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

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Summary. A catalogue is presented of 109 X-ray sources at low galactic latitude ($|b| < 10°$) observed by the Leicester Sky Survey Instrument on *Ariel V.* The catalogue is based on observations extending over a 5½-yr period and gives details of the position (in some cases including an improved error box), 2–10 keV flux, X-ray variability and, where possible, the proposed optical identification of each source. Nine of the sources have not been previously reported. The flux calibration and sky coverage of the survey are described and a comparison is made with the 4U catalogue. The distribution, log *N*–log *S* relation, X-ray variability and optical identifications of the sources are then briefly discussed.

1 Introduction

This paper presents a catalogue of X-ray sources detected at galactic latitudes $|b| < 10°$ by the Leicester Sky Survey Instrument (SSI) on *Ariel V.* The catalogue is based on observations extending over a 5½-yr period from the launch of the satellite on 1974 October 15 until its re-entry on 1980 March 14, during which time the satellite completed 30 152 orbits. Although a number of preliminary lists of low latitude sources observed by the SSI have already been published (Villa *et al.* 1976; Seward *et al.* 1976a, b; Watson *et al.* 1979), the present work is the first to cover the whole galactic plane and represents the first part of a final *Ariel V* catalogue. The second part (McHardy *et al.* 1981, hereafter Paper II) is an up-dated version of the 2A catalogue (Cooke *et al.* 1978, hereafter 2A) and covers the high latitude sky. Sources in both parts of the final *Ariel V* catalogue are designated as 3A.

The two parts of the 3A catalogue differ significantly in character. A galactic X-ray source population superimposed on an apparently isotropic distribution of relatively faint extragalactic sources gives rise to a considerable disparity in the number density of bright X-ray sources found at high and low galactic latitudes. In the region $|b| > 10°$ there are 142 catalogued 3A sources (Paper II) in a sky area of 10.4 sr, with a median source flux of

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~ 0.8 SSI count s^{-1}. By comparison the present catalogue contains 109 sources in 2.2 sr with a median source flux of ~ 4 SSI count s^{-1}. The overall effect in terms of the 3A survey is that in many regions of the galactic plane source confusion dominates (as a result of the relatively large field of view of the SSI) whereas at high latitudes it is the sensitivity of the SSI (effective area ~ 290 cm^2) which is the limiting factor.

The observations and the data analysis method, including the technique employed to cope with source confusion, are described in the next section. The catalogue is then presented in Section 3. Further sections give details of the SSI flux calibration, the effective sky coverage of the survey and a comparison with earlier work including the 4U catalogue (Forman *et al.* 1978). Finally the distribution, log N–log S relation, X-ray variability and optical identifications of the sources are discussed. Over 50 per cent of the sources have reasonably secure optical identifications and the majority of these identifications are with binary star systems (with 2–10 keV luminosities of 10^{35}–10^{38} erg s^{-1}).

2 SSI observations and data analysis

A detailed description of the SSI is given by Villa *et al.* (1976). It consists of a set of collimated proportional counters which view the sky from the side of the spin-stabilized satellite with a field of view 0.75° × 10.6° (FWHM), and with the long axis inclined at 65° to the spin plane. Most of the data were taken in a standard survey mode of operation. In this mode counts recorded as the SSI scans around a great circle on the sky are summed in 1024 azimuthal channels or sectors by the on-board electronics for the period of one orbit (~ 90 min). After the completion of an orbit the data are transmitted to a ground station and relayed to Leicester. No spectral resolution is available in this survey mode; the observations therefore cover the full 2–18 keV spectral range of the HE system of the SSI.

The method of data analysis is similar to that described in the 2A catalogue. Data taken during the periods (of typically 3–20 day) in which the satellite maintained a nearly fixed spin-axis orientation were first superimposed to improve sensitivity. Subsequent analysis was then restricted to those superimposed data sets (hereafter referred to as summed-orbit records) consisting of data from at least 10 orbits (see Table 1). After background fitting and subtraction, the summed-orbit records were searched for peaks which, when fitted by an equivalent point source response, were significant at the 2.5 σ level or greater. In the case of a 10 orbit sum this corresponds to a minimum source flux of ~ 1.4 SSI count s^{-1}. These peaks were matched against the predicted positions and fluxes of sources in a preliminary catalogue; this preliminary catalogue comprised all the X-ray sources which were reliably established (in the view of the authors) at that time. Fig. 1 shows a section from a typical summed orbit record with peaks matched to catalogued sources. In many regions of the galactic plane source confusion is a serious problem for the SSI. The exclusion of peaks in

Table 1. Details of the summed-orbit records used to produce the 3A catalogue.

Number of orbits comprising a record	Number of such records used
10–19	179
20–39	236
40–79	105
80–149	24
⩾150	8
Total	552

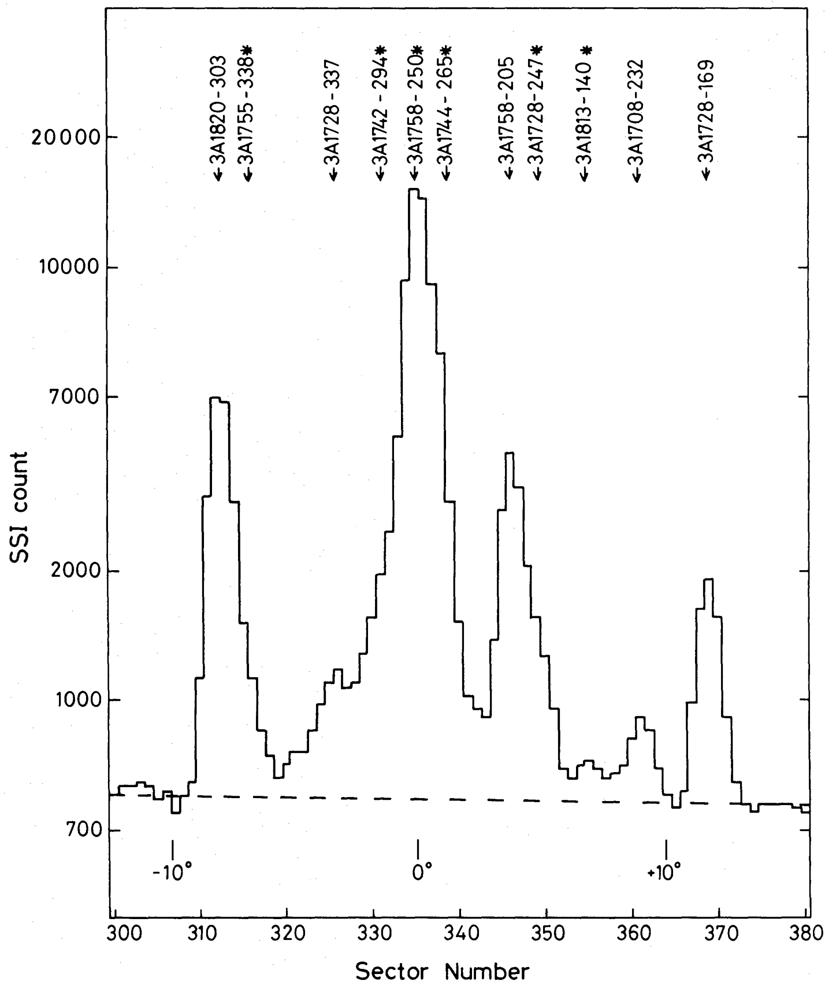

Figure 1. A scan across the galactic plane through the Galactic Centre. The record consists of data from 27 orbits giving an exposure time (centre of collimator) of ~ 47 s. Peaks in the data detected above a best fitting background level (dashed-line) have been matched to catalogued sources as indicated. Source confusion is clearly a problem in the Galactic Centre region and in this particular observation the sources marked with an asterisk have a 'confusion parameter' exceeding 10 per cent.

which there was a substantial contribution from more than one source was achieved by use of a 'confusion parameter' which provided a crude estimate of the fraction of the observed flux probably originating in (catalogued) sources other than the source to which the peak had been assigned. Generally if this fraction exceeded 10 per cent then the peak was not considered further. It should be noted here that the ratio of the narrow axis to the long axis of the SSI collimator (i.e. FWHM of $0.75° \times 10.6°$) is such as to cause this confusion parameter, for any particular source, to be an extremely rapid function of the position angle of the collimator. As a result in many cases it was possible to obtain useful observations of a source despite the presence of other nearby sources (i.e. within a few degrees). A peak was also excluded if its shape was inconsistent with a point source response, if the background fitting in the region of the peak was inadequate, or if the peak was in a region contaminated by direct solar X-rays or by fluorescent X-rays from the upper atmosphere of the Earth. Peaks on the summed-orbit records which were not matched to established sources were plotted as 'lines of position' on a map of the galactic plane (*cf.* 2A) and regions in which there were multiple intersections of such lines of position were investigated as the locations of tentative 'new' sources, which could be added to the preliminary catalogue. A necessary condition for adding a source to this catalogue was that it was detectable at the 3σ level on at least three occasions. Also using this criterion a number of sources originally included in the preliminary catalogue were subsequently removed. A final catalogue was obtained after a number of iterations of this procedure.

The error boxes for sources in this final catalogue were determined by the method described in 2A except that an additional procedure to refine peak positions (and hence the error boxes) was employed. This procedure involved correcting the satellite attitude information by the comparison of the observed peak positions for known strong sources with those predicted from previously published accurate ($\lesssim$ 1 arcmin) positions for the sources (notably from the *SAS-3* satellite).

Finally, a flux and a variability code (see next section) were assigned to each source in the catalogue by examination of the corresponding X-ray light curve. For this purpose *all* observations (including non-detections, but obviously excluding confused or otherwise poor data) in which the source was positioned within 7° of the central response of the collimator (measured perpendicular to the spin plane) were used.

3 The catalogue

The *Ariel V* (3A) catalogue of X-ray sources at low galactic latitudes ($|b| < 10°$) is presented in Table 2*. Information is given for each source under the following headings:

Ariel name. This is derived from the source position quoted in the table (see below).

Alternative names. Alternative names for the X-ray source. In the main these are based on observations by satellites as follows: 4U – *Uhuru* (4U catalogue, Forman *et al.* 1978); 2S – *SAS-3*; A – *Ariel V* (both earlier SSI and rotation modulation collimator observations); H – *HEAO-1* (A2 and A3 experiments); MX – *OSO-7* or *SAS-3*; 1E – *Einstein* observatory.

A source name from earlier, mainly rocket, observations which is derived from the galactic coordinates of the source (e.g. GX 301–2) is quoted if this is in common use, as is any other frequently used name (e.g. Cen X-3). References to these alternative names may be found in Forman *et al.* (1978) or Bradt, Doxsey & Jernigan (1979), although in some instances references are given in the table.

Position and position code. The source position in celestial (RA, Dec: 1950.0) and galactic (*l*, *b*) coordinates. These are given in degrees and rounded to two decimal places. Since accurate X-ray positions (notably from *SAS-3* and *HEAO-1* satellite observations), as well as optical and radio positions are available for many of the bright, low latitude X-ray sources, the quoted source positions are not restricted to those derived from SSI observations. The Position Code indicates the following:

3A = position based on SSI observations;
X-RAY = position from other published X-ray observations;
OPT/RAD = position from published observations of the optical/radio couterparts to the X-ray source.

Reference to the published source positions may be found in Bradt *et al.* (1979) unless a reference is quoted in the table.

Error box corners and box area. RA and Dec (1950.0) of the corners of a rectangle enclosing the 90 per cent confidence ellipse and the area of this ellipse in square degrees (*cf.* 2A). This information is only quoted for sources with a Position Code = 3A, i.e those sources for which the SSI observations provide information of a precision which is comparable to, or better than, previously reported X-ray measurements (above 2 keV).

*The source 3A 0327 + 438 has b = 10°.02, and also appears in Paper II.

Table 2. *Ariel V* SSI – low galactic latitude catalogue.

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A0022+638	4U0022+63	5.60 63.88	120.08 1.43	X-RAY [A]						3.3 .2			S	TYCHO SNR	
3A0026+593	4U0027+59 A0026+59	6.57 59.32	120.10 -3.15	X-RAY [B]						1.7	.5	12.0	I		FLARING MJD 42615-55
3A0053+604	4U0054+60 2S0053+604	13.42 60.45	123.58 -2.15	OPT						2.4 .2			S	STAR: GAMMA CAS	Be STAR V=1.6-3.0 [C,D]
3A0114+650	2S0114+650	18.67 65.03	125.71 2.56	OPT						1.1	<.5	4.6	I	STAR	B0.5IIIe, V=11 [E]
3A0142+614	4U0142+61 2S0142+614	25.73 61.50	129.39 -.43	X-RAY						2.0 .2			S	STAR?	V~20 [F]
3A0241+622	4U0241+61 2S0241+622	40.26 62.26	135.64 2.43	X-RAY [G]						.7	.5	6.0	I	QSO	Z=0.0438, B=16.7 [G] X-RAY FLARE [1]
3A0310+465	4U0310+46	47.55 46.55	146.76 -9.45	X-RAY [A]						.5 .1			S		
3A0327+438		51.95 43.83	150.90 -10.02	3A	51.84 43.30	51.87 44.53	52.07 44.53	52.03 43.30	.14		<.5	5.0	T	STAR: GK PER	OLD NOVA, V~13.5, X-RAY TRANSIENT MJD 43654-702 [2]
3A0415+376	4U0407+37? H0412+378 [H]	63.90 37.67	161.93 -8.91	3A	63.97 37.12	63.50 38.17	63.79 38.25	64.25 37.20	.23	1.0 .1			S	N GALAXY: 3C 111	Z=0.0485 [I,J]
3A0446+449	4U0446+44 H0446+449 [K]	71.50 44.93	160.47 .21	X-RAY [K]						2.4 .2			S	CLUSTER	CLUSTER CONTAINS 3C129, 3C129.1 [K]

[A] : FORMAN ET AL. 1978
[B] : CARPENTER ET AL. 1977
[C] : BRADT ET AL. 1977
[D] : MOFFATT, HAUPT & SCHMIDT-KALER 1973
[E] : MARGON & BRADT 1977
[F] : DOWER ET AL. 1978
[G] : APPARAO ET AL. 1978
[H] : MARSHALL ET AL. 1979
[I] : MARSHALL ET AL. 1978
[J] : SARGENT 1977
[K] : SCHWARTZ ET AL. 1979

Table 2 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3AØ531+219	4UØ531+21	82.88 21.98	184.56 -5.79	X-RAY [A]						4Ø3.Ø 5.Ø			S	CRAB SNR & PULSAR	PULSAR PERIOD Ø.Ø33 s
3AØ535+262	AØ535+26 2SØ535+262 4UØ538+26?	83.95 26.29	181.45 -2.64	OPT							<2.Ø	1Ø8Ø.Ø	T	STAR: HDE24577Ø	BØVe, V=9.1 [B,C] REC. TRANS., PULSAR 1Ø4 s [D,E] [3,4]
3AØ559+29Ø		89.94 29.Ø3	181.84 3.31	3A	89.63 29.Ø2	9Ø.ØØ 29.29	9Ø.24 29.Ø5	89.87 28.77	.11	1.Ø .1			S		
3AØ614+224	4UØ617+23	93.57 22.4Ø	189.23 2.95	3A	93.17 22.13	93.63 22.86	93.93 22.7Ø	93.47 21.97	.22	.8 .1			S	IC443 SNR	
3AØ614+Ø91	4UØ614+Ø9 2SØ614+Ø91	93.59 9.16	2ØØ.87 -3.37	OPT						14.Ø	6.Ø	32.Ø	I	STAR	B=18.8 [F,G] X-RAY BURSTER ? [H,I] X-RAY PERIOD 5.2 d [5]
3AØ62Ø-ØØ3	AØ62Ø-ØØ 2SØ62Ø-ØØ3 MON X-1	95.Ø5 -.32	2Ø9.96 -6.54	OPT							<1.Ø	5ØØØØ	T	STAR: V616 MON	NOVA MON 1975, K5-7V, V=18.3 [J,K] [6,7]
3AØ63Ø+218		97.51 21.87	191.41 5.93	3A	97.13 21.3Ø	97.49 22.57	97.85 22.48	97.49 21.21	.38	.8 .1			S		
3AØ632+Ø5Ø		98.21 5.Ø5	2Ø6.66 -1.25	3A	98.Ø9 4.38	98.Ø1 5.7Ø	98.29 5.72	98.37 4.4Ø	.25	.8 .1			S		
3AØ645+134		1Ø1.48 13.49	2ØØ.64 5.5Ø	3A	1Ø1.93 13.9Ø	1Ø1.58 12.9Ø	1Ø1.Ø2 13.Ø9	1Ø1.37 14.Ø8	.47	.6 .1			S		
3AØ656-Ø72	MXØ656-Ø7 [M]	1Ø4.ØØ -7.2Ø	22Ø.2Ø -1.76	X-RAY [L]							<.5	8.Ø	T		OUTBURST MJD 42765 - 812, TRANSIENT? [L,M,N] [32]

[A] : FORMAN ET AL. 1978
[B] : HUTCHINGS ET AL. 1978
[C] : MARGON ET AL. 1977
[D] : ROSENBERG ET AL. 1975
[E] : BRADT ET AL. 1976
[F] : MURDIN ET AL. 1974
[G] : DAVIDSEN ET AL. 1974
[H] : LEWIN 1976a
[I] : SWANK ET AL. 1978
[J] : OKE 1977
[K] : MURDIN ET AL. 198Ø
[L] : CARPENTER ET AL. 1975
[M] : CLARK, SCHMIDT & ANGEL 1975
[N] : KALUZIENSKI ET AL. 1976

ARIEL NAME	ALTERNATIVE NAMES	--- POSITION --- RA DEC	LII BII	CODE	----------- ERRORBOX ----------- RA DEC	RA DEC	RA DEC	RA DEC	AREA	AV ERR	------- FLUX -------- MIN	MAX	CODE	IDENT	OTHER INFORMATION
3AØ658-114		1Ø4.69 -11.44	224.28 -3.11	3A	1Ø5.18 -11.67	1Ø4.17 -11.65	1Ø4.18 -11.21	1Ø5.19 -11.23	.32	.6 .1			S		
3AØ726-26Ø	4UØ728-25	111.71 -26.Ø7	24Ø.34 -4.Ø8	3A	111.78 -26.21	111.52 -26.11	111.61 -25.93	111.87 -26.Ø3	.Ø4	1.7	.5	9.Ø	I		FLARE MJD 42661-3 [32]
3AØ745-191	4UØ739-19?	116.32 -19.11	236.39 3.Ø5	3A	116.22 -19.26	116.15 -19.Ø2	116.39 -18.95	116.46 -19.19	.Ø4	1.3 .1			S		PKS Ø745-191 [A] IN BOX [32]
3AØ821-427	4UØ821-42	125.39 -42.74	26Ø.44 -3.21	X-RAY [B]						2.Ø .1			S	PUP A SNR	
3AØ834-45Ø	4UØ833-45	128.51 -45.Ø4	263.62 -2.76	3A	128.66 -45.Ø2	128.49 -45.16	128.32 -45.Ø6	128.48 -44.92	.Ø2	4.7	3.Ø	12.Ø	I	VELA PULSAR REGION	RADIO PULSAR 79 ms [C] EXTENDED SOURCE [8], FLARE [9]
3AØ851-467	4UØ842-47? AØ854-46	132.96 -46.72	266.87 -1.39	3A	133.19 -46.74	132.89 -46.88	132.69 -46.68	132.99 -46.54	.Ø5	1.3 .1			S		[1Ø,32]
3AØ9ØØ-4Ø3	4UØ9ØØ-4Ø VELA X-1	135.Ø6 -4Ø.36	263.Ø6 3.93	OPT						26.Ø	<2.Ø	48.Ø	I	STAR: HD77581	BØ.5Ib, V~6.9, ECL. BINARY 8.97 d, PULSAR 283 s [D,E][11,12,13]
3AØ918-549	4UØ919-54 2SØ918-549	139.73 -54.99	275.85 -3.84	X-RAY						4.5	2.Ø	9.Ø	I		
3AØ921-63Ø	2SØ921-63Ø HØ921-631 [F]	14Ø.35 -63.Ø8	281.84 -9.34	OPT						1.Ø .1			S	STAR	B~17 [G] [32]
3A1Ø36-565	4U1Ø36-56 A1Ø34-56	159.Ø4 -56.55	285.42 1.46	X-RAY [B]						1.2	.5	4.5	I		FLARE MJD 42362-7Ø [1Ø,32]

[A] : EKERS 1969
[B] : FORMAN ET AL. 1978
[C] : LARGE, VAUGHN & MILLS 1968
[D] : JONES & LILLER 1973
[E] : McCLINTOCK ET AL. 1976
[F] : MARSHALL ET AL. 1979
[G] : BRADT, DOXSEY & JERNIGAN 1979

Table 2 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	--- POSITION --- RA DEC	LII BII	CODE	----------- ERRORBOX ----------- RA DEC	RA DEC	RA DEC	RA DEC	AREA	------- FLUX -------- AV ERR	MIN	MAX	CODE	IDENT	OTHER INFORMATION
3A1042-595	4U1037-60 A1044-59	160.59 -59.51	287.55 -.76	3A	159.63 -59.76	161.21 -59.14	161.40 -59.26	159.81 -59.88	.12	1.3 .1			S	ETA CARINAE	SEE EINSTEIN RESULTS [A] [10]
3A1119-603	4U1118-60 CEN X-3	169.76 -60.35	292.09 .34	OPT						33.0	4.0	120.0	I	KRZEMINSKI STAR	O6.5II-III, V~13.4 [B,C] ECL.BIN. 2.09 d PLSR 4.8s[D,E][14,15]
3A1137-651	4U1137-65	174.32 -65.10	295.54 -3.54	X-RAY [F]						.8 .1			S	STAR: HD101379	V=5.1, RS CVn SYSTEM [S] [32]
3A1145-616	1E1145-614 [G]	176.27 -61.65	295.49 .02	3A	176.03 -61.69	176.37 -61.52	176.52 -61.58	176.18 -61.76	.02	4.0	2.0	16.0	I		PULSAR 297 s [G,H] [16]
3A1145-619	4U1145-61 2S1145-619	176.43 -61.95	295.63 -.26	3A	176.28 -62.12	176.11 -61.85	176.48 -61.80	176.65 -62.06	.04		<4.0	65.0	T	STAR: HEN 715	BIVne, V=9.0 [I,J] REC. TRANS 187.5d?[16] PULSAR 292 s [G,H]
3A1223-624	4U1223-62 2S1223-624 GX301-2	185.96 -62.49	300.10 -.04	OPT						14.0	5.0	48.0	I	STAR: WRA 977	B1.5Ia, V=10.8 [K] PLSR 699 s [L,M] X-RAY BIN 35d [M] 41.4d [17]
3A1239-599	2S1239-599 A1238-59 [N]	189.78 -59.93	301.76 2.65	X-RAY						6.0 .4			S		
3A1246-588	4U1246-58 A1246-58 [N]	191.66 -58.85	302.70 3.75	X-RAY [N]						2.0	<1.0	20.0	I		
3A1254-690	4U1254-69 2S1254-690	193.59 -69.02	303.48 -6.42	OPT						12.5	11.0	16.0	I	STAR	V=19.1 [O]
3A1258-613	4U1258-61 2S1258-613 GX304-1	194.55 -61.33	304.10 1.25	OPT						4.5	2.5	28.0	I	STAR	B0-B5V, V=14.7 [P] PULSAR 272 s [Q,R] FLARE MJD 43126-30

[A] : SEWARD ET AL. 1979
[B] : OSMER, HILTNER & WHELAN 1975
[C] : KRZEMINSKI 1974
[D] : SCHREIER ET AL. 1972
[E] : GIACCONI ET AL. 1971
[F] : FORMAN ET AL. 1978
[G] : LAMB ET AL. 1980
[H] : WHITE ET AL. 1980a
[I] : FEAST ET AL. 1961
[J] : JONES, CHETIN & LILLER 1974
[K] : VIDAL 1973
[L] : WHITE ET AL. 1976
[M] : KELLEY, RAPPAPORT & PETRE 1980
[N] : CARPENTER ET AL. 1977
[O] : GRIFFITHS ET AL. 1978
[P] : MASON ET AL. 1978
[Q] : McCLINTOCK ET AL. 1977b
[R] : HUCKLE ET AL. 1977
[S] : GARCIA ET AL. 1980

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A1322-616	4U1323-62	200.63 -61.60	306.98 .74	3A	200.26 -61.75	200.48 -61.40	200.90 -61.46	200.69 -61.81	.06	2.0 .2			S		[32]
3A1344-602	4U1344-60 A1343-60	206.06 -60.27	309.80 1.60	3A	205.85 -60.44	205.86 -60.09	206.27 -60.10	206.26 -60.44	.06	1.7	1.0	3.0	I	KE19A,B	SNR? [A,B] [10,18,32]
3A1417-624	4U1416-62 2S1417-624	214.36 -62.47	313.02 -1.60	X-RAY						.6 .2			S		PULSAR 17.64 s [C]
3A1438-626	4U1425-61? A1439-61 MX1439-62	219.61 -62.65	315.20 -2.66	3A	219.72 -62.13	220.10 -63.08	219.40 -63.13	219.03 -62.18	.26	1.0 .2			S	SNR: MSH 14-63	[D,E] [10,32]
3A1448-556	4U1446-55	222.01 -55.65	319.29 3.15	3A	221.73 -55.95	221.86 -55.32	222.24 -55.34	222.11 -55.98	.12	1.9 .2			S		[32]
3A1510-590	4U1510-59	227.53 -59.00	320.31 -1.21	X-RAY [E]						3.0 .2			S		SNR: MSH15-52? [D,E]
3A1516-569	4U1516-56 2S1516-569 CIR X-1	229.20 -56.99	322.12 .04	OPT						23.0	<2.0	340.0	I	STAR	PERIODIC VARIATIONS 16.6 d, ALSO SEEN IN IR & RADIO [G,H] [19]
3A1524-617	2S1524-617 TRA X-1	231.02 -61.71	320.32 -4.43	OPT							<2.0	320.0	T	STAR	X-RAY & OPTICAL NOVA NOV 1974 [20,21]
3A1538-522	4U1538-52 2S1538-522	234.66 -52.23	327.42 2.16	OPT						6.0	<1.0	9.0	I	STAR	B0I, V~14 [I] ECL. BIN. 3.7 d, PULSAR 529 s [J,K] [22]
3A1543-624	4U1543-62 2S1543-624	235.89 -62.41	321.76 -6.34	OPT						13.0	7.0	17.0	I	STAR	B~20 [L]

[A] : KESTEVEN 1968
[B] : MILNE 1969
[C] : KELLEY ET AL. 1981
[D] : CLARK & CASWELL 1976
[E] : WINKLER 1978
[F] : FORMAN ET AL. 1978
[G] : WHELAN ET AL. 1977
[H] : GLASS 1978
[I] : CRAMPTON, HUTCHINGS & COWLEY 1978
[J] : BECKER ET AL. 1977a
[K] : DAVISON 1977
[L] : McCLINTOCK ET AL. 1978

Table 2 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	--- POSITION --- RA DEC	LII BII	CODE	----------- ERRORBOX ----------- RA DEC	RA DEC	RA DEC	RA DEC	AREA	------- FLUX -------- AV ERR	MIN	MAX	CODE	IDENT	OTHER INFORMATION
3A1556-6Ø5	4U1556-6Ø 2S1556-6Ø5	239.2Ø -6Ø.6Ø	324.14 -5.93	X-RAY						5.6 .5			S	STAR	B~19.5 [A]
3A1624-49Ø	4U1624-49 2S1624-49Ø	246.Ø8 -49.Ø9	334.92 -.26	X-RAY						21.Ø	18.Ø	25.Ø	I		HEAO-1 POSN. [B]
3A163Ø-472	4U163Ø-47	247.57 -47.28	336.91 .26	X-RAY [C]							<2.Ø	36Ø.Ø	T		RECURRENT TRANSIENT [23,24]
3A1636-536	4U1636-53 2S1636-536	249.23 -53.65	332.92 -4.82	OPT						84.Ø	4Ø.Ø	124.Ø	I	STAR	V=17.5 [D] X-RAY BURSTER [E,F] BRIGHT BULGE SOURCE
3A1642-455	4U1642-45 2S1642-455 GX34Ø+Ø	25Ø.54 -45.52	339.59 -.Ø8	X-RAY						188.Ø	155.Ø	24Ø.Ø	I		BRIGHT BULGE SOURCE
3A1658-298	4U17Ø4-3Ø	254.73 -29.87	353.83 7.27	OPT						5.Ø	<1.Ø	15.Ø	I	STAR	V=18.3 [G] X-RAY BURSTER [H]
3A1659-487	4U1658-48 MX1658-48 GX339-4	254.76 -48.72	338.94 -4.33	OPT						63.Ø	14.Ø	96.Ø	I	STAR	V=16.6 [G] BRIGHT BULGE SOURCE
3A17Ø2-363	4U17Ø2-36 2S17Ø2-363 SCO X-2	255.6Ø -36.36	349.1Ø 2.75	X-RAY						3ØØ.Ø	24Ø.Ø	375.Ø	I		HEAO-1 POSN [B] BRIGHT BULGE SOURCE
3A17Ø5-25Ø	H17Ø5-25Ø NOVA OPH	256.29 -25.Ø3	358.58 9.Ø6	OPT							<2.Ø	14ØØ	T	STAR	X-RAY & OPTICAL NOVA AUG - SEPT 1977 [25]
3A17Ø5-44Ø	4U17Ø5-44 2S17Ø5-44Ø	256.33 -44.Ø4	343.32 -2.34	X-RAY						1ØØ.Ø	15.Ø	17Ø.Ø	I		HEAO-1 POSN [B] BRIGHT BULGE SOURCE

[A] : CHARLES ET AL. 1979
[B] : REID ET AL. 198Ø
[C] : FORMAN ET AL. 1978
[D] : McCLINTOCK ET AL. 1977a
[E] : SWANK ET AL. 1976a
[F] : HOFFMAN, LEWIN & DOTY 1977b
[G] : DOXSEY ET AL. 1979
[H] : LEWIN, HOFFMAN & DOTY 1976

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A17Ø8-4Ø7	4U17Ø8-4Ø MX17Ø9-4Ø [Q]	257.Ø9 -4Ø.77	346.28 -.84	X-RAY [A]						22.Ø	16.Ø	24.Ø	I		
3A17Ø8-232	4U17Ø8-23	257.25 -23.29	.53 9.36	X-RAY [A]						1Ø.Ø 1.Ø			S	CLUSTER	cD TYPE CLUSTER Z=Ø.Ø28 [B]
3A1715-321	2S1715-321 MX1716-31 [C]	258.88 -32.12	354.13 3.Ø7	X-RAY						1Ø.Ø 1.Ø			S		HEAO-1 POSN [D]
3A1728-337	4U1728-33 2S1728-337	262.17 -33.8Ø	354.3Ø -.15	X-RAY						54.Ø	64.Ø	74.Ø	I		X-RAY BURSTER [E,F] BRIGHT BULGE SOURCE
3A1728-169	4U1728-16 2S1728-169 GX9+9	262.21 -16.92	8.52 9.Ø4	OPT						11Ø.Ø	9Ø.Ø	13Ø.Ø	I	STAR	V=16.6 [B] BRIGHT BULGE SOURCE
3A1728-247	4U1728-24 2S1728-247 GX1+4	262.24 -24.71	1.94 4.79	OPT						34.Ø	26.Ø	46.Ø	I	STAR	V~19 [G], BRIGHT IN IR [H], PULSAR 135 s 197Ø - 11Ø s 198Ø[I,J]
3A1735-444	4U1735-44 2S1735-444	263.83 -44.42	346.Ø5 -6.99	OPT						6Ø.Ø	42.Ø	82.Ø	I	STAR	V=17.5 [K], X-RAY/OPT BURSTER [L,M] BRIGHT BULGE SOURCE
3A1742-294	A1742-294 2S1742-294 GCX-1	265.72 -29.5Ø	359.56 -.39	X-RAY						67.Ø	5Ø.Ø	1Ø5.Ø	I		BRIGHT PERSISTENT SOURCE NEAR GALACTIC CENTRE [N,O]
3A1744-265	4U1744-26 2S1744-265 GX3+1	266.2Ø -26.55	2.29 .79	X-RAY						167.Ø	88.Ø	21Ø.Ø	I		HEAO-1 POSN [D] BRIGHT BULGE SOURCE X-RAY BURSTER [R]
3A1746-37Ø	4U1746-37 2S1746-37Ø	266.7Ø -37.Ø4	353.53 -5.Ø1	OPT						2Ø.Ø	15.Ø	28.Ø	I	GLOB.CLUS: NGC 6441	X-RAY BURSTER ? [P]

[A] : FORMAN ET AL. 1978
[B] : JOHNSTON ET AL. 1981
[C] : MARKERT ET AL. 1976
[D] : REID ET AL. 198Ø
[E] : LEWIN 1976b
[F] : HOFFMAN, LEWIN & DOTY 1977a
[G] : DAVIDSEN, MALINA & BOWYER 1977
[H] : GLASS & FEAST 1973
[I] : LEWIN, RICKER & McCLINTOCK 1971
[J] : RICKETTS ET AL. 1981
[K] : McCLINTOCK ET AL. 1977a
[L] : GRINDLAY ET AL. 1978
[M] : LEWIN ET AL. 198Ø
[N] : PROCTOR, SKINNER & WILMORE 1978
[O] : CRUDDACE ET AL. 1978
[P] : LI & CLARK 1977
[Q] : MARKERT ET AL. 1977
[R] : ODA 198Øb

Table 2 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A1755-338	4U1755-33 2S1755-338	268.84 -33.80	357.22 -4.87	OPT						36.0	30.0	45.0	I	STAR	B~19.3 [A]
3A1758-250	4U1758-25 2S1758-250 GX5-1	269.51 -25.08	5.08 -1.02	X-RAY						460.0	410.0	544.0	I		HEAO-1 POSN [E] BRIGHT BULGE SOURCE
3A1758-205	4U1758-20 2S1758-205 GX9+1	269.64 -20.53	9.07 1.15	X-RAY						250.0	213.0	277.0	I		HEAO-1 POSN [E] BRIGHT BULGE SOURCE
3A1811-171	4U1811-17 2S1811-171 GX13+1	272.91 -17.17	13.52 .11	X-RAY						130.0	92.0	164.0	I		BRIGHT BULGE SOURCE
3A1812-121	4U1812-12	273.11 -12.13	18.03 2.36	X-RAY [B]						8.0	5.5	11.0	I		
3A1813-140	4U1813-14 2S1813-140 GX17+2	273.30 -14.05	16.43 1.28	OPT						260.0	230.0	300.0	I	STAR	V=17.5 [C] BRIGHT BULGE SOURCE
3A1815-257		273.91 -25.78	6.40 -4.83	3A	273.43 -26.42	274.12 -24.94	274.39 -25.04	273.70 -26.52	.35	5.0	2.5	9.5	I		
3A1820-303	4U1820-30 2S1820-303	275.12 -30.39	2.79 -7.91	OPT						100.0	36.0	137.0	I	GLOB.CLUS: NGC 6624	X-RAY BURSTER [D] BRIGHT BULGE SOURCE
3A1822-000	4U1823-00 2S1822-000 A1822+00	275.70 -.04	29.94 5.79	X-RAY						12.5	9.0	17.0	I		HEAO-1 POSN [E] [26]
3A1831-232	4U1831-23	277.94 -23.21	10.40 -6.90	X-RAY [B]						4.0	<1.0	6.0	I		

[A] : McCLINTOCK ET AL. 1978
[B] : FORMAN ET AL. 1978
[C] : DAVIDSEN, MALINA & BOWYER 1976
[D] : GRINDLAY ET AL. 1976
[E] : REID ET AL. 1980

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A1833-078	A1829-06 H1833-077 [L]	278.43 -7.86	24.27 -.25	3A	278.38 -7.66	278.61 -7.97	278.48 -8.06	278.25 -7.75	.05	4.0	<1.0	12.0	I		HEAO-1 POSN [D] G24.7+0.6 SNR NEARBY [26]
3A1837+049	4U1837+04 2S1837+049 SER X-1	279.37 4.99	36.12 4.84	OPT						77.0	58.0	110.0	I	STAR	B~19.2 [A] X-RAY BURSTER [B] BRIGHT BULGE SOURCE
3A1845-024	A1845-02 2S1845-024	281.42 -2.48	30.42 -.40	X-RAY						4.0	<1.0	17.0	I		[26]
3A1850-087	4U1850-08 2S1850-087 A1850-08	282.59 -8.77	25.36 -4.32	OPT						2.4	<1.0	9.0	I	GLOB.CLUS: NGC 6712	X-RAY BURSTER [C] [26]
3A1855+011	4U1857+01? A1850+00	283.90 1.13	34.76 -.95	3A	283.49 1.03	284.27 1.41	284.35 1.26	283.57 .88	.12	2.4	1.0	6.0	I		W44 SNR NEARBY [26]
3A1905+000	2S1905+00 A1905+00	286.48 .09	35.03 -3.71	X-RAY						10.0	3.3	14.0	I		HEAO-1 POSN [D] X-RAY BURSTER? [E] [26]
3A1907+097	4U1907+09 A1907+09	286.75 9.76	43.73 .54	3A	286.75 9.58	286.59 9.89	286.71 9.95	286.87 9.64	.04	6.0	2.0	86.0	I	STAR	V=16.4 [F] X-RAY BINARY 8.4 d [26,27]
3A1907+074	4U1909+07 A1908+07	286.98 7.44	41.77 -.74	3A	286.96 7.25	286.82 7.46	286.99 7.58	287.13 7.36	.04	3.5	1.0	5.0	I		[26]
3A1908+005	4U1908+00 2S1908+005 AQL X-1	287.18 .50	35.72 -4.14	OPT							<2.0	160.0	T	STAR	REC. OPT & X-RAY TRANSIENT SEE [G] [28] X-RAY BURSTER [M]
3A1909+048	4U1908+05 A1909+04	287.26 4.87	39.63 -2.19	3A	287.17 4.93	287.35 4.89	287.33 4.77	287.15 4.82	.02	2.3	1.0	4.0	I	STAR: SS 433	V~14, 164 d OPT [H] 13.1d OPT [I] W50 NEARBY [J,K] [25]

[A] : THORSTENSEN, CHARLES & BOWYER 1978
[B] : LI ET AL. 1977
[C] : SWANK ET AL. 1976b
[D] : REID ET AL. 1980
[E] : LEWIN ET AL. 1976
[F] : SCHWARTZ ET AL. 1980a
[G] : BRADT, DOXSEY & JERNIGAN 1979
[H] : MARGON ET AL. 1979
[I] : CRAMPTON, COWLEY & HUTCHINGS 1980
[J] : CLARK & MURDIN 1978
[K] : RYLE ET AL. 1978
[L] : MARSHALL ET AL. 1979
[M] : ODA 1980a

Table 2 – *continued*

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A1909+119		287.31 11.97	45.94 1.08	3A	287.52 11.63	286.91 11.90	287.07 12.26	287.68 12.00	.21	1.3 .2			S		
3A1916-053	4U1915-05 2S1916-053 A1916-05	289.04 -5.33	31.36 -8.46	X-RAY						6.6	1.0	12.0	I	STAR	B~19.5 [A] X-RAY BURSTER [B] [26]
3A1926+201		291.60 20.17	55.11 1.33	3A	290.89 19.82	291.94 20.77	292.24 20.48	291.19 19.53	.45	.6 .1			S		
3A1942+274		295.74 27.49	63.35 1.65	3A	295.87 27.06	295.47 27.85	295.60 27.90	296.00 27.11	.08		<.5	8.0	T		TRANSIENT OBSERVED MJD 43100 - 138
3A1954+319	4U1954+31	298.51 31.96	68.42 1.87	X-RAY [C]						4.0	<.5	10.0	I		
3A1956+350	4U1956+35 CYG X-1	299.12 35.07	71.34 3.07	RAD						150.0	90.0	385.0	I	STAR: HDE226868	O9.7Iab [D], V=8.9 RAPID VARIABILITY IN X-RAYS SEE [E] [29]
3A1957+115	4U1957+11 2S1957+115	299.26 11.57	51.31 -9.33	OPT						11.0	7.0	30.0	I	STAR	V=18.7 [F]
3A1958+407	4U1957+40	299.70 40.77	76.44 5.68	3A	299.35 40.67	299.88 41.03	300.05 40.88	299.53 40.52	.08	1.6 .2			S	CYG A	EXTENDED X-RAY SOURCE CENTRED ON RADIO GALAXY [G,H]
3A2019+395	4U2019+39	304.75 39.50	77.50 1.75	X-RAY [C]						.4 .1			S		
3A2030+407	4U2030+40 CYG X-3	307.66 40.79	79.85 .70	RAD						84.0	40.0	145.0	I	IR STAR	K=11.4 [I], RADIO FLARES, X-RAY BINARY 4.8 h SEE [E] [30]

[A] : BRADT ET AL. 1976
[B] : BECKER ET AL. 1977b
[C] : FORMAN ET AL. 1978
[D] : WALBORN 1973
[E] : BRADT, DOXSEY & JERNIGAN 1979
[F] : MARGON, THORSTENSEN & BOWYER 1978
[G] : LONGAIR & WILLMORE 1974
[H] : FABBIANO ET AL. 1979
[I] : BECKLIN ET AL. 1972

ARIEL NAME	ALTERNATIVE NAMES	POSITION RA DEC	POSITION LII BII	POSITION CODE	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX RA DEC	ERRORBOX AREA	FLUX AV ERR	FLUX MIN	FLUX MAX	FLUX CODE	IDENT	OTHER INFORMATION
3A2Ø48+443	4U2Ø48+44	312.15 44.38	84.71 .32	X-RAY [A]						.6 .1			S		
3A2Ø56+493	4U2Ø56+49	314.ØØ 49.33	89.3Ø 2.55	X-RAY [A]						1.Ø	<.5	3.Ø	I		
3A2129+47Ø	4U2129+47	322.4Ø 47.Ø7	91.58 -3.Ø4	OPT						3.4	<1.Ø	6.2	I	STAR	B=16.8 - 18.Ø [B] X-RAY BINARY Ø.22 d [B,C]
3A2129+571	4U2135+57	322.46 57.16	98.46 4.35	3A	323.51 57.48	322.ØØ 56.55	321.41 56.84	322.92 57.76	.32	.4 .1			S		
3A214Ø+433	A214Ø+43 H214Ø+433 [D]	325.18 43.36	9Ø.56 -7.1Ø	OPT						2.2	<.5	8.Ø	I	STAR: SS CYG	DWARF NOVA. HARD X-RAYS DURING OPTICAL LOW STATE [D,E] [31]
3A22Ø6+543	4U22Ø6+54 A22Ø4+54	331.52 54.34	1ØØ.64 -1.Ø5	3A	331.48 54.19	331.29 54.38	331.53 54.47	331.72 54.28	.Ø3	2.Ø	.5	4.3	I		[18]
3A2237+6Ø8	4U2238+6Ø	339.41 6Ø.81	1Ø7.65 2.17	3A	339.59 61.Ø6	339.64 6Ø.54	339.15 6Ø.53	339.1Ø 61.Ø5	.1Ø	.8	<.5	3.6	I		
3A2316+618	4U2316+61	349.15 61.8Ø	112.31 1.13	X-RAY [A]						.8 .2			S		
3A2321+585	4U2321+58	35Ø.3Ø 58.56	111.75 -2.12	X-RAY [A]						19.6 1.Ø			S	CAS A SNR	EINSTEIN RESULTS [F,G]

[A] : FORMAN ET AL. 1978
[B] : THORSTENSEN ET AL. 1979
[C] : ULMER ET AL. 198Ø
[D] : FABBIANO ET AL. 1978
[E] : HEISE ET AL. 1978
[F] : MURRAY ET AL. 1979
[G] : FABIAN ET AL. 198Ø

SSI PUBLICATIONS REFERENCE LIST

[1] : MARSHALL, WARWICK & POUNDS 1981
[2] : KING, RICKETTS & WARWICK 1979
[3] : RICKETTS et al. 1975
[4] : SIMS 1981
[5] : MARSHALL & MILLIT 1981
[6] : ELVIS et al. 1975
[7] : RICKETTS, POUNDS & TURNER 1975
[8] : SMITH 1978
[9] : SMITH & POUNDS 1977
[1Ø] : SEWARD et al. 1976b
[11] : EADIE et al. 1975
[12] : WATSON & GRIFFITHS 1977
[13] : DUPREE et al. 198Ø
[14] : POUNDS et al. 1975
[15] : JACKSON 1975
[16] : WATSON, WARWICK & RICKETTS 1981
[17] : WATSON, WARWICK & CORBETT 1981
[18] : VILLA et al. 1976
[19] : WATSON 1979a
[2Ø] : KALUZIENSKI et al. 1975
[21] : MURDIN et al. 1976
[22] : DAVISON 1977
[23] : JONES et al. 1976
[24] : SIMS & WATSON 1978
[25] : WATSON, RICKETTS & GRIFFITHS 1978
[26] : SEWARD et al. 1976a
[27] : MARSHALL & RICKETTS 198Ø
[28] : WATSON 1976
[29] : WALKER, WATSON & HOLT 1977
[3Ø] : HOLT et al. 1976
[31] : RICKETTS, RAINE & KING 1979
[32] : WATSON et al. 1979

Source flux and variability code. The source flux (in SSI count s^{-1}) and a variability code are quoted as follows:

Varibility code	Flux values quoted
S = Steady	Weighted mean flux from *all* observations, $\pm 1\sigma$ error.
I = Irregular	Mean flux from *all* observations and an estimate of the minimum and maximum observed flux.
T = Transient	Upper limit to flux outside of transient outbursts and an estimate of the maximum observed flux during an outburst.

Transient sources are classed as those which generally are not detected by the SSI but which exhibit relatively short duration ($\lesssim 50$ day), and often dramatic, flux increases (c.f. Kaluzienski 1977; Cominsky *et al.* 1978). In some sources these transient outbursts are recurrent (e.g. A 0535 + 26). Of the remaining sources, those with a formal probability < 1 per cent that the X-ray light curve could result from steady X-ray emission were classed as irregular.

Identification. The suggested identification of the X-ray source (taken from previously published results).

Other information. Very restricted details of the identification (where appropriate), and of any reported periodicities in the X-ray emission from the source. Where possible key references to these details are quoted in the table. However, more detailed information and references on many of the sources may be found in Bradt *et al.* (1979), Forman *et al.* (1978) and Amnuel, Guseinov & Rakhamimov (1979). Numbered references refer to earlier papers based on *SSI observations* of sources in the catalogue. These are grouped together at the end of the table to provide a convenient list.

4 Calibration of the flux scale

The calibration of the SSI observations is based on the average count rate observed on the Crab nebula of 403 ± 5 SSI count s^{-1}. Assuming a spectrum for the Crab nebula of the form $N(E) = 9.7E^{-2.1}$ photon $cm^{-2}\,s^{-1}\,keV^{-1}$ (Toor & Seward 1974), this leads to a conversion factor (for a source with a Crab-type spectrum)

$$1 \text{ SSI count s}^{-1} = 5.3 \times 10^{-11} \text{ erg cm}^{-2}\,\text{s}^{-1}\ (2\text{–}10\,\text{keV})$$

$$= 2.75\,\mu\text{Jy (averaged over 2–10 keV or at 4.9 keV)}$$

with an uncertainty ~ 15 per cent (arising from the precision to which the above spectrum is known).

The conversion factor from count rate to energy flux units for sources with other spectral forms can then be calculated using the values for the SSI detector efficiency given in 2A. Fig. 2 shows the conversion factor obtained for a power law and for an exponential spectrum, including in both cases the effect of a low-energy photoelectric cut-off. Note that the variations in the conversion factor from the previously adopted value of 5.1×10^{-11} erg $cm^{-2}\,s^{-1}$/SSI count s^{-1} (see 2A) do not exceed ~10 per cent over a wide range of spectral form (i.e. well within the uncertainty of the calibration).

The use of the Crab nebula as a calibration source relies, of course, on the constancy of its X-ray flux. Fig. 3 shows the observed count rate on this source during the lifetime of *Ariel V*. There is no evidence for any significant variation in the count rate as a function of time (*cf.* Forman, Jones & Tananbaum 1976). A search for any linear trend in the data indicated a formal decrease in the count rate of 0.5 ± 0.7 per cent yr^{-1} (to 90 per cent confidence).

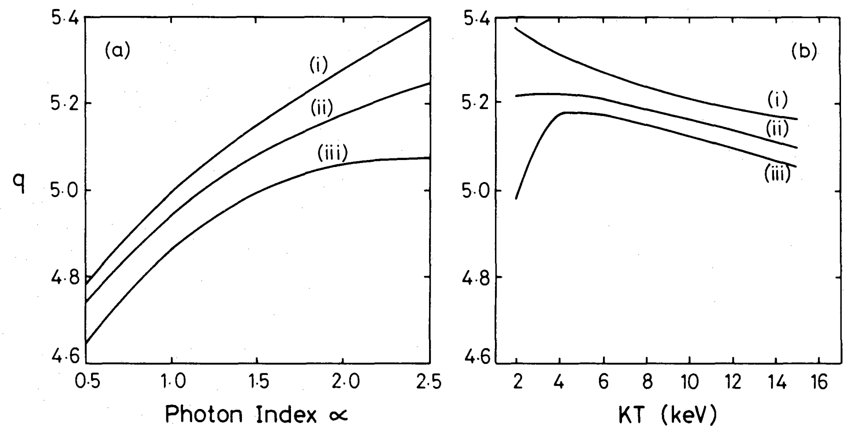

Figure 2. The conversion factor q (in units of 10^{-11} erg cm^{-2} s^{-1}/SSI count s^{-1}) from an SSI count rate to a 2–10 keV energy flux for (a) a power law spectrum, $N(E) \propto E^{-\alpha}$, (b) an exponential spectrum, $N(E) \propto \exp(-E/kT)\,E^{-1}$, both modified by a low energy cut-off of the form $\exp(-(E_A/E)^{8/3})$. The curves correspond to (i) $E_A = 0$; (ii) $E_A = 1.8$ keV ($N_H \approx 2 \times 10^{22}$ atom cm^{-2}) and (iii) $E_A = 3.3$ keV ($N_H \approx 10^{23}$ atom cm^{-2}).

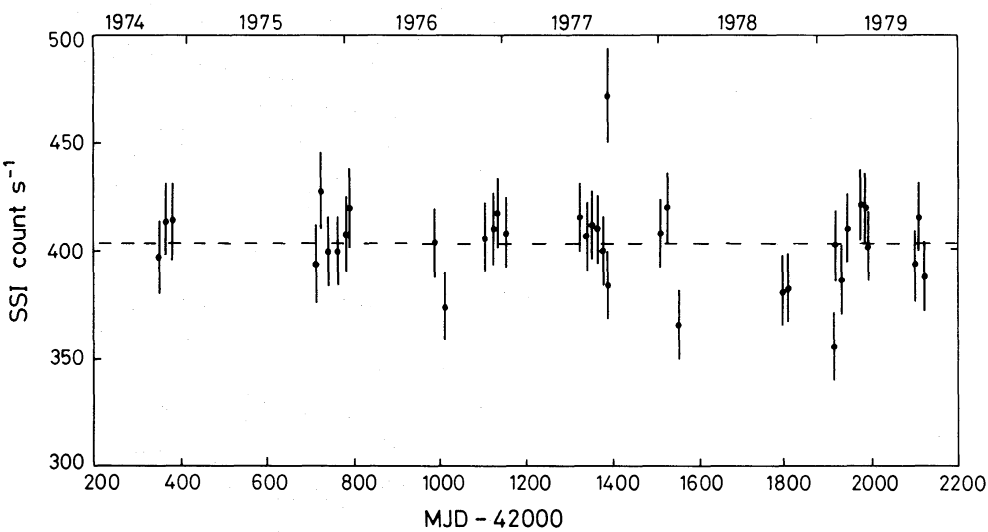

Figure 3. The observed count rate on the Crab nebula measured over a 5-yr period. There is no evidence for any significant trend in the data.

A factor to convert SSI count s^{-1} to *Uhuru* count s^{-1} may be obtained as the ratio of the count rates observed on the Crab in the 3A and 4U catalogues. This gives

1 SSI count s^{-1} = 2.3 *Uhuru* count s^{-1}

which is in good agreement with the value obtained from an analysis of 2A and 4U (PST) fluxes given in the 4U catalogue (Forman *et al.* 1978). Finally a similar exercise indicates that for comparisons with the *OSO-7* catalogue (Markert *et al.* 1978)

1 SSI count s^{-1} = 0.15 *OSO-7* count s^{-1} (3–10 keV).

5 Sky coverage

In many regions of the galactic plane it is source confusion rather than the sensitivity of the available observations which determines the effective area of sky surveyed to any particular flux level. An attempt has been made to provide an estimate of the effective sky coverage of the catalogue by determining the third deepest observation at positions set out on a 2°

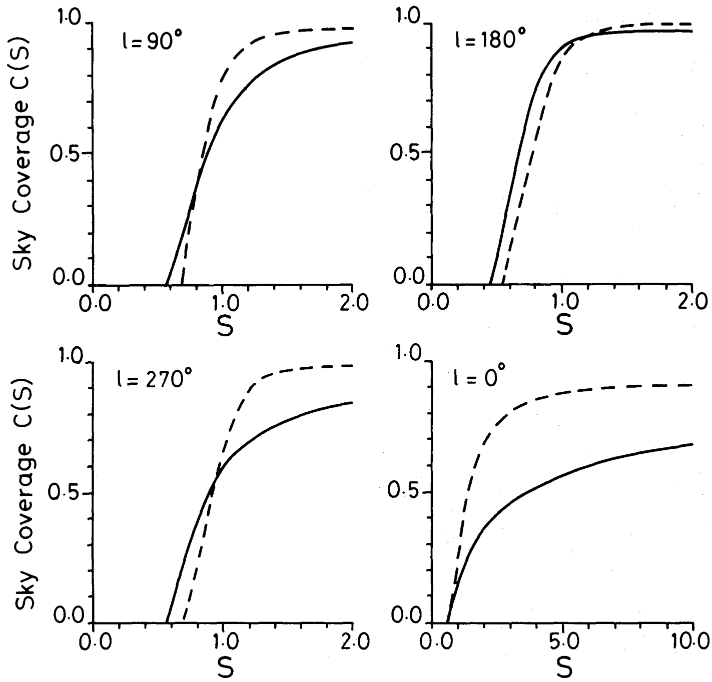

Figure 4. The probability, $C(S)$, of a source of flux S (SSI count s^{-1}) appearing above both the sensitivity (3σ) and confusion limits on at least three summed-orbit records (see text). These sky coverage curves are shown separately for four longitude regions (quadrants centred on the specified galactic longitude) and also for the galactic latitude ranges $|b| \leqslant 5°$ (full lines), and $5 < |b| \leqslant 10°$ (dashed lines).

square grid covering the low latitude region. This involves taking all the observations at a particular position and for each observation computing both the source flux which would give, in the absence of other sources, a 3σ peak in the data (the sensitivity limit) and the source flux for which the associated confusion parameter (which is calculated from estimates of the fluxes of nearby catalogued sources) was less than 10 per cent (the confusion limit). The minimum source flux to give three observations above both the sensitivity and confusion limit was calculated for each position and by combining the results over the grid of positions it was then possible to determine an estimate of the effective sky coverage. Fig. 4 shows the results obtained for different regions of the galactic plane.

The effect of strong source confusion in the Galactic Centre region is evident. It appears, however, that in some regions of the galactic plane (in particular the anti-centre region) the

Table 3. Comparison of the 3A and 4U catalogues for the region $|b| < 10°$.

Total number of 3A/4U sources	109/138
Number of 3A/4U transients	10/11
Number of 3A sources★ not in 4U	21

4U error box area (deg²)	Number in 4U★	Percentage also in 3A
< 0.01	40	95
0.01–0.05	20	80
0.05–0.10	8	75
0.10–0.50	28	46
0.50–1.00	11	36
1.00–5.00	20	5

★ Excludes sources described as transient.

sky coverage approaches that achieved in the *Ariel V* survey at high galactic latitudes (see Paper II).

In conclusion it should be noted that the rather complicated iterative procedure used to produce the catalogue (Section 2) is only crudely modelled by the above procedure, and also that no account is taken of the high degree of variability exhibited by many low latitude X-ray sources.

6 Comparison with previous work

6.1 COMPARISON WITH THE 4U CATALOGUE

Table 3 shows a comparison of the present catalogue and the 4U catalogue (Forman *et al.* 1978) for the common region of sky. Although there is considerable consistency between the two catalogues for bright sources (which generally have small 4U error boxes), the overlap of the catalogues is by no means complete. In particular it should be noted that relatively few of the sources in the 4U catalogue with large error boxes (i.e. with area $> 0.5\ \mathrm{deg}^2$) appear in the 3A catalogue. Excluding these sources, ~ 80 per cent of the sources in either catalogue appear in the other.

Table 4. Details of 4U sources with $|b| < 10°$ and error box area $< 0.5\ \mathrm{deg}^2$ which do not appear in the 3A catalogue.

4U source	3A flux (SSI count s^{-1})	Comments
4U 0033 + 58	0.2 ± 0.1	No significant detections
4U 0115 + 63	0.9 ± 0.3	4U transient. $< 3 \times 3\sigma$ detections
4U 0322 + 59	0.2 ± 0.1	$< 3 \times 3\sigma$ detections
4U 0404 + 47	0.1 ± 0.1	$< 3 \times 3\sigma$ detections
4U 0407 + 37	0.0 ± 0.3	$< 3 \times 3\sigma$ detections. 3A 0415 + 376 nearby
4U 0515 + 38	0.1 ± 0.1	No significant detections
4U 0538 + 26	–	Association of 4U source with nearby recurrent transient A 0535 + 26 unclear.
4U 0813 – 38	0.0 ± 0.1	No significant detections
4U 0836 – 42	0.7 ± 0.3	4U transient. $< 3 \times 3\sigma$ detections
4U 0854 – 44	0.1 ± 0.2	No significant detections
4U 1110 – 58	<2.2	Confused region
4U 1210 – 64	< 2.4	Confused region
4U 1314 – 64	0.0 ± 0.2	No significant detections
4U 1543 – 47	< 3.5	4U transient. Confused region
4U 1608 – 52	< 3.0	Confused region
4U 1700 – 37	–	Strongly confused region
4U 1702 – 42	–	Strongly confused region
4U 1705 – 32	–	Strongly confused region
4U 1715 – 39	–	Strongly confused region
4U 1722 – 30	–	Strongly confused region
4U 1730 – 22	–	4U transient. Strongly confused region.
4U 1735 – 28	–	4U transient. Strongly confused region.
4U 1743 – 29	–	Extended 4U source at Galactic Centre. A 1742 – 294 nearby. Strongly confused region.
4U 1743 – 19	–	4U transient. Strongly confused region.
4U 1832 – 05	< 2.6	Confused region
4U 1901 + 03	< 3.0	4U transient. Confused region.
4U 1920 + 34	< 2.8	Confused region
4U 1933 + 36	< 2.9	Confused region
4U 2028 + 42	< 2.6	Confused region
4U 2134 + 55	< 2.2	Confused region

Table 4 provides a list of the 4U sources with $|b| < 10°$ and error box area < 0.5 deg^2 which do not appear in the 3A catalogue. Where possible details of the SSI observations in the region of each source are given. The 3A flux represents the average flux from *all* unconfused observations at the 4U source position. However, for sources which are confused along many position angles it is only possible to give a 3σ upper limit based on the *best* single observation and in a number of cases strong source confusion prevents any clear sighting of the source.

6.2 COMPARISON WITH EARLIER WORK BASED ON SSI OBSERVATIONS

A number of preliminary lists of low latitude sources observed by the SSI have already been published (Villa *et al.* 1976; Seward *et al.* 1976a, b; Watson *et al.* 1979). These lists cover only restricted regions of the galactic plane and are based on only a fraction of the data base now available. The majority of sources which were previously reported have now been confirmed by subsequent *Ariel V* and other satellite observations. A number of sources have, however, failed to reach the final 3A compilation. In many cases this is the result of additional data leading to a different (and more probable) choice of intersections on the lines of position map (see Section 2). Sources in this second category are listed in Table 5.

Table 5. Previously reported *Ariel V* (SSI) sources (with $|b| < 10°$) not confirmed in the 3A catalogue.

Source	Reference	Source	Reference
A 0338 + 50	1	A 1556 – 52	3
A 0503 + 35	1	A 1621 – 52	3
A 0709 – 114	4	A 1815 – 08	1
A 0709 – 221	4	A 1831 – 10/A 1829 – 10	1, 2
A 0835 – 48	3	A 1840 + 01	1, 2
A 1014 – 57	3	A 1847 – 05	2
A 1215 – 59	3	A 1918 + 14	1, 2
A 1250 – 66	3	A 2031 + 31	1
A 1354 – 64	3	A 2033 + 36	1
A 1415 – 60/A 1416 – 589	3, 4	A 2246 + 60	1
A 1452 – 60	3		

References: 1. Villa *et al.* (1976), 2. Seward *et al.* (1976a), 3. Seward *et al.* (1976b), 4 (Watson *et al.* (1979).

7 Discussion

7.1 THE SOURCE DISTRIBUTION AND LOG N – LOG S RELATION

The 3A low-latitude catalogue is reasonably complete for sources with flux $S \gtrsim 2$ SSI count s^{-1} (and more than 50 per cent complete for sources with $S \gtrsim 1$ SSI count s^{-1}) except in the galactic longitude range $|l| < 45°$. In this region source confusion seriously reduces the effective sky coverage for $S \lesssim 5$ SSI count s^{-1} (see Fig. 4).

The distribution of the 3A sources in galactic latitude and longitude is shown in Fig. 5. The most prominent feature is the concentration of the brightest sources in the direction of the Galactic Centre (Fig. 5a), and effect which is much less marked at intermediate fluxes (Fig. 5b and c). Also the latitude distribution for the region $|l| < 45°$ is considerably wider than that observed in other directions (Fig. 5d and e). The implication is that a population of X-ray sources exists within the galactic bulge (and extends up to 2 kpc from the galactic plane). The group of bright sources often collectively referred to as the 'galactic bulge X-ray

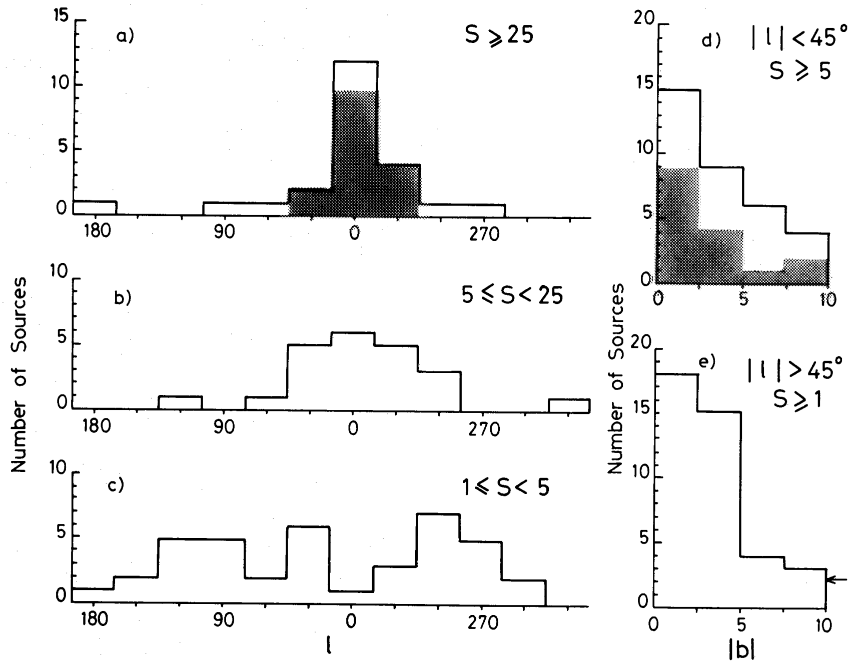

Figure 5. The source distribution in galactic latitude and longitude. Transient sources have been excluded. The group of bright sources often referred to as the 'galactic bulge X-ray sources' are shown shaded (A 1742 – 29 has been included in this class). The arrow indicates (with suitable normalization) the average number density of 3A high latitude sources (with mean flux $S \geq 1$ SSI count s^{-1}).

sources' (e.g. see Bradt *et al.* 1979) are shown shaded in Fig. 5. The properties (e.g. soft X-ray spectra, lack of pulse and eclipse periods and high luminosities $L_X > 10^{36}$ erg s^{-1}) and possible nature of these sources and their relation to burst sources have been discussed by many authors (e.g. see Lewin & Clark 1978 and references therein). Rothenflug, Rocchia & Cassé (1979) and Meurs (1978) have argued from the distribution of 4U sources (which is not dissimilar to that for 3A sources) that the majority of galactic X-ray sources (excluding the bulge and globular cluster sources) have a Population I origin (and $L_X \sim 10^{35}–10^{38}$ erg s^{-1}). This view appears reasonably compatible with the available optical identification data (see below) and also with recent *Einstein* observations of X-ray sources in M31 (Van Speybrock *et al.* 1979). However, an interesting feature in Fig. 5(e) is that in the galactic latitude range from 5° to 10° the observed number density of sources has fallen to a level approaching that observed at high latitudes (Paper II). Although at least 60 per cent of the high latitude sources (with $S \geq 1$ SSI count s^{-1}) have been shown to have an extragalactic origin, the number of identifications with relatively nearby (galactic) stellar sources has steadily increased over recent years (Paper II). This points to a third galactic population of hard (> 2 keV) and relatively low luminosity ($L_X < 10^{35}$ erg s^{-1}) X-ray sources.

Fig. 6 shows the observed number–flux relation for the 3A low-latitude catalogue (excluding transient sources). Separate curves are shown for the galactic bulge region ($|l| < 45°$) and the rest of the galactic plane. The former curve must reflect the luminosity function of the galactic bulge population and appears to cut-off near the Eddington limit for a source $\sim 1 M_\odot$. (L_X (2–10 keV) of $\sim 10^{38}$ erg s^{-1} corresponding at a distance of 10 kpc to a count rate of ~160 SSI count s^{-1}.) By comparison the number–flux relation for the region $|l| > 45°$ follows (approximately) a power law form over a flux range spanning two decades. The observations are consistent with $N(>S) = 37\,S^{-0.62}$, with a standard deviation in the exponent of ±0.15. (Here sky coverage corrections have been neglected but are estimated to be of relatively small magnitude.) A similar slope for the galactic source counts has been

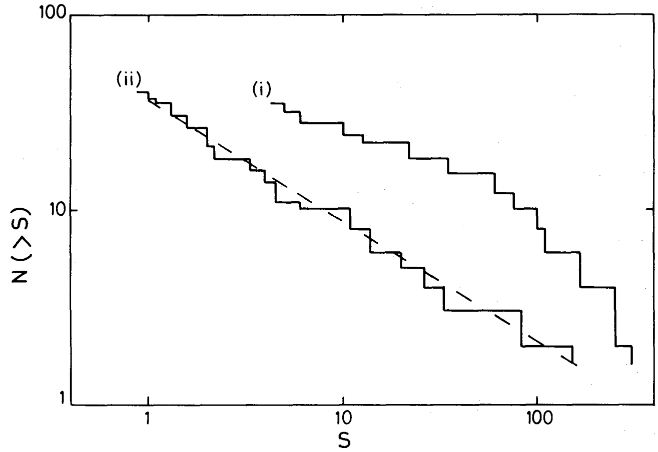

Figure 6. The integral log N–log S relation for 3A sources with $|b| < 10°$. Mean fluxes have been used if sources are classed as irregular. Transient sources have been excluded. Curve (i) sources with $|l| < 45°$, $S \geqslant 5$ SSI count s^{-1}. Curve (ii) sources with $|l| > 45°$, $S \geqslant 1$ SSI count s^{-1}. The dashed line corresponds to the best fitting power law, $N(>S) = 37\, S^{-0.62}$.

determined from both *Uhuru* and *OSO-7* observations (Matilsky *et al.* 1973; Markert *et al.* 1977). The observed source count relation must reflect a number of factors including the distribution of the different source populations, their luminosity functions and geometrical effects within the galaxy (e.g. Johnson 1978). These points will be discussed in a later paper.

7.2 X-RAY VARIABILITY

Of the 109 sources in the catalogue, 63 show irregular or periodic variations and a further 10 are transients or recurrent transients. While the remainder have been classed as 'steady', they are (apart from the supernova remnants) mostly rather faint so that similar variability may well have escaped detection. It seems reasonable therefore to conclude that almost all compact galactic X-ray sources are variable (*cf.* Forman *et al.* 1976). Fig. 7 illustrates the range of variability observed. The SSI observations relate to X-ray variability on a time-scale $\gtrsim 1$ day and to phenomena such as periodic modulation of the X-ray emission from a source (arising in many, but not all cases, from the binary nature of the source), transient and flaring outbursts, high–low states and a range of less dramatic but chaotic variability (see

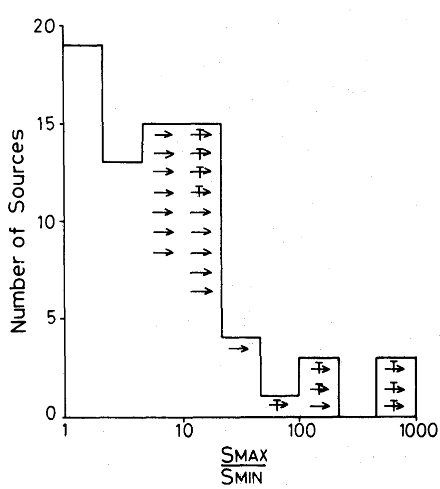

Figure 7. The ratio of the maximum to minimum X-ray flux for the sources classed as irregular or transient (marked T). Lower limits are indicated by arrows.

review by Watson 1979b). The present analysis is not, however, sensitive to short-lived (< 1 day) transients. (A survey of the entire *Ariel V* data base for such events is in progress and will be reported elsewhere.)

Table 6. Details of the optical identifications.

Systems containing early type (OB) stars	11 + 1?
Globular clusters	3
Systems containing faint (low mass?) stars	23
Supernova remnants	7 + 2?
Other galactic sources (2 cat. variables, 1 RS CVn, SS 433, Eta Carinae)	5
Extragalactic objects	5 + 1?
Unidentified bright bulge sources	9
Other unidentified sources	42

7.3 OPTICAL IDENTIFICATIONS

The identification of X-ray sources in the galactic plane proves to be extremely difficult unless relatively precise ($\lesssim 1$ arcmin) X-ray positions are available. Many of the early identifications of galactic X-ray sources therefore relied on strong supporting evidence such as identical periodicities or simultaneous outbursts in the X-ray and optical bands. However, in recent years the number of secure identifications has greatly increased as the result of precise position measurements by modulation collimators on *Ariel V, SAS-3* and *HEAO 1* (see Bradt *et al.* 1979). At present identifications have been proposed for ~ 50 per cent of the sources in the low-latitude catalogue. Table 6 shows a breakdown of these identifications from which it is clear that the great majority of the sources are galactic objects. Furthermore the evidence (both observational and theoretical) strongly supports the view that the great majority of the compact galactic X-ray sources are close binary systems in which the X-ray emission is powered by accretion of mass lost from a non-degenerate star onto a compact object (black hole, neutron star or white dwarf). The interesting bifurcation of the stellar identifications into high mass (OB star) systems and faint low mass systems is reflected to some degree in the X-ray properties of the sources (e.g. see Margon 1979; Watson 1979c and references therein).

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