.04 -16.74	194.25 -17.12	193.42 -17.55	.308	.50 .17			S	A1644 *	CLUSTER OF GALAXIES [Q]
3A1257+282	2A1257+283 4U1257+28	194.40 28.22	56.79 87.93	194.39 28.19	194.36 28.23	194.41 28.25	194.43 28.21	.002	6.52 .08			S	COMA CL ****	= A1656 [P] CLUSTER OF GALAXIES
3A1306-015	2A1306-012	196.58 -1.57	311.88 60.73	196.98 -1.37	196.31 -1.99	196.12 -1.78	196.78 -1.16	.210	1.06 .09			S	A1689 ***	PROBABLY >1 SOURCE (CONFIRMED BY EINSTEIN IPC [M])

[A] : BRADT ET AL.1979A.
[B] : BRADT ET AL.1979B.
[C] : TANANBAUM ET AL.1979.
[D] : DOWER ET AL.1980.
[E] : ELVIS 1976.
[F] : MARSHALL ET AL.1979.
[G] : LAWRENCE 1978.
[H] : GRIFFITHS ET AL.1979B.
[I] : LAWRENCE 1980.
[J] : SCHWARTZ ET AL.1979A.
[K] : MARSHALL ET AL.1981.
[L] : WATSON ET AL.1978.
[M] : LEICESTER EINSTEIN GUEST OBS.
[N] : WILSON ET AL.1979.
[O] : GORENSTEIN ET AL.1977.
[P] : GORENSTEIN ET AL.1979.
[Q] : RICKETTS 1978.

1981MNRAS.197..893M

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	FLUX CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1311+448		197.98 44.81	109.76 71.99	197.91 44.35	197.36 45.01	197.97 45.26	198.51 44.59	.303	.42 .14			S		MCG8-24-094 & OTHER GALAXIES IN ERROR BOX
3A1312+366	H1310+371 [F]	198.06 36.69	96.59 79.49	198.04 36.14	197.45 36.88	198.01 37.16	198.60 36.42	.372	.21 .07			S	NGC5033 *	HEXELG [F]
3A1322-427	2A1322-427 4U1322-42	200.62 -42.73	309.51 19.45	200.71 -42.69	200.66 -42.80	200.53 -42.78	200.57 -42.66	.010	9.04 .14	4.60 .60	17.32 1.12	I	NGC5128 ****	RADIO GALAXY, CEN A [I,J,K]
3A1327-312	2A1326-311 4U1325-31 MX1325-31	201.75 -31.26	312.44 30.64	201.76 -30.69	202.24 -31.70	201.72 -31.88	201.24 -30.87	.406	.93 .16			S	CLUSTER **	
3A1344-325	2A1344-325 4U1345-32 MX1347-32	206.24 -32.58	316.41 28.56	205.91 -32.61	206.39 -32.42	206.48 -32.59	206.01 -32.78	.068	2.75 .12			S	CLUSTER **	
3A1346+269	2A1346+266 4U1348+25?	206.72 26.91	34.16 77.13	206.89 27.06	206.70 26.73	206.55 26.80	206.74 27.13	.043	1.08 .05			S	A1795 ****	CLUSTER OF GALAXIES [A]
3A1346-301	2A1347-300	206.70 -30.11	317.56 30.85	207.09 -30.28	206.24 -30.27	206.25 -29.93	207.09 -29.94	.182	1.76 .17	.88 .40	5.64 .12	I	IC4329A ***	SEYFERT GALAXY IN A CLUSTER. [B,H]
3A1348+700	2A1348+700	207.04 70.06	115.74 46.50	207.52 69.65	205.88 70.24	206.53 70.46	208.17 69.86	.200	.56 .08			S	MCG12-13-24 **	HEXELG. SEYFERT MKN279 V.NEAR HEAO A-3 ERROR BOX [C,H]
3A1357+629		209.32 62.94	110.26 52.74	209.65 62.54	208.52 63.27	208.89 63.39	210.02 62.65	.144		0.00 .32	3.64 .56	T		SAO16229 V=7.3 IN ERROR BOX
3A1411-028	2A1410-029 4U1410-03	212.96 -2.89	339.66 53.73	213.27 -2.83	212.73 -3.10	212.64 -2.92	213.19 -2.65	.091	1.36 .09			S	NGC5506 ***	HEXELG [D,E,G]

[A] : JONES ET AL.1979.
[B] : DELVAILLE ET AL.1978B.
[C] : DOWER ET AL.1980.
[D] : RICKER ET AL.1977.
[E] : GRIFFITHS ET AL.1979A.
[F] : MARSHALL ET AL.1979.
[G] : MARSHALL & WARWICK 1979.
[H] : MARSHALL ET AL.1981.
[I] : COOKE ET AL.1978B.
[J] : DELVAILLE ET AL.1978A.
[K] : LAWRENCE ET AL.1977.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	FLUX CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1415+253	2A1415+255 4U1414+25	213.91 25.36	31.92 70.51	213.64 25.23	214.06 25.59	214.18 25.48	213.76 25.12	.066	.93 .05			S	NGC5548 ***	SEYFERT GALAXY [E,F]
3A1422+481	2A1418+485	215.73 48.19	88.07 62.36	215.38 47.91	215.49 48.49	216.03 48.45	215.92 47.87	.170	.44 .06			S		SAO45045 V=7.4 IN BOX. PROB.>1 SOURCE
3A1422+425		215.56 42.58	77.81 65.75	216.29 42.79	215.22 42.04	214.76 42.39	215.83 43.14	.429	.61 .17			S		GALAXY NGC5608 NEAR ERROR BOX
3A1431-409		217.87 -40.95	323.04 17.64	217.06 -41.01	218.31 -40.40	218.67 -40.81	217.41 -41.43	.414		0.00 .36	4.60 .92	T	STAR **	PROBABLE RS CVN SYSTEM V=12.2 [B,G,H]
3A1509+058	2A1508+062 MX1514+06?	227.36 5.88	6.64 50.32	227.53 5.74	227.12 5.77	227.14 6.04	227.55 6.02	.089	1.85 .15			S	A2029 **	CLUSTER OF GALAXIES
3A1514+264	2A1518+274	228.65 26.43	39.81 57.64	228.14 26.08	228.88 27.00	229.17 26.81	228.43 25.89	.310	.37 .07			S		ZWG135.036 (PLUS OTHERS) IN ERROR BOX
3A1518+080	2A1519+082	229.51 8.06	11.34 49.83	229.09 8.04	229.82 8.40	229.96 8.12	229.23 7.77	.190	.55 .14			S	MKW3S ****	CD GROUP, DOMINANT GALAXY IS NGC5920 [D]
3A1558+276	2A1556+274 4U1556+27	239.60 27.61	44.71 48.27	239.31 27.50	239.71 27.82	239.86 27.68	239.45 27.36	.072	1.56 .06			S	A2142 **	CLUSTER OF GALAXIES
3A1559+162	2A1600+164 4U1601+15	239.99 16.25	29.08 44.58	239.66 16.13	240.16 16.55	240.29 16.40	239.80 15.98	.102	.96 .06			S	A2147 ****	CLUSTER OF GALAXIES [C]
3A1612-752	2A1556-756	243.07 -75.20	314.98 -17.56	239.93 -75.26	245.44 -74.79	245.91 -75.11	240.30 -75.59	.388	.91 .12			S		

[A] : BRADT ET AL.1979A.
[B] : COOKE 1976.
[C] : JONES ET AL.1979.
[D] : KRISS ET AL.1980.
[E] : GRIFFITHS ET AL.1979B.
[F] : MARSHALL ET AL.1981.
[G] : FAIRALL, PRIVATE COMMUNICATION.
[H] : BOOTH & CHARLES, PRIVATE COMM.

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1617-155	2A1616-155 4U1617-15 SCO X-1[A]	244.26 -15.55	359.07 23.77	244.17 -15.58	244.31 -15.47	244.35 -15.52	244.21 -15.63	.008	4768. 21.	3584. 114.	6274. 210.	I	V818 SCO ****	[A] STAR V=12.2-13.3
3A1627+397	2A1626+396 4U1627+39	246.88 39.71	63.01 43.58	247.17 39.83	246.72 39.49	246.57 39.61	247.02 39.95	.062	1.34 .06			S	A2199 **	CLUSTER OF GALAXIES
3A1627-674	2A1627-673 4U1626-67 [A]	246.84 -67.40	321.76 -13.13	246.77 -67.27	247.17 -67.46	246.90 -67.54	246.50 -67.35	.025	10.02 .24	7.04 1.00	11.20 .52	I	STAR ****	[A] V=18.5 7.7S PULSAR
3A1631+060	2A1630+057 4U1636+05	247.92 6.01	21.63 33.10	247.34 5.97	248.26 6.45	248.46 6.06	247.54 5.58	.346	.49 .09			S		A2204 IN ERROR BOX
3A1633-644	2A1631-644 4U1631-64	248.41 -64.41	324.48 -11.63	248.36 -64.16	248.87 -64.52	248.36 -64.66	247.85 -64.30	.084	2.63 .20			S	CLUSTER **	
3A1653+398	4U1651+39	253.27 39.88	63.68 38.69	250.39 38.69	255.61 41.07	255.79 40.81	250.59 38.45	1.150	.64 .09			S	MKN501 ***	BL LAC OBJECT [C]
3A1656+353	2A1655+353 4U1656+35 HER X-1[A]	254.04 35.38	58.11 37.49	253.92 35.38	254.11 35.46	254.16 35.39	253.97 35.31	.011	5.46 .08	0.00 1.00	42.80 1.84	I	HZ HER ****	[A] LATE A - EARLY F STAR B=13.2-14.7
3A1702+340	2A1659+337	255.51 34.09	56.79 36.07	254.43 33.80	256.34 34.67	256.56 34.33	254.65 33.47	.553	.41 .08			S		CLUSTERS A2244 & A2245 IN ERROR BOX
3A1703+241	2A1704+241 4U1703+26?	255.95 24.14	45.20 33.17	256.15 24.08	255.78 23.97	255.70 24.18	256.07 24.30	.063	1.22 .08	0.00 .76	4.20 .60	I	HD154791 ***	M STAR V=7.5 [D]
3A1703+611	2A1705+609	255.95 61.17	90.54 36.36	256.51 61.59	256.25 60.69	255.33 60.75	255.57 61.65	.324	.44 .09			S		GAL. NGC6292 IN BOX. QSO 3CR351 IN BOX[E]

[A] : BRADT ET AL.1979A.
[B] : JONES ET AL.1979.
[C] : SCHWARTZ ET AL.1978.
[D] : GARCIA ET AL.1980.
[E] : ZAMORANI ET AL.1981.

1981MNRAS.197..893M

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	LII BII	ERROR BOX RA DEC	RA DEC	RA DEC	RA DEC	AREA	FLUX AV ERR	MIN ERR	MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A1709+787	2A1705+786 4U1707+78	257.46 78.72	110.97 31.61	256.60 78.56	257.16 78.89	258.07 78.83	257.49 78.51	.049	1.06 .07			S	A2256 ****	CLUSTER OF GALAXIES [B]
3A1815+498	2A1815+500 4U1813+50 [A]	273.76 49.84	77.85 25.86	273.61 49.80	273.73 49.94	273.91 49.88	273.78 49.73	.016	2.33 .08			S	AM HER ****	[A] STAR V=13.1-12.3
3A1822-371	2A1822-371 4U1822-37 SGR X-7[A]	275.63 -37.13	356.87 -11.32	275.49 -37.14	275.67 -37.03	275.75 -37.12	275.58 -37.23	.016	10.27 .15	8.84 .56	13.16 .76	I	STAR ****	[A,C] V=16.3
3A1830+779		277.57 77.96	109.42 27.72	275.86 77.68	277.19 78.39	279.11 78.23	277.70 77.53	.253	.40 .08			S		STAR SAO9151 (K0, V=5.8) V. NEAR ERROR BOX
3A1851-312	4U1849-31	282.97 -31.20	4.99 -14.36	283.17 -31.13	282.89 -31.40	282.73 -31.28	283.01 -31.01	.053	1.76 .14			S	V1223 SGR ***	CATACLYSMIC VARIABLE V=13.2-14.2 [D,G]
3A1914-591	2A1914-589 4U1924-59?	288.54 -59.15	337.69 -26.42	287.43 -59.14	289.05 -58.71	289.52 -59.16	287.89 -59.60	.390	.56 .16			S	ESO141-G55 ***	SEYFERT GALAXY [E,F]
3A1919+438	2A1919+438 4U1919+44	289.98 43.85	75.71 13.46	289.80 43.80	289.99 43.98	290.14 43.90	289.94 43.72	.023	2.69 .10			S	A2319 ****	CLUSTER OF GALAXIES [B]
3A1926-450		291.68 -45.05	353.48 -25.37	292.17 -44.65	291.86 -45.59	291.17 -45.47	291.50 -44.54	.370	.33 .08			S		
3A1937-104	2A1938-105	294.45 -10.48	29.08 -15.55	294.96 -10.27	294.04 -10.93	293.90 -10.73	294.82 -10.07	.230	.85 .07			S	NGC6814 **	SEYFERT GALAXY [E]
3A1956+041		299.07 4.19	44.70 -12.86	297.96 3.18	299.79 5.34	300.05 5.12	298.22 2.96	.940		0.00 .32	4.92 .60	T		

[A] : BRADT ET AL.1979A.
[B] : JONES ET AL.1979.
[C] : WHITE ET AL.1980.
[D] : REID ET AL.1980.
[E] : MARSHALL ET AL.1981.
[F] : GRIFFITHS ET AL.1979B.
[G] : STEINER ET AL.1980.

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A2008-568	2A2009-569	302.03 -56.88	340.98 -33.34	301.44 -56.95	302.24 -56.55	302.62 -56.77	301.81 -57.18	.140	1.44 .12			S	CLUSTER *	
3A2041-107	2A2040-115	310.36 -10.78	36.10 -29.80	310.08 -10.96	310.38 -10.47	310.61 -10.60	310.31 -11.10	.118	.99 .09			S	MKN509 ***	SEYFERT GALAXY [D,E]
3A2127+119	2A2127+120 4U2129+12 [A]	321.87 11.98	65.03 -27.28	321.69 11.97	321.96 12.10	322.03 11.96	321.76 11.82	.039	2.49 .11	1.28 .36	19.36 .76	I	NGC7078 ****	[A] GLOBULAR CLUSTER
3A2142+380	2A2142+381 4U2142+38 CYG X-2[A]	325.62 38.08	87.30 -11.31	325.67 38.06	325.59 38.04	325.57 38.09	325.65 38.11	.003	165.0 .8	113.1 3.7	280.0 9.8	I	STAR ****	[A] V=15.5
3A2153-607	2A2155-609	328.33 -60.76	331.94 -45.56	326.88 -61.29	328.92 -59.95	329.67 -60.21	327.64 -61.57	.601	.74 .16			S		
3A2156-306	2A2151-316 H2155-304	329.03 -30.60	17.51 -52.29	329.27 -30.52	328.83 -30.85	328.70 -30.72	329.15 -30.39	.063	1.01 .06	0.00 .36	4.24 .68	I	PKS2155-30 ***	BL LAC OBJECT [B,D]
3A2159-320	H2158-321 [C]	329.92 -32.08	15.19 -53.18	330.62 -31.84	329.40 -32.66	329.11 -32.34	330.33 -31.53	.400	.50 .07			S		NGC7172 & OTHER NEARBY GALAXIES IN BOX
3A2202-477	H2209-471 [C]	330.55 -47.71	349.45 -51.85	331.76 -46.85	329.70 -48.96	329.08 -48.69	331.16 -46.59	.997	.22 .08			S		SEYFERT NGC7213 NEAR BOX. STAR ALPHA GRU (B5 V, V=1.7) IN BOX
3A2214-103		333.55 -10.36	50.48 -49.85	332.78 -11.14	333.96 -9.34	334.29 -9.55	333.11 -11.35	.708	.44 .12			S		
3A2221-018	2A2220-022 H2216-0277 [C]	335.28 -1.88	62.37 -46.39	334.94 -2.29	335.18 -1.40	335.58 -1.51	335.33 -2.40	.300	.63 .10			S	A2440 *	CLUSTER OF GALAXIES

[A] : BRADT ET AL.1979A.
[B] : SCHWARTZ ET AL.1979A.
[C] : MARSHALL ET AL.1979.
[D] : MARSHALL ET AL.1981.
[E] : DOWER ET AL.1980.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	LII BII	ERROR BOX RA DEC	RA DEC	RA DEC	RA DEC	AREA	FLUX AV ERR	MIN ERR	MAX ERR	CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A2228-382	H2233-378 [H]	337.13 -38.27	3.62 -58.77	337.64 -38.02	336.84 -38.71	336.56 -38.51	337.37 -37.82	.210	.61 .06			S		NGC7297,7299 IN BOX
3A2233-259	2A2237-256 MX2244-247	338.43 -25.97	27.86 -59.84	337.96 -26.23	338.51 -25.52	338.83 -25.72	338.28 -26.43	.230	.61 .07			S	NGC7314 **	HEXELG [D,G]
3A2248-185	2A2251-179	342.04 -18.51	44.29 -60.89	342.74 -17.98	341.51 -19.22	341.31 -19.04	342.54 -17.80	.377	.70 .09			S	MR2251-179 ***	QUASAR/SEYFERT [A,G]
3A2253-033	H2252-035 [H]	343.38 -3.32	69.06 -53.40	343.85 -3.20	343.12 -3.77	342.86 -3.43	343.58 -2.87	.302	.65 .11			S	STAR ***	CATACLYSMIC VARIABLE V=13 [E]
3A2258+083	2A2259+085 4U2300+08	344.68 8.40	82.34 -45.34	345.10 8.23	344.26 8.11	344.19 8.56	345.03 8.69	.290	.86 .10	0.00 .60	2.68 .36	I	NGC7469 ***	SEYFERT GALAXY [B,G]
3A2302-089	2A2302-088 4U2305-07?	345.66 -8.98	64.21 -58.87	345.84 -8.91	345.64 -9.20	345.44 -9.06	345.65 -8.77	.065	1.40 .10			S	MCG-2-58-22 ***	SEYFERT GALAXY [B,G]
3A2316-426	2A2315-428	349.06 -42.61	348.02 -65.81	348.87 -42.69	349.06 -42.42	349.24 -42.49	349.05 -42.76	.034	1.00 .05			S	NGC7582 ****	[C,F]
3A2316-280	2A2318-272	349.22 -28.06	25.77 -69.64	348.58 -28.73	349.28 -27.28	349.71 -27.45	349.01 -28.90	.552	.34 .06			S		
3A2320+163	2A2322+166 4U2315+15	350.01 16.34	94.12 -41.23	350.49 16.08	349.52 16.01	349.47 16.60	350.45 16.67	.425	.38 .09			S	A2589 *	CLUSTER OF GALAXIES
3A2345-283	2A2344-285	356.36 -28.31	25.59 -75.93	356.16 -28.51	356.28 -28.07	356.53 -28.12	356.41 -28.57	.080	.63 .05			S	KLEM. 44 **	CLUSTER OF GALAXIES

[A] : RICKER ET AL.1978.
[B] : DOWER ET AL.1980.
[C] : WARD ET AL.1978.
[D] : McHARDY ET AL.1981.
[E] : GRIFFITHS ET AL.1980.
[F] : MACCACARO & PEROLA 1981.
[G] : MARSHALL ET AL.1981.
[H] : MARSHALL ET AL.1979.

Table 1 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX RA DEC	ERROR BOX AREA	FLUX AV ERR	FLUX MIN ERR	FLUX MAX ERR	FLUX CODE	IDENT OBJECT CODE	OTHER INFORMATION
3A2355+284	A0000+28	358.88 28.40	109.00 -32.74	1.75 27.68	355.75 28.76	355.81 29.06	1.83 27.98	1.090		0.00 .32	3.88 .80	T	HD224085 ***	RS CVN SYSTEM [A,B] V=7.5
3A2356-341	4U0009-33?	359.04 -34.17	358.91 -76.80	358.35 -35.08	359.25 -33.22	359.56 -33.32	358.67 -35.19	.510	.40 .06			S		(CD?)GROUP IN SOUTH PART OF BOX. NGC7793 OUTSIDE BOX TO NORTH

[A] : COOKE 1976.

[B] : SCHWARTZ ET AL.1981.

communication). In addition for 3A 1306 – 015, Leicester guest observations with the *Einstein* X-ray observatory imaging proportional counter (IPC) show two sources about 40 arcmin apart, the stronger of which is identified with the cluster of galaxies Abell 1689 (D = 6, R = 4, BM = II–III).

The complete (i.e. high and low galactic latitude) 3A catalogue of 250 X-ray sources is shown mapped on the sky in Fig. 1(a).

5 Discussion

This catalogue contains 142 sources, 37 more than in the 2A catalogue. The main effect of increasing the data base from 10 000 to 30 000 orbits has not been to increase the maximum depth of the survey as this is limited by the number of consecutive orbits which can be summed over a particular point, but has been to improve both the uniformity of the sky coverage and the average error box size, and to increase the possibility of detecting variable sources. These points are considered in greater depth in Section 5.1 where a more detailed comparison is made between the 2A and 3A catalogues. Comparison is also made between the 3A and both the *HEAO–A2* (Marshall *et al.* 1979) and 4U (Forman *et al.* 1978) X-ray source lists. The identification content of this catalogue is summarized in Table 4 and discussed in detail in Section 5.2 where again comparison is made with 2A. Finally, in Section 5.3, we consider the possible nature of the unidentified sources.

5.1 COMPARISON OF 3A WITH 2A, A2 AND 4U

5.1.1 3A versus 2A

Of the 105 sources listed in 2A, 96 remain in 3A. The PST is not used in 3A and of the 10 PST sources listed in 2A, three are discussed below and the other seven are now 3A sources. The nine 2A sources which are not included in 3A are listed in Table 2. Two of these, of which one was a PST source, have been jointly replaced by a single source and two more are PST sources with fluxes below the 3A limit for their respective regions of sky. For all the remaining five there is some evidence in the data base. However, our present criteria for acceptance of both lops and sources is marginally more rigorous than in 2A and these five do not satisfy the present criteria.

Of the remaining 96, 34 have error box areas which have been substantially improved (factor 2 reduction or better), 56 are essentially unchanged and six are substantially ($\geqslant$ factor 2) worse. These changes are explained by a combination of an increase in the data base, an improvement in the positioning of the LOPs by using the precisely known positions

Table 2. 2A sources not included in the 3A catalogue.

Source	Comments
2A 0054 – 015	
2A 0102 – 222	PST } source Both replaced by 3A 0103 – 232
2A 0102 – 242	
2A 0349 – 139	
2A 0456 – 449	
2A 0708 – 357	PST source
2A 0815 – 075	
2A 0859 + 509	PST source
2A 1854 + 683	12 nearly parallel, overlapping LOPs in this region

Table 3. *HEAO-A2* and 4U sources not included in the 3A catalogue but for which there is some evidence in the SSI data base.

H 0111 – 149	H 1332 – 336
4U 0148 + 36	H 1645 – 284
4U 0519 + 06	4U 1916 – 79
4U 0541 + 60	H 2226 + 014

of bright galactic sources, a marginal increase in the rigour with which these LOPs were selected, and an improved estimate of position errors.

The sky coverage is now more uniform than in 2A and the 90 per cent coverage flux has dropped from 1.2 to 0.8 SSI count s^{-1}. Forty-six additional sources are listed of which 22 have been presented in previous lists such as 4U and A2, and 24 are completely new. For the 22 additional sources already known, the 3A boxes are generally smaller leading to improved chances of identification e.g. see Section 5.2.3.

Finally, the variability code given to a number of sources has changed between 2A and 3A due to the three-fold increase in the data base. Different assignments of 'steady' or 'irregular' also occur for several sources in the more detailed study of active galaxies by Marshall, Warwick & Pounds (1981) using the same data base as 3A but with somewhat different criteria. Essentially, all these changes have occurred for sources lying near the boundary of the variability criteria used. Specifically in comparing 2A and 3A, three sources are now listed as 'irregular' which were 'steady' in 2A (viz. 3A 0609 + 491, 3A 1346 – 301 and 3A 1627 – 674), while six others have changed in the reverse direction (viz. 3A 0342 – 536, 3A 0430 – 615, 3A 0551 + 467, 3A 1218 + 303, 3A 2248 – 185 and 3A 2316 – 426). It is interesting to note that the first two sources in this group are both identified with rich southern clusters. The doubt on these associations which was noted in 2A on the grounds of the variability rating has now been removed.

5.1.2 3A versus A2 and 4U

In Table 1 we give the 4U or H designations of possible counterparts to 3A sources. In this way 73 4U and 12 H sources are mentioned. We do not give upper limits for the many sources we do not list. However, we do present, in Table 3, a list of 4U and H sources for which there is some supporting evidence in our data, but which do not fulfil our catalogue criteria. This evidence generally consists of two LOPs intersecting at the location of the H or 4U box.

5.2 THE IDENTIFIED SOURCES

The identification content of the catalogue is summarized in Table 4. The identifications have been drawn from previous studies (as referenced in Table 1), from examination of lists of well known interesting objects (Table 5), and from detailed study of the optical sky surveys, e.g. Palomar, UK Schmidt and ESO-B. To be considered as 'identified' an object must have at least one asterisk in the 'identification code' of Table 1. Objects listed only in the 'other information' column are included in Table 4 but are followed by a question mark. We do not claim good identifications with such objects but merely put them forward as possible candidates. We reserve the classification 'unidentified' for those sources about whose identification content we say nothing. The three main classes of identified sources,

Table 4. High galactic latitude optical identifications.

Type of object	Number of sources
Clusters of galaxies	32 + 5?
(cD) groups of galaxies	3 + 1?
Active galaxies (including QSOs and BL Lacs)	34 + 8?
Globular clusters	2
Other galactic stellar systems including sources in SMC and LMC	26 + 6?
Normal galaxies (M31)	1
SNRs (CTA 1)	1
Unidentified	23

Table 5. Catalogues and lists of interesting objects searched for possible coincidences with 3A error boxes.

Master List of Non-stellar Optical Astronomical Objects (Dixon & Sonneborn 1980).
This list includes, amongst other catalogues: Abell's catalogue of rich clusters of galaxies; NGC; Markarian lists of uv excess galaxies.
Variable Star Catalogue (Kukarkin *et al.* 1969)
RS CVn systems (e.g. compilation by Walter *et al.* 1980)
SAO Star Catalogue ($m_V \lesssim 7.5$) (Smithsonian Institution, Washington D.C., 1966).

i.e. clusters of galaxies, active galaxies and stars, are discussed in more detail below where comparison with the identification content of 2A is also drawn.

5.2.1 *Clusters of galaxies*

The number of sources identified with clusters in 3A is almost the same as in 2A. Six 2A sources which had clusters as proposed identifications have not been accepted for 3A, and three sources are no longer considered well identified with clusters due to movements of source position.

It is interesting to note that two clusters which are mentioned as possible identifications (Abell 22, Abell 1391) are distance class 6 clusters. However, both these clusters are very rich and of Bautz–Morgan (1970) class I, and so are plausible candidates. Their luminosities, if the identifications are confirmed, are $\approx 10^{45.5}\,\mathrm{erg\,s^{-1}}$ (2–10 keV) which would make them, by a small margin, the most luminous clusters detected by *Ariel V*.

5.2.2 *Active galaxies*

There were 16 active galaxies with identification codes of at least one asterisk in 2A which have since been confirmed by other spacecraft, and another two whose identification is now in doubt. A further three galaxies mentioned as possible identifications have also since been confirmed. Six unidentified 2A sources have subsequently been identified with active galaxies.

Eight new 3A sources can be confidently identified with active galaxies. It is also possible that some or all of 3A 2159 – 320, 3A 2202 – 477 and 3A 2228 – 382 will eventually be identified with one of the bright ($m_V \lesssim 13$) galaxies in or near their boxes.

5.2.3 *Stars*

One of the major differences between 2A and 3A is the far greater number of identifications with stars. By 'stars' we mean both individual stars and all types of binary system. Only six stars were identified in 2A as against 26 in 3A. Of the difference 10 resulted from the identification of existing 2A sources by higher resolution instruments and 10 from the identification of new sources. Collaboration with the *HEAO-1* A3 group has been particularly useful in this respect, leading to the identification of 3A 1851 – 312 with V1223 Sgr (Steiner *et al.* 1980) a 13th mag cataclysmic variable, 3A 2253 – 033 with a 13th mag cataclysmic variable (Griffiths *et al.* 1980) and the transient 3A 2355 + 284 with the RS CVn system HD 224085 (Schwartz *et al.* 1980b).

5.3 THE UNIDENTIFIED SOURCES

There are eight identifications with miscellaneous objects (see Table 4), leaving 23 sources 'unidentified'. By 'unidentified' we mean we cannot find any obvious possible counterparts in the error boxes and so have no entry for them in either the 'ident' or 'other information' columns of Table 1. The 20 sources for which we have no entry in the 'ident' column but for which we do make mention in the 'other information' column, and which therefore appear in Table 4 followed by a question mark, are also strictly speaking unidentified. However, from previous experience we expect at least say one third of these sources to be subsequently identified with the objects mentioned in the 'other information' column, and so we do not describe them by the term 'unidentified'. It is of interest to speculate what the 'unidentified' sources will eventually turn out to be. We consider the possibility of identification with members of previously known classes of X-ray emitting objects.

Apart from the clusters mentioned earlier it is unlikely that many more rich clusters will be proposed as possible identifications, as these are generally not too difficult to detect optically and so we would hope to have picked up any possible candidates in our examination of the error boxes on the Sky Surveys. It is more probable that a few poorer groups of galaxies will have been missed as, on the whole, these are less prominent and have a greater random chance of appearing in the error boxes. Also it is difficult to tell whether the group, or an individual galaxy therein, is responsible for the X-ray emission. (Of eight groups mentioned in 2A, four were subsequently shown to have genuine poor cluster emission and four turned out to be active galaxies in the groups.)

It is unlikely that many more of the larger optically bright active galaxies, over and above those mentioned in the comments, will be identified as there are few such galaxies in the error boxes. Many of the boxes contain fainter optical galaxies ($m_V \gtrsim 15$) but unless they have significantly higher X-ray to optical luminosity ratios (L_X/L_{opt}) than those already known, they are unlikely to be powerful X-ray sources. The identifications are therefore very likely to be with stellar type objects. The unidentified sources are isotropically distributed and so we must consider either distant objects such as QSOs and BL Lacs, or nearby (~ 100 pc) stars.

Considering first QSOs, we have searched our data base for evidence of X-ray emission from the well known optically bright members of the class. 3C 273 ($B = 13.1$) and MR 2251 – 179 ($B = 16.0$) are detected but there is no evidence for any of the six QSOs with $B < 16.5$ listed by Green (1976) in his survey of 10 000 deg^2 of the sky. We therefore do not expect that many of the presently unidentified sources will be identified with QSOs. The situation regarding BL Lacs is more complex as they are more difficult to find systematically. However, as with the QSOs, it is possible to make the broad statement that, apart from the optically brightest examples of the class such as Mkn 421, 1218 + 303 and Mkn 501, we do not detect the well known BL Lacs (e.g. Stein, O'Dell & Strittmatter 1976). We therefore do not expect to identify many of the 3A unidentified sources with BL Lacs.

Considering nearby stars, the two well known classes of X-ray emitting stars above 2 keV are RS CVn systems and cataclysmic variables. With the exception of the 12 mag probable RS CVn which we propose as a possible identification for 3A 1431–409, all other RS CVns detected by the SSI are $\lesssim 8$ mag. They are also, in general, associated with transient X-ray sources. However, the vast majority of unidentified sources are not transients and their error boxes contain few stars brighter than 8 mag, so we do not expect that many more will eventually be identified with RS CVn systems similar to those which we have already found. Cataclysmic variables, on the other hand, can typically be detected by the SSI at optical magnitudes 13–15, and within the limits of the SSI's sensitivity are usually classed as 'steady'. We therefore consider them reasonable candidates for the identification of the presently unidentified sources.

Acknowledgments

It is a pleasure to acknowledge the assistance and advice we have had from other members of the X-ray Astronomy Group at Leicester and in particular from Clive Page, Martin Ricketts, Mike Watson, Martin Elvis and Pete Grimley. We thank those members of the scientific, engineering and technical staff responsible for the design and construction of the SSI. The efficient operation of *Ariel V* by the team at the Appleton Laboratory, Slough, is also acknowledged. We have benefited from discussions on the SSI and *HEAO-A2* data with Frank Marshall and Richard Mushotzky (NASA Goddard Space Flight Center). The *Ariel V* project is funded by the SRC, which also provided financial support for Ian McHardy, Andy Lawrence and John Pye.

References

Bautz, L. P. & Morgan, W. W., 1970. *Astrophys. J.*, **162**, L149.

Bradt, H. V., Burke, B. F., Canizares, C. R., Greenfield, P. E., Kelley, R. L., McClintock, J. E., Van Paradijs, J. and Koski, A. T., 1978. *Astrophys. J.*, **226**, L111.

Bradt, H. V., Doxsey, R. E. and Jernigan, J. E., 1979a. *(COSPAR) X-ray Astronomy*, p. 3, eds Baity, W. A. & Peterson, L. E., Pergamon Press, Oxford.

Bradt, H. V., Doxsey, R. E., Johnston, M. D., Schwartz, D. A., Burkhead, M. S., Dent, W. A., Liller, W. & Smith, A. G., 1979b. *Astrophys. J.*, **230**, L5.

Charles, P., Thorstenson, J., Bowyer, S. & Middlemarch, J., 1979. *Astrophys. J.*, **231**, L131.

Condon, J. J., 1974. *Astrophys. J.*, **188**, 279.

Cooke, B. A., 1976. *Nature*, **262**, 195.

Cooke, B. A., Lawrence, A. & Perola, G. C., 1978b. *Mon. Not. R. astr. Soc.*, **182**, 661.

Cooke, B. A., Ricketts, M. J., Maccacaro, T., Pye, J. P., Elvis, M., Watson, M. G., Griffiths, R. E., Pounds, K. A., McHardy, I., Maccagni, D., Seward, F. D., Page, C. G. & Turner, M. J. L., 1978a. *Mon. Not. R. astr. Soc.*, **182**, 489.

Delvaille, J. P., Epstein, A. & Schnopper, H. W., 1978a. *Astrophys. J.*, **219**, L81.

Delvaille, J. P., Geller, M. J. & Schnopper, H. W., 1978b. *Astrophys. J.*, **226**, L69.

Dixon, R. S. & Sonneborn, G., 1980. *Master List of Nonstellar Optical Astronomical Objects*, Ohio State University Press.

Dower, R. G., Griffiths, R. E., Bradt, H. V., Doxsey, R. E. & Johnston, M. D., 1980. *Astrophys. J.*, **235**, 355.

Elvis, M., 1976. *Mon. Not. R. astr. Soc.*, **177**, 7P.

Forman, W., Jones, C., Cominsky, L., Julien, P., Murray, S., Peters, G., Tananbaum, H. & Giacconi, R., 1978. *Astrophys. J. Suppl.*, **38**, 357.

Garcia, M., Conroy, M., Doxsey, R., Griffiths, R. E., Johnston, M., Ralph, E., Roberts, W. & Schwartz, D. A., 1980. *Bull. Am. astr. Soc.*, **12**, 527.

Gorenstein, P., Fabricant, D., Topka, K., Tucker, W. & Harnden, F. R., 1977. *Astrophys. J.*, **216**, L95.

Gorenstein, P., Fabricant, D., Topka, K., Harnden, F. R. & Tucker, W. H., 1978. *Astrophys. J.*, **224**, 718.

Gorenstein, P., Fabricant, D., Topka, K. & Harnden, F. R., 1979. *Astrophys. J.*, **230**, 26.

Green, R. F. 1976. *Publs astr. Soc. Pacif.*, **88**, 665.

Griffiths, R. E. & Seward, F. D., 1977. *Mon. Not. R. astr. Soc.*, **180**, 75P.

Griffiths, R. E., Doxsey, R. E., Johnston, M. D., Schwartz, D. A., Schwarz, J. & Blades, J. G., 1979a. *Astrophys. J.*, **230**, L21.

Griffiths, R. E., Briel, U., Schwartz, D. A., Schwarz, J., Doxsey, R. E. & Johnston, M. D., 1979b. *Mon. Not. R. astr. Soc.*, **188**, 813.

Griffiths, R. E., Ward, M. J., Blades, J. C., Wilson, A. S., Chaisson, L. & Johnston, D., 1979c. *Astrophys. J.*, **232**, L27.

Griffiths, R. E., Lamb, D. Q., Ward, M. J., Wilson, A. S., Charles, P. A., Thorstensen, J., McHardy, I. M. & Lawrence, A., 1980. *Mon. Not. R. astr. Soc.*, **193**, 25P.

Hearn, D. R., Marshall, F. J. & Jernigan, J. G., 1979. *Astrophys. J.*, **227**, L63.

Jones, C., Mandel, E., Schwarz, J., Forman, W., Murray, S. S. & Harnden, F. R., 1979. *Astrophys. J.*, **234**, L21.

King, A. R., Ricketts, M. J. & Warwick, R. S., 1979. *Mon. Not. R. astr. Soc.*, **187**, 77P.

Kriss, G. A., Canizares, C. R., McClintock, J. E. & Feigelson, E. D., 1980. *Astrophys. J.*, **235**, L61.

Kukarkin, B. V., Kholopov, P. N., Efremov, Yu. N., Kukarkina, N. P., Kurochkin, N. E., Medvedeva, G. I., Perova, N. B., Psorsky, Yu. P., Fedorovich, V. P. & Frolov, M. S., 1969. *General Catalogue of Variable Stars;* 1971, Supplement, Astron. Council Acad. Sci. USSR, Moscow.

Lawrence, A., 1978. *Mon. Not. R. astr. Soc.*, **185**, 423.

Lawrence, A., 1980. *Mon. Not. R. astr. Soc.*, **192**, 83.

Lawrence, A., Pye, J. P. & Elvis, M., 1977. *Mon. Not. R. astr. Soc.*, **181**, 93P.

Maccacaro, T. & Perola, G. C., 1981. *Astrophys. J.*, **246**, L11.

Markert, T. H., Canizares, C. R., Clark, G. W., Li, F. K., Northridge, P. L., Sprott, G. F. & Wargo, G. F., 1976. *Astrophys. J.*, **206**, 265.

Marshall, F. E., Boldt, E. A., Holt, S. S., Mushotzky, R. F., Pravdo, S. H., Rothschild, R. E. & Serlemitsos, P. J., 1979. *Astrophys. J. Suppl.*, **40**, 657.

Marshall, N. & Warwick, R. S., 1979. *Mon. Not. R. astr. Soc.*, **189**, 37P.

Marshall, N., Warwick, R. S. & Pounds, K. A., 1981. *Mon. Not. R. astr. Soc.*, **194**, 987.

Mills, B. Y. & Slee, O. B., 1957. *Aust. J. Phys.*, **10**, 162.

Mills, B. Y., Davies, I. M. & Robertson, J. G., 1973. *Aust. J. Phys.*, **26**, 417.

Murdoch, H. S., Crawford, D. F. & Jauncey, D. L., 1973. *Astrophys. J.*, **183**, 1.

McHardy, I. M. *et al.*, 1981. In preparation.

Pravdo, S. H., Boldt, E. A., Marshall, F. E., McKee, J., Mushotzky, R. F., Smith, B. W. & Reichert, G., 1979. *Astrophys. J.*, **234**, 1.

Pye, J. P. & Cooke, B. A., 1976. *Mon. Not. R. astr. Soc.*, **177**, 21P.

Reid, C. A., Johnston, M. D., Bradt, H. V., Doxsey, R. E., Griffiths, R. E. & Schwartz, D. A., 1980. *Astr. J.*, **85**, 1062.

Ricker, G. R., 1978a. *Nature*, **271**, 334.

Ricker, G. R., Dower, R. G., Jernigan, J. G., Doxsey, R. E., Bradt, H. V. & Schnopper, H. W., 1977. MIT preprint no. CSR-P-77-33.

Ricker, G. R., Clarke, G. W., Doxsey, R. E., Dower, R. G. & Jernigan, J. G., 1978b. *Nature*, **271**, 35.

Ricketts, M. J., 1978. *Mon. Not. R. astr. Soc.*, **183**, 51P.

Ricketts, M. J., Cooke, B. A. & Pounds, K. A., 1976. *Nature*, **259**, 546.

Scheuer, P. A. G., 1974. *Mon. Not. R. astr. Soc.*, **166**, 329.

Schnopper, H. W., Epstein, A., Delvaille, J. P., Tucker, W., Doxsey, R. & Jernigan, G., 1977. *Astrophys. J.*, **215**, L7.

Schwartz, D. A., Bradt, H., Doxsey, R. E., Griffiths, R. E., Gursky, H., Johnston, M. D. & Schwarz, J., 1978. *Astrophys. J.*, **224**, L103.

Schwartz, D. A., Bradt, H. V., Briel, U., Dower, R., Doxsey, R., Fabbiano, G., Griffiths, R., Gursky, H., Johnston, M., Leach, R., Liller, W., Ramsey, A. & Schwarz, J., 1979b. *(COSPAR) X-ray Astronomy*, p. 435, eds Baity, W. A. & Peterson, L. E., Pergamon Press, Oxford.

Schwartz, D. A., Doxsey, R. E., Griffiths, R. E., Johnston, M. D. & Schwarz, J., 1979a. *Astrophys. J.*, **229**, L53.

Schwartz, D. A., Schwarz, J. & Tucker, W., 1980a. *Astrophys. J.*, **238**, L59.

Schwartz, D. A., Davis, M., Doxsey, R. E., Griffiths, R. E., Huchra, J., Johnston, M. D., Mushotzky, R. F., Swank, J. & Tonry, J., 1980b. *Astrophys. J.*, **238**, L53.

Schwartz, D. A., Garcia, M., Ralph, E., Doxsey, R. E., Johnston, M. D., Lawrence, A., McHardy, I. M. & Pye, J. P., 1981. *Mon. Not. R. astr. Soc.*, **196**, 95.

Sieber, W., Haslam, C. G. T. & Salter, C. J., 1979. *Astr. Astrophys.*, **74**, 361.

Stein, W. A., O'Dell, S. L. & Strittmatter, P. A., 1976. *A. Rev. Astr. Astrophys.*, **14**, 173.

Steiner, J. E., Watson, M. G., Schwartz, D. A., Jablonski, F. J., Busko, I. C., Pye, J. P. & McHardy, I. M., 1980. *IAU Circ. 3529.*

Swank, J. H. & White, N. E., 1980. NASA Technical Memorandum 80655, to appear in *Proceedings of the Workshop on Cool Stars, Stellar Systems and the Sun,* Smithsonian Astrophysical Observatory Report.

Tananbaum, H., Avni, Y., Branduardi, G., Elvis, M., Fabbiano, G., Fiegelson, E., Giacconi, R., Henry, J. P., Pye, J. P., Soltan, A. & Zamorani, G., 1979. *Astrophys. J.,* **234,** L9.

Ulmer, M. P. & Cruddace, R. G., 1981. *Astrophys. J.,* **246,** L99.

Van Speybroeck, L., Epstein, A., Forman, W., Giacconi, R., Jones, C., Liller, W. & Smarr, L., 1979. *Astrophys. J.,* **234,** L45.

Villa, G., Page, C. G., Turner, M. J. L., Cooke, B. A., Ricketts, M. J. & Pounds, K. A., 1976. *Mon. Not. R. astr. Soc.,* **176,** 609.

Walter, F., Charles, P. & Bowyer, S., 1978a. *Astrophys. J.,* **225,** L119.

Walter, F., Charles, P. & Bowyer, S., 1978b. *Nature,* **274,** 569.

Walter, F. M., Cash, W., Charles, P. A. & Bowyer, C. S., 1980. *Astrophys. J.,* **236,** 212.

Ward, M. J., Wilson, A. S., Penston, M. V., Elvis, M., Maccacaro, T. & Tritton, K. P., 1978. *Astrophys. J.,* **223,** 788.

Warwick, R. S. & Pye, J. P., 1978. *Mon. Not. R. astr. Soc.,* **183,** 169.

Warwick, R. S., Marshall, N., Fraser, G. W., Watson, M. G., Lawrence, A., Page, C. G., Pounds, K. A., Ricketts, M. J., Sims, M. R. & Smith, A., 1981. *Mon. Not. R. astr. Soc.,* **197,** 865.

Watson, M. G. & Ricketts, M. J., 1978. *Mon. Not. R. astr. Soc.,* **183,** 35P.

Watson, M. G., Sherrington, M. R. & Jameson, R. F., 1978. *Mon. Not. R. astr. Soc.,* **184,** 79P.

White, N. E., Sanford, P. W. & Weiler, E. J., 1978. *Nature,* **274,** 569.

White, N. E., Holt, S. S., Boldt, E. A. & Serlemitsos, P. J., 1980. *IAU Circ. 3482.*

Wilson, A. S., Ward, M. J., Axon, D. J., Elvis, M. & Meurs, E. J. A., 1979. *Mon. Not. R. astr. Soc.,* **187,** 109.

Zamorani, G., Henry, J. P., Maccacaro, T., Tananbaum, H., Soltan, A., Avni, Y., Liebert, J., Stocke, J., Strittmatter, P. A., Weymann, R. J., Smith, M. G. & Condon, J. J., 1981. *Astrophys. J.,* **245,** 357.