# The Ariel $V$ (SSI) catalogue of high galactic latitude ( $|b|>10^{\circ}$ ) X-ray sources 

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Summary. The 2A catalogue is the result of 10000 orbits of observation by the Leicester University Sky Survey Instrument on the Ariel $V$ satellite and it contains 105 X-ray sources with $|b|>10^{\circ}$. The procedures and criteria used in establishing these sources and measuring their intensities and positions are described. As a consequence of the comparatively small error boxes ( 0.1 to 0.5 square degree) and the sensitivity limit of the survey ( 90 per cent of the sky to better than 1.2 Ariel count/s $\approx 3.2$ Uhuru count/s), new optical identifications are suggested.

## 1 Introduction

The Leicester Sky Survey Instrument (SSI) on Ariel $V$ started observations of X-ray sources in 1974 October. Its principal aims were (i) to carry out a new and more complete sky survey in the $2-18 \mathrm{keV}$ range (the 3 U survey by Giacconi et al. 1974 was essentially complete over the whole sky only down to $\sim 10$ Uhuru count/s, with decreasing coverage down to $\sim 2$ Uhuru count/s), (ii) to take a detailed study of source variability, and (iii) to improve the positional accuracy of less well-defined 3 U sources and aid their identification. As many of the sources seen by the SSI near the galactic plane have already been described (Villa et al. 1976; Seward et al. 1976a, b), this catalogue has been restricted to $|b|>10^{\circ}$ in order to concentrate on X-ray sources which are potentially extragalactic. The data presented are the result of approximately two years of surveying, producing a sky coverage to a depth of approximately 1.2 Ariel count/s ( $\approx 3.2$ Uhuru count/s) and a catalogue containing 105 sources.

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Figure 1. Part of a 51 -orbit superimposed data set showing the Coma Cluster, 2A $1257+283$, a source with improved position 2 A $1346+266$ (was $3 \mathrm{U} 1349+24$ ), identified now with A1795 and two new Ariel sources 2A $1415+255$ (identified with a Seyfert Galaxy NGC 5548) and 2A $1219+305$. The bestfitting background and the sky exposure time (centre of collimator) are also shown.

## 2 Description of the instrument

A detailed description of the SSI has been published previously (Villa et al. 1976). Briefly it consists of a set of proportional counters viewing from the side of the spin-stabilized spacecraft and having a 'fan beam' field of view set by mechanical collimators. The field of view is $0^{\circ} .75 \times 12^{\circ} .0$ (FWHM) with the long axis inclined at $65^{\circ}$ to the spin plane. As the satellite spins, the SSI therefore sweeps over a great circle of the sky, viewing a strip some $10^{\circ}$ wide. Most of the survey data were taken in a mode where a $360^{\circ}$ strip of sky, divided in 1024 spatial elements or sectors, is integrated for one orbit. No spectral resolution is used in this mode so that the data apply to the whole spectral range $2-18 \mathrm{keV}$. The sensitivity is such that in one orbit a source $\sim 5$ Ariel count/s at 100 per cent collimator transmission is visible at the $3 \sigma$ level above a background of diffuse X-rays and cosmic rays. Typically Ariel $V$ holds a given spin-axis position for several days, correcting the attitude drift as necessary, so that we are able to superimpose data from many orbits and improve the sensitivity. Fig. 1 shows part of an observation with the SSI at high galactic latitude, where 51 orbits have been superimposed. In general, observations of sources which are more than $6^{\circ}$ from the centre of the collimator have not been used to estimate source positions, intensities or upper limits on intensities.

## 3 Data analysis

Sets of superimposed orbit data are scanned automatically, and the first task is to fit an acceptable background. The background level is only a slowly varying function of position since (a) the high energy particle flux is spread evenly in all sectors by the axial rotation of the spacecraft, (b) the diffuse cosmic X-ray flux is apparently isotropic, and exposure time varies slowly with position, (c) fluorescent X-rays from the upper atmosphere of the Earth, which are detectable during solar outbursts, are spread over many sectors by the orbital motion of the spacecraft. The chance of background fluctuations giving rise to a significant peak with a shape like that of a source is very small, so that the probability of an inter-
section of three such lines is negligible. With the background subtracted, the data are searched for any peaks which, when fitted by the equivalent of a point-source response, exceed the local background by $2.5 \sigma$. The file of positions and heights is then matched against a catalogue of known sources, mainly 3U and MX (Markert et al. 1975), and peaks inconsistent with a position within the quoted error box are listed as new sources. Eventually all the 'matched' and 'new' peaks are plotted on an all-sky map as boxes (called 'lines of position' hereafter) of length $24^{\circ}$ and angular width as defined in Section 5. Using this map, potential new sources are picked out by eye by searching for plausible intersections of at least three lines of position. Revised positions for sources already catalogued are determined in the same way, except that a minimum of five detections of $2.5 \sigma$ or greater was required for any source which did not satisfy the three times $3 \sigma$ criterion (see Section 5).

Before assigning a source to the 2 A catalogue, the data from which each line of position was derived were checked for reasonableness of background fitting and peak shape, and the possibility that the peak was due to a distant sighting of a very strong galactic source, e.g. Sco X-1 or the Sun, was investigated. Supporting positional data of less statistical significance were also searched for.

## 4 Sky coverage

The concentration of the Ariel $V$ spin-axis pointing directions in the galactic plane (influenced by the other, on-axis experiments) has produced a non-uniform sky coverage with highest density near the galactic poles. However, we have attempted to achieve, for all points in the sky, at least three data sets which are capable of yielding a $3 \sigma$ signal from sources of intensity 1 Ariel count/s. Following the criterion of requiring three intersecting $3 \sigma$ lines of position, the minimum source intensity detectable in a region of sky is that capable of producing a $3 \sigma$ peak in the data set which is the third most sensitive for that region. Contours of this parameter on an azimuthal equal-area projection are shown in Fig. 2(a) and (b). The fraction of sky covered as a function of source intensity is shown in Fig. 3 (solid line). This method produces a small underestimate of the sky coverage which is discussed in Section 9.

## 5 Determination of source position

During the production of this catalogue, it became obvious that a number of 3 U and MX sources were not detected by the SSI and therefore that at least some high-latitude X-ray sources are variable, but on unknown timescales. Criteria for source existence based on a consistent intensity could therefore be misleading and the 2 A criteria are based on significance alone, namely that a source must have produced at least three sightings of $3 \sigma$ or greater. In some cases, when the Ariel $V$ pointing experiments have returned several times to a particular source, the three sightings could produce lines of position at very similar position angles. In such cases additional observations were arranged to produce a new line of position as nearly orthogonal as possible.

To produce a positional error box for a source, the line-of-position data were combined using a probability contouring program to give the 90 per cent iso-probability contour and the point of maximum probability density (see for example Davison 1973). The latter is the quoted source position (Table 1, column 4) and has been used for computation of the source intensity: To facilitate replotting a source error box (e.g. on star charts), the 90 per cent contours were fitted by ellipses and the corners of the circumscribing rectangle (in azimuthal equal-area projection) having sides parallel to the ellipse axes are quoted in Table 1, column 5.


| COVERAGE | CT. ${ }^{-1}$ $\leqslant 0.7$ |
| :---: | :---: |
|  | 0.9 |
|  | 1.2 |
| $\ldots \ldots \ldots \ldots$ | 1.4 |

(a)

(b)

Figure 2. (a and b) Sky coverage maps showing minimum detectable (3 $\sigma$ ) intensity for source discovery at each point in the sky. Intensity contours are $: \leqslant 0.7$ Ariel count/s = Black; 0.9 Ariel count/s = - - ; 1.2 Ariel count/s= $\qquad$ ; 1.4 Ariel count/s = $\qquad$ The maps are equal-area azimuthal projections in $l$, $b$ with grid lines at intervals of $20^{\circ}$ with additional lines at $b= \pm 10^{\circ}$. Fig. 2(a) has its centre at $\left(0^{\circ}, 0^{\circ}\right)$ and (b) at ( $180^{\circ}, 0^{\circ}$ ). The 'confused regions' described in Section 9 and Table 3 are enclosed with heavy lines.


Figure 3. Percentage of the high-latitude sky ( $|b|>10^{\circ}$ ) covered to a minimum detectable ( $3 \sigma$ ) intensity $<S$ Ariel count/s for source discovery, according to the criteria of (a) the minimum detectable intensity on the third most sensitive data set (solid line), and (b) the minimum detectable intensity for which the probable number of sightings, taking account of all useful data sets, is just three (dashed line).

Each input line of position to the contouring program was a one-dimensional Gaussian distribution, perpendicular to the major axis of the line of position, of standard deviation $\sigma$ given by
$\sigma^{2}=(\mathrm{FWHM})^{2} / 3 \sigma_{\mathrm{D}}^{2}+A^{2}$
where $\sigma_{\mathrm{D}}=S / \sqrt{ } N$, the signal-to-root-background counts of the peak detected in the data set, and $A$ is an angle ( $=0^{\circ} .07$ ) which represents a positional error arising from systematic errors in the spacecraft attitude and the mechanical alignment of the SSI, and is estimated by contouring sources with very precise positions (e.g. Cyg X-1, Crab Nebula). The accuracy of this distribution width was tested by using the routine analysis procedures on simulated randomized data. A comparison of the $\sigma$ from the distribution of peak positions found in the simulation, with that calculated from the above formula with the simulated signal-to-noise ratio, shows that the formula is appropriate for $\sigma_{\mathrm{D}}>3$. For a relatively intense high-latitude X-ray source such as 2A $0316+413$ (Perseus Cluster/NGC 1275), for which we have a large number of source detections, the resulting contour is essentially a test of the positional accuracy possible with the SSI. The contour, Fig. 4, is approximately circular of width $\sim 0^{\circ} .1$ and agrees well with the error box for $3 \mathrm{U} 0316+41$ and the actual position of NGC 1275.

As this is a catalogue of X-ray sources detected by the SSI, all the objects in Table 1 have a 2 A name (the prefix 2 distinguishing sources from those previously reported from any of the Ariel $V$ experiments which have a variety of detection and location criteria). To reflect the general improvement in source positions obtained with the SSI, the IAU notation has been adopted with an additional digit in the declination part of the source name. The distribution of error box sizes in the 2A and 3U catalogues is shown in Fig. 5. In the Uhuru catalogue the second peak and the largest error boxes presumably result from observations with the side 2 detector $\left(5^{\circ} \times 5^{\circ}\right.$ collimator). Because of the size of some of the 3 U error boxes it is difficult to know whether or not a nearby 2 A source should be associated with it. Tentative associations are flagged with a question mark. Comparing the 2A and MX data,
Table 1

[C] : LUCKE ET AL. 1976.


OTHER INFORMATION

| 8. $77-272.24$ | 39.04 -52.54 | 38.76 52.94 | 38.37 2.71 | 38.65 52.40 | . 478 | . 5 | S |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{ccc}2.98 & 146.45 \\ 1.38 & -15.57\end{array}$ | 42.75 41.18 | 42.84 41.61 | 43.17 41.57 | 43.08 41.14 | . 83 | 1.9 .1 | S | $\mathrm{NGFC}_{4 *} 1129$ | GROUP |
| 3.07 <br> 6.09 <br> .09 .28 <br> -45.18 | 43.02 5.72 | 42.75 6.31 | 43.15 6.47 | $43.37$ | , 192 | 5 .1 | S |  | A ${ }_{\text {WHIC }}$ |



| 2AO316-443 NEN | 49.05 -44.31 | 48.57 -44.52 | 48.98 -43.92 | 49.49 -44009 | 49.78 4.70 | . 210 | - 5 |  | S | CLUSTER(E) | PKS0 316-44 IN BOX |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $2 \mathrm{AO} 316+413$ CON 3 U0316+41 | 49.111 41.37 4 | 48.98 41.31 | 49.08 41.46 | 49.22 41.4 | 49.12 41.26 | - 15 | 18.5 .4 |  | S | $\begin{aligned} & \text { PERSEUS CL } \\ & * * * \end{aligned}$ | EXTENDED[B]. CONTAINS PT. SOURCE NGC1 $275[\mathrm{CJ}$ |
| 2AO335+096 NEW | $\begin{array}{r}53.83 \\ 9.63 \\ \hline 176.29 \\ \hline\end{array}$ | 53.36 9.13 | 53.86 10.34 | 54.26 10.18 | 53.75 8.97 | . 414 | . 1 |  | 5 | GROUP | LINE OF GALS ${ }^{\text {AINI }}$ CONT- |
| 2A0343-536 IMP 3U0328-52 | $\begin{array}{r}55.82 \\ -53.63 \\ \hline\end{array}$ | 56.28 -53.64 | 55.61 -53.89 | 55.36 -53.64 | 56.13 | . 110 | $\square_{1}^{7}$ | 1.4 | I |  | $\begin{aligned} & \text { CLUSTER CAOSYC-E } 38 \\ & \text { ON EDGE OF BOX }\left[\begin{array}{l} \text { DI } \end{array}\right. \end{aligned}$ |
| 2AO349-139 NEW |  | 56.99 -14.36 | 57.54 -13.55 | 57.55 -13.59 | - 54.538 | . 296 | - 3 |  | S |  | QUASAR PKSC349-1403 NEARBY |

[C]: GORENSTEIN ET AL. 1977.


Table 1 - continued
> ariel name st oryer

| ariel name st oryer |  | $\begin{gathered} -\cdots- \\ \cdots \text { RA } \\ \text { DEC } \end{gathered}$ |  | $\begin{gathered} \text { ERROR BOX } \\ \text { RA } \\ \text { DEC } \end{gathered}$ |  | AREA | - $\begin{gathered}\text { AV } \\ \text { AR } \\ \text { ER }\end{gathered}$ | INTEN MIN ERR | $\begin{aligned} & \text { SITY TMX } \\ & \text { MQR } \\ & \text { ERR } \end{aligned}$ | ---- |  | Other information |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2A0352+309 CON 340352+30 | 58.05 36.94 -17 -17 | 58.02 30.8 8 | 57.97 | 58.09 | 58: 58 | - 12 | 7. ${ }^{8}$ | 6:6 | 11:3 | I |  |  |
| 2A0411+103 IMP 3U0405+10 | $\begin{aligned} & 62.81 \\ & 10 \\ & 10 \\ & 39\end{aligned} 1-28.45$ | 62.64 10.15 | 62.53 <br> 10 <br> 000 | 62.91 10 | 62.92 10.16 | . 100 | 1.21 |  |  | S | ${ }_{4}{ }_{4} 78$ | [01 |
| 2A0430-615 IMP 3U0426-53 | 67 -61.74 57 | 68.27 -61.41 | $67: 41$ -61.84 | -67.16 | 68.63 -61.30 | - 77 | 1.11 | . 1 | 2:0 | I |  | CLUSTER SERS 4 C 16 IN eOXIE,K1. PKSO429-61 |
| 2AO431-136 NEW | $\begin{array}{cc}67.80 \\ -13.61 & 239.85 \\ -36.61\end{array}$ | 67.70 -13.81 | 67.57 -13.41 | -67.888 | 67.91 -13.79 | - UE 7 | : 1 |  |  | s | ${ }_{4}^{4} 996$ | L. F. PADIO (F) |
| 2A0456-449 IMP 3U051J-44 | 74.17 -4.953 -38.178 | 73.37 -45.86 | 73.87 -43.90 | 74.87 -44.02 | 74.41 $-45: 94$ | 1.130 | :1 |  |  | 5 |  |  |
| 2A0512-399 IMP MXC513-40 | 78.15 -39.9744 .36 -34.99 | 78.25 -39.74 | 78.31 -40.19 | 78.03 -40.21 | -37.98 | . 475 | 1.2 | . 5 | 3.0 .4 | I | NGC1851 | glob ular cluster (G,H,I) |
|  |  | 80.34 -72.17 | 79.99 -72.07 | -71:37 | -72:64 | . 316 | 7:0 |  |  |  |  | IN LMCMC. |
| 2A0526-328 NEW |  | -31.49 | -31:51 | ${ }_{-31}^{81} \cdot 9.9 \%$ | $-31.94$ | . 169 | : 1 |  |  | S |  |  |
| 2A0532-664 CON 3 LMC5 $32-66$ | 83.13 $-66.43-32.37 ~$ | 83.75 -66.78 | 82.0\% | 82. 56 | 84.18 -66.53 | . 210 | 2:0 |  |  |  |  |  |
| 2A0532-056 IMP 3U0527-35 | 83.21 <br> -5.65 <br> 609.23 | 83.18 -5.89 | 83.08 -5.41 | 83.21 -5.38 | 83.31 -5.86 | -ن5 3 | 1:9 |  |  |  | ${ }_{*} 2$ ORI | ORION NEBULA. [J] |
|  | ${ }_{5}^{197}{ }^{97} .$ $1977 .$ |  |  | $\begin{aligned} & \text { WHITE ET } \\ & \text { VIDAL } 197 \\ & \text { MAC } A O C A G N I \end{aligned}$ | $7 L^{\prime} \cdot 1976$ ET AL. | 1987 . |  |  |  | $\begin{array}{ll} 1 & 1 \\ 1 & 1 \\ 1 & 5 \\ 1 & 6 \end{array}$ | $\begin{aligned} & \text { ILLER } 1975 \\ & \text { EDMAN } 1977 \end{aligned}$ $\text { ELINAAN } 1977$ | RIVATE COMMUNICATION |


[B]: VIDAL 1975. [C]:WEEDMAN 1977.

Table 1 - continued

| ARIEL NAME ST OTHER | $\begin{aligned} & \text { POSITION } \\ & \text { RQ } \\ & \text { DEC } \\ & \text { LII } \end{aligned}$ |  | -2 ERROR $B O X$ RA <br> RA RA  <br> DEC DE RAC | AREA | $\begin{aligned} & \text { AV } \\ & \text { ERR } \end{aligned}$ | $\begin{aligned} & \text { INTENSI TY } \\ & \text { MIN MAX } \\ & \text { ERR EKDE } \\ & \text { ERS } \end{aligned}$ | $\begin{aligned} & I D D E N T T \\ & \text { OB JECT } \\ & \text { CODE } \end{aligned}$ | OTHER INFORMATION |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2AC906-095 IMP 300901-j9 | $\begin{array}{r}136.57 \\ -9.54 \\ \hline 24.63 \\ \hline 24\end{array}$ | 136.48 -9.75 | $\begin{array}{rrrr}136.38 & 136.63 & 136.73 \\ -9.36 & -9.31 & -9.74\end{array}$ | - 285 | 1.6 | S | A754 [A] | $\begin{aligned} & \text { WKBO 906-095 } \\ & \text { MSHO } 9-002 \end{aligned}$ |
| 2AC 922-317 NEW | $\begin{array}{rrr}1+C \\ -31.73 & 259.72 \\ 13.06\end{array}$ | 140.51 |  | . 472 | 1.3 | S |  | [B] |
| 2AO943-14J NEN | $\begin{array}{rrr}1+5.84 \\ -14.03 ~ & 249.66 \\ 28.84\end{array}$ | 145.76 -14.18 | $\begin{array}{cccc}145.71 & 145.98 & 145.96 \\ -13.8 \mathrm{E} & -13.87 & -14.19\end{array}$ | .365 | 1.6 | S | $\text { NGC2 } 992 / 3$ | POSSIBLE INTERACTING SY STEM |
| 2A0946-31C CON 3U0946-30 | $\begin{array}{rrr}146.60 \\ -31.02 & 253.11 \\ 17.14\end{array}$ | 146.39 -30.48 | 147.06 -31.42 146.76146 .15 | . 197 | 1. 1 | S |  | NGC3001 ON EDGE, NGC2 997 OUTSIDE |
| 2A0954+700 IMP 3UC943+71 |  | 147.52 69.67 | $\begin{array}{cccc}148.62 & 149.63 & 148.49 \\ 70.53 & 76.51 & 69.54\end{array}$ | - 311 | ${ }_{-1} 7$ | S | ${ }_{78}^{\text {M }} 2$ |  |
| 2A1033-270 IMP 3U104'4-30 | 158.38  <br> -27.01 259.27 | 158.46 -27.39 |  | . 182 | $\cdot 7$ $\cdot 1$ | S | ${ }_{*}^{\text {A1 }} 060$ |  |
| 2A1058-226 NEW | $\begin{array}{rr}154.66 & 272.26 \\ -22.67 & 33.28\end{array}$ | 164.77 -23.32 |  | . 377 | +5 .1 | S | ${ }_{4} 1146[\mathrm{Cl}$ | NGC3511,3513 JUST OUTSIDE BOX |
| 2A1102+384 NEW | 165.50 38.42 4959.92 | 165.28 38.38 | $\begin{array}{rrrr}165.62 & 165.73 & 165 \\ 38.58 & 38.46 & 38.26\end{array}$ | . 36 | -8 | $\begin{array}{r} 18.9 \quad F \\ 2.0 \end{array}$ | $\underset{*}{\text { MKN }}$ + 21 | EL LAC OBJECT [D] |
| 2A1135-373 NEW | 173.94 -37.36 | 174.17 -37.65 | 173.53 <br> -37.24 | -118 | 1. $\frac{1}{1}$ | S |  | SEYFERT GALAXY [E] |
| 2A1141+199 CON 3 PST $1144+19$ | 175.34 19.9535 .09 92.84 | 175.32 21.34 |  | 1.950 | - 6 |  | A1367 | 3C264 IN CLUSTER RPRO B=0.017 |




Table 1 - continued

| ariel name st other | POSITION RA, OEC BII | -RA | PA ER DEC |  | AREA | --̇-- AVR ER | $\begin{aligned} & \text { INTENS } \\ & \text { MIN } \\ & \text { ERR } \end{aligned}$ | ITY MAX ER | CODE |  | OTHER INFORMATION |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2A1326-311 IMP MX1327-31 | 201.71 <br> -31.15 <br> 150 <br> 30 | 201.33 -3008 | 202.20 -31.02 | $\begin{array}{cc}202.05 & 201.17 \\ -31 & 51 \\ -31.31\end{array}$ | . 314 | 1.2 | 000 | 00 | S | $\underset{*}{\text { clu }}$ ( TER | PKS1 327-31 |
| 2A1344-325 IMP MX1347-32 | $\begin{array}{rrr}306 \\ -32055 & 315.38 \\ 28.60\end{array}$ | 20598 | 205.53 | 206.52 205.84 | - 101 | 2.8 | 00 | 0 0.0 | s |  |  |
| 2A1346+266 IMP $301349+2$ - | 206.70 | 206.45 | 206.71 |  | . 078 | 1.11 | $0: 0$ | 000 | 5 | ${ }_{74}^{41795}$ | 4026.42 |
| 2A1347-300 NEW | $20 ¢$ -30.708 08 | $206: 43$ $-30: 02$ | 207:03 | 207:00 206.49 | . 100 | 1:7 | 0:0 | 0:0 | S | SEE INFO | CLUSTER CONNAINS |
| 2A1348+700 NEW | 207004115 | $207: 50$ 0963 | 2050:76 | 200.48 70.408590 | . 275 | : 2 |  | 000 | 5 | $\underset{* *}{\text { MK }}$ N279 | SEYFERT GALAXY (A) |
| 2A1410-029 CON 31J1410-03 | 212.59 339.09 | ${ }^{212} \mathbf{2} \mathbf{2} .85$ | 212.84 -2.64 |  | .207 | 1.3 .1 | $0: 0$ | 00 | s | ${ }_{*}^{\text {NGSC506 }}$ | EMISSION LINE GAL[B] NGC5507 AL SO IN BOX |
| 2A1415+255 NEW | 213.9132 .80 | 214.23 | 213:74 | 213.56 214.0595 | . 114 | .$_{1}^{8}$ |  | 000 | s | ${ }_{*}^{\mathrm{N} G 65548}$ | SEYFERT GALAXY (A) |
| 2A1418+485 NEW | 214.5789 .65 | 214.47 | 214.30 43.83 | 214.85 48.93500 | . 223 | : 4 | 0.0 | 0.0 | S | ${ }_{4 *}^{41904}$ | CLUSTER CENTRE JUST |
| 2A1508+062 NEW M $\times 1514+06$ ? |  | 227.41 | 227.00 5.03 |  | . 094 | ${ }^{1} \cdot 4$ | 0.0 | 0.0 | s | ${ }_{*}^{42} 029$ | A2033 ALSO NEAR |
| $241518+274 \begin{gathered}\text { P } \\ \text { PS }\end{gathered}$ | 229.50 271.82 | 229.75 28.58 | 227.77 26.12 | 228.53 25.61 230.56 28.05 | 2.700 | . 5 | 0.0 | 0.0 |  |  |  |

[B]: WILSON ET AL. 1975 .
[A]: WEEDMAN 1977.


[^1]| ARIEL NAME | ST OTHER | $\begin{aligned} & \text { POSITION } \\ & \text { RA } \\ & 0 \equiv C \quad \text { LI } I \frac{I}{I} \end{aligned}$ | $\begin{aligned} & -R A \\ & \text { RAC } \end{aligned}$ |  | $\begin{gathered} \text { RROR } B O X \\ \text { RA } \\ \text { DE } \end{gathered}$ |  | AREA | $\begin{aligned} & \text { AV } \\ & \text { ERR } \end{aligned}$ | INTENSI TY MIN MAX ERR ERR | CODE | $\begin{aligned} & \text { I O E ENT } \\ & \text { OBJECT } \\ & \text { CODE } \end{aligned}$ | OTHER INFORMAT ION |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 242009-569 | NE W | 302.28 -56.950 .90 95 -33048 | 322.71 -56.89 | 302.06 -57.18 | 361.83 | 302.47 -56.73 | . 072 | 1.2 |  | S | CLUSTER | CLUSTER ELONGATED NW-SE |
| 2A2040-115 | NEW | 310.19 $-11.56-29.91$ | 309.88 -12.17 | 310.14 -10.83 | 310.50 -10.90 | 310.24 -12.23 | . 398 | 19 $\cdot 1$ |  | S | MKN509 | SEYFERT GALAXY [A] |
| 2A2127+120 | IMP 3U2131+11 | $\begin{array}{rrr}321.84 & 65.09 \\ 12.08 & -27.19\end{array}$ | 321.65 12.07 | 321.94 12.21 | 322.01 12.08 | 321.72 11.93 | . 035 | 2.2 .1 | $\begin{array}{rrr}1.4 & 4.3 \\ .3\end{array}$ | I | NGC7 ${ }_{*}$ | GLOBULAR CLUSTER [ $B, C, D$ ] |
| 2A2142+381 | CON $302142+38$ | 325.68  <br> 38.14 87.38 <br> 11.29  | 325.78 38.19 | 325.06 38.19 | 325.07 38.10 | 325.78 38.10 | . 011 | 132.0 | $\begin{array}{rrr}90.0 & 300.0 \\ 5.0 & 10.0\end{array}$ | I | STAR [E] | $\begin{aligned} & 0.850 \text { RAO. VEL_PERIOD } \\ & \text { RADIO SOURGE }\{E, F\} \end{aligned}$ |
| 2A2151-316 | NEW | 327.95 -31.67 $-515: 48$ | 327.34 -32.02 | 328.30 -31.13 | 328.53 -31.31 | 327.57 -32.20 | . 254 | $\begin{array}{r}\text { - } \\ \bullet \\ \hline 1\end{array}$ |  |  |  | CONF USED REGION. 3 V . DIST. GROUPS IN BOX |
| 2A2155-609 | NEW MX2140-50? | $\begin{array}{r}328.85 \\ -50.98 \\ \hline 131.49\end{array}$ | 327.92 -61.58 | 328.82 -60.24 | 329.67 -60.38 | 328.80 -61.72 | . 515 | 8 $\cdot 8$ |  | S |  |  |
| 2A2220-022 | NEW | $\begin{array}{rrr}335.11 & 61.84 \\ -2.22 & -46.47\end{array}$ | 334.84 -2.48 | 335.07 -1.84 | 335.37 -1.95 | 335.15 -2.59 | . 174 | 1.0 .1 |  | S | A2440 |  |
| 2A2237-256 | NEW MX2244-24? | $\begin{array}{rr}339.33 & 28.85 \\ -25.62-60.57\end{array}$ | 338.64 -26.06 | 339.63 -24.93 | 339.94 | 338.94 -26.28 | . 408 | . 5 |  | S |  | MCG-04-53-026 IN BOX MC G-04-53-018 NEARBY |
| 2A2251-179 | NEW | 342.79 -17.97 -615.91 | 342.25 -18.19 | 343.09 -17.55 | 343.25 | 342.41 -18.38 | . 187 | 8 $\cdot 1$ | $\begin{array}{rr}.2 & 1.7 \\ .2 & .4\end{array}$ | I | GROUP |  |
| 2A2259+085 | NE ${ }^{\text {PS }}$ | 344.88  <br> 8.50 82.66 | 343.69 8.61 | 343.87 7.99 | 345.62 8.49 | 345.45 9.11 | . 920 | 1. 1 |  |  | NGC7469 | SEYFERT GALAXY [A] RPROB<0. 001 |


Table 1 - continued

[A]: MACCACARO ET AL. 1977.

## Notes on Table 1:

Column 1, ARIEL NAME: A 2A designation implies a source from this catalogue. This name supersedes all previous designations. The name is truncated to minutes of RA and the first decimal place in declination.
Column 2, STATUS: NEW = New source
IMP = Source with improved position
CON = Confirmed source
PST = Source established by Point Summation Technique only (see Section 8).
Column 3, OTHER NAMES: Designation in other catalogues if considered to be counterpart of 2A source (see Section 5). Any common name also given here.
Column 4, POSITION: Position of maximum probability in degrees of RA, dec (1950) and $l, b$ rounded to two decimal places.
Column 5, ERROR BOX: RA and dec (1950) of the corners of a rectangle enclosing the 90 per cent confidence ellipse (see Section 5).
Column 6, AREA: Area of the 90 per cent confidence ellipse in square degrees.
Column 7, INTENSITY AND VARIABILITY CODE: The intensity values and the variability codes are assigned as follows:
Variability Code Intensity Quotation
$\mathrm{S}=$ Steady source $\quad$ Weighted mean of all observations of intensity $\pm 1 \sigma$ error.
I = Irregular source Weighted mean of all observations of intensity $\pm 1 \sigma$ error; maximum intensity $\pm 1 \sigma$ error; minimum intensity $\pm 1 \sigma$ error (maximum and minimum intensity defined as observations most significantly above and below the mean).
$\mathrm{P}=$ Periodic source $\quad$ Typical maximum intensity $\pm 1 \sigma$ error; typical minimum intensity $\pm 1 \sigma$ error.
$\mathrm{F}=$ Flaring source $\quad$ Weighted mean of all steady observations $\pm 1 \sigma$ error; maximum flare point $\pm 1 \sigma$ error; other relevant data, e.g. timescale, in Column 10.
$\mathrm{T}=$ Transient source PST upper limit ( $3 \sigma$ plus 'measured' intensity) for nondetections; maximum intensity $\pm 1 \sigma$ error; other relevant data in Column 10.
All intensities are given in Ariel count/s (see Section 6).
Column 9, IDENT: Suggested identifications obtained as described in Section 10 and previous identifications as referenced. The star identification code expresses confidence in the identification as follows:
$* * * *=$ Almost certain: the object is inside a small ( $<0.1$ square degree) X-ray error box. There is substantial supporting evidence from other X-ray, optical, etc. observations.
*** = Very likely: as above but with weaker supporting evidence.
** = Probable: the object is jusi outside a small X-ray error box or inside a larger one and has supporting evidence.

* = Possible : positional coincidence only.

Column 10, OTHER INFORMATION: Other relevant data on the X-ray source, including references to previous identification, supporting evidence in other wavebands, timescales for periodic or transient sources, etc. For PST sources the probability P of the source arising by chance in the total sky area surveyed is given by $\mathrm{RPROB}=\mathrm{P}$ (see Section 8).


Figure 4. SSI error contours for 2A $0316+413$ which contains NGC 1275 . The isoprobability contours are at 68 (A), 90 (B) and 99.8 per cent (C). D is the quoted box for $3 U 0316+41$ and the four stars are the corners of the rectangle circumscribing the best-fitting ellipse to $B$. The solid circle is the position of NGC 1275.
we find two cases (MX $0600+46$ and MX $1514+06$ ) where a single MX source has been resolved into two separate 2 A sources.

## 6 Determination of source intensities

We have summarized the intensity behaviour of a source in the 2 A catalogue by a variability code and by intensities depending on that code. Light curves of sources of specific interest have been, or will be, published separately (e.g. for NGC 4151, Elvis 1976; and for NGC 5128, Lawrence et al., 1977).

To obtain the variability code, the observed intensity values for a source (i.e. all observations of intensity with the source within $6^{\circ}$ of the centre of the collimator) were first tested


Figure 5. Frequency distributions of error box areas for the 2A catalogue (non-PST error boxes only) and the 3 U catalogue.


Figure 6. The SSI detector efficiency. Curve (a) shows the intrinsic efficiency while (b) includes the effects of detector energy resolution and pulse-height windows. The energy ranges of the two detector units of the SSI are indicated.
for consistency with a constant source intensity. This hypothesis was rejected if the formal probability associated with the $\chi^{2}$ value was less than 1 per cent. If non-constant, the light curve was examined and assigned a variability code and appropriate intensities. The notes to Table 1 explain how the intensities and their errors were derived. For few of the sources assigned the variability code 'I' was the probability very much less than 1 per cent. Therefore the maximum and minimum intensity values quoted for these sources are not dramatically different from the average value.

Conversion of Ariel counts into an X-ray luminosity, or into other units, requires knowledge of the source spectrum, which has been measured in only a few cases. The conversion factor obtained from measurements of the Crab spectrum from Toor \& Seward (1974) is $5.1 \times 10^{-11} \mathrm{erg} \mathrm{cm}^{-2} \mathrm{~s}^{-1}(2-10 \mathrm{keV})$ per Ariel count/s. Varying the photon number index from 1 to 3 varies this value by a factor from 0.94 to 1.03 . For a thermal spectrum with temperature varying between 2 and 16 keV , the factor is between 0.98 and 1.02 . The general conversion factors for comparison with previous catalogues are

$$
\begin{aligned}
1 \text { Ariel count/s } & \approx 2.7 \text { Uhuru count/s }(2 \sim 6 \mathrm{keV}) \\
& \approx 0.2 \text { OSO }-7 \text { count/s }(3 \sim 10 \mathrm{keV}) .
\end{aligned}
$$

To aid intensity comparisons of heavily cut-off sources, the SSI efficiency against energy is given in Fig. 6.

## 7 Angular sizes of sources

The main limitation on angular size measurements is that the collimator width, projected along the direction of the scan, is about 50 arcmin. Drifts in attitude during the period of data collection (one orbit), and the redistribution of counts needed to compensate for larger drifts in the analysis of sums of orbits, together broaden the effective response by about one sector (21 arcmin), so that a point source produces significant counts in five or six sectors. Provided that the signal-to-noise ratio is large enough, it is possible to get estimates, or at least upper limits, of source angular diameters by least-squares fits of suitably broadened collimator functions to the observed data. Since most sources are very much less than $1^{\circ}$
across, we do not expect to be able to improve on current estimates (Kellogg \& Murray 1974) in these cases, although little effort has been applied to this problem so far.

## 8 Point-Summation Technique (PST)

In addition to source detection by the intersection of $3 \sigma$ lines of position (see Section 3), we have searched for X-ray emission from selected astronomical objects by a PointSummation Technique (PST) applied to the total data. A similar technique was used on the Uhuru data to provide upper limits for some active galaxies and globular clusters (Ulmer \& Murray 1976; Ulmer et al. 1976). Given the position of the object, all suitable scan data are summed by using the position as a datum and ignoring the direction of the scan path. Data are excluded if affected by nearby catalogued X-ray sources or other forms of interference.

The summation is repeated for a $4^{\circ} \times 4^{\circ}$ grid of points around the object, and each time the collimator response function is fitted to give the signal-to-noise ratio (SNR). The criteria for the existence of a PST source are that near the object the SNR be above an adequate threshold and that the contours of SNR be consistent with a point source, since any excess in the superimposed data must be of the shape of the collimator response.

In order to determine the required threshold, the PST procedure was applied to over 200 positions, of which 70 per cent were chosen randomly over the sky and the remainder were in three areas of $\sim 40$ square degree each (not necessarily remote from known sources). Examination of the correlation of SNR's of pairs of points in the same grid as a function of spacing showed that, for points $1^{\circ}$ apart, the correlation observed could occur by chance with a probability of 0.8 per cent, while for points $1^{\circ} .25$ apart the probability was 7.8 per cent. Thus the maximum density of essentially independent samples is $\sim 1$ per square degree. The area of sky searched with the technique, including objects of various classes and 3U X-ray source error boxes, totalled $\sim 850$ square degrees. The distribution of the SNR's at the $\sim 200$ positions was found to have a standard deviation of 1.14 and a mean value of 0.33 , the difference from zero being accountable by the method of fitting the background to the data. From the distribution, the SNR values for each PST source have been used to calculate the probability of chance occurrence in the area searched. A threshold value for SNR of 4.6 has been used, which in the area sampled should only be exceeded by chance with a probability of 0.1 . For most of the PST sources the actual chance probability was much lower than this, the values being given in Table 1, column 10. The positional error box quoted for PST sources is a quadrilateral (in azimuthal equal-area projection) which just encloses the contour $\left(\mathrm{SNR}_{\mathrm{pk}}-1\right)$; simulations show that this contour is a reasonable approximation to the 90 per cent confidence region for the source location. The quoted source position is that of $\mathrm{SNR}_{\mathrm{pk}}$ and the intensity is that found at this point.

Lists of objects which have been examined have yielded mostly upper limits in the range $0.15-0.5$ Ariel count/s. These are given in Table 2 . Some objects, notably some Seyfert galaxies, have given data satisfying the above source-detection criteria and these sources are included in the catalogue and flagged 'PST' in column 2 of Table 1. In addition there are some sources which, although not eventually satisfying the catalogue criteria described in Section 3, nevertheless had sufficient supporting data at lower significance to be made secure on the basis of the PST. These are also flagged PST in column 2. Since only a small amount of sky has been examined by the PST, these sources should not be used in any statistical analysis of source occurrence.

No upper limits are included in the catalogue unless they relate to a previously catalogued source for which we did not obtain data satisfying the catalogue criteria in Section 3. (In

Table 2. SSI upper limits on unconfirmed 3U, MX and other sources obtained by Point Summation Technique (PST).

| Source | SSI <br> upper <br> limit | Reported $\dagger$ <br> intensity | Intensity $\dagger$ <br> error | Source | SSI <br> upper <br> limit | Reported $\dagger$ <br> intensity | Intensity $\dagger$ <br> error |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $3 \mathrm{U} 0001-31$ | 0.63 | 1.19 | 0.15 | $3 \mathrm{U} 0917-63$ | 0.50 | 1.48 | 0.19 |
| $0012-05$ | 0.43 | 1.81 | 0.74 | $1169+59$ | 0.56 | 0.89 | 0.15 |
| $0032+24$ | 0.74 | 2.52 | 0.52 | $1144-74$ | 0.32 | 1.59 | 0.30 |
| $0055-79$ | 0.60 | 0.81 | 0.22 | $1231+07$ | $1.20 \ddagger$ | 2.48 | 0.52 |
| $0138-01$ | 0.34 | 2.30 | 0.63 | $1237-07$ | 1.07 | 0.48 | 0.15 |
| $0151+36$ | 0.73 | 0.89 | 0.15 | $1439-39$ | 0.42 | 1.22 | 0.15 |
| $0302-47$ | 0.28 | 1.22 | 0.30 | $1443+43$ | 0.36 | 1.11 | 0.26 |
| $0400-59$ | 0.35 | 1.41 | 0.22 | $1645+21$ | 0.82 | 2.26 | 0.67 |
| $0431-10$ | 0.80 | 1.11 | 0.11 | $1736+43$ | 1.40 | 4.00 | 0.89 |
| $0440+06$ | 1.19 | 2.07 | 0.33 | $1849-77$ | 0.45 | 1.11 | 0.19 |
| $0449+66$ | 0.73 | 3.00 | 0.85 | $1904+67$ | 0.45 | 1.85 | 0.37 |
| $0530-37$ | 0.90 | 0.93 | 0.11 | $1956+65$ | 0.45 | 1.74 | 0.15 |
| $0545-32$ | 0.75 | 1.19 | 0.15 | $1959-69$ | 0.38 | 1.04 | 0.15 |
| $0705-55$ | 0.60 | 1.19 | 0.15 | $2041+75$ | 0.45 | 1.26 | 0.26 |
| $0750-49$ | 0.30 | 3.48 | 0.85 | $2128+81$ | 0.55 | 0.56 | 0.11 |
| $0804-53$ | $1.40 \ddagger$ | 1.33 | 0.19 | $2346+26$ | 0.63 | 2.59 | 0.44 |
|  |  |  |  | A2255§ | 0.42 | 0.59 | 0.20 |

Notes:

* Measured intensity plus $3 \sigma$ error in Ariel count/s (present work).
$\dagger$ Reported intensity and $1 \sigma$ error corrected to Ariel count/s according to conversions given in Section 6. $\ddagger$ Upper limit from most sensitive data set only. § From Cooke \& Maccagni 1976.
fact none of the sources in Table 2 produced even $3 \times 2.5 \sigma$ lines of position.) In this case the upper limits given in Table 2 have been obtained by surveying the whole quoted error box with the PST and quoting an upper limit derived from the peak intensity found. Some 3 U and MX sources not detected in the main (lines of position) survey were located by this means and are included in Table 1. In each case we have assumed the source to be steady.

Subsequent papers will be concerned with clusters of galaxies (Ricketts et al., in preparation), Seyfert galaxies (Elvis et al. 1978) and QSO's (White \& Ricketts 1977b) investigated with the PST.

## 9 Completeness of the Sky Survey, and source confusion

In addition to the three most sensitive data sets which cross a point in the sky, there may be additional data sets which are almost as sensitive with respect to source detection. Because of counting statistics (and possibly because of source variability, should it exist), there is a certain probability that a source with an intensity below that calculated for a $3 \sigma$ detection on the third most sensitive data set will be detected on that set, or even on less sensitive ones. This probability increases with the number and sensitivity of these additional data sets.

The result is that the fractional sky coverage at any intensity will always be underestimated. We have investigated, at most of the non-PST source positions in the catalogue, the relation between the minimum source intensity $(I)$ which would yield a $3 \sigma$ peak on the third most sensitive data set, and the intensity ( $I^{\prime}$ ) for which the probable number of


Figure 7. Log $N / \log S$ plot for 2A catalogue sources. Number of sources $N\left(|b|>10^{\circ}\right)$ of intensity $\geqslant S$, is plotted against intensity $S . N$ is corrected for sky coverage. Known galactic sources, PST sources and sources in confused regions have been excluded, together with the transient $2 \mathrm{~A} 0042+323$. 2A $1322-427$ (NGC 5128) has been included at its 'average' intensity. A straight line of slope -1.5 is shown for comparison.
detections is just 3 , taking into account all useful data sets. We find that the relation may be represented by $I=I^{\prime}+(0.1 \pm 0.05)$ Ariel count/s. Hence at a typical point in the sky the coverage is to a strength $\sim 0.1$ Ariel count/s below that estimated from the third most sensitive data set. The effect on the sky coverage as a function of source intensity is shown in Fig. 3.

We have used the 2A sources (excluding PST established sources, sources in confused regions, known galactic sources, and the transient source $2 \mathrm{~A} 0042+323$ ) and sky coverage (corrected as above and in Section 4) to produce the integral source number/intensity $(\log N / \log S)$ distribution shown in Fig. 7 (where $N$ is referred to the area of sky $|b|>10^{\circ}$ ). For comparison with the measured distribution, Fig. 7 also shows a line of slope -1.5 . To examine the latitude distribution of sources we have repeated the above procedure for $|b|>10^{\circ}$ in five equal-area latitude bands in each hemisphere, thus obtaining $N(S>0.8$ Ariel count/s) for each band. These numbers were then tested for consistency with there being an equal number of sources in each band. The resulting $\chi^{2}$ value was 4.3 with 9 degrees of freedom, and was therefore quite consistent with an isotropic latitude distribution of sources. A more detailed analysis of the $\log N / \log S$ and spatial distributions is in preparation (Warwick \& Pye 1978).

Other effects can produce spurious X-ray sources. These are (a) conjunctions of spurious $3 \sigma$ lines of position occurring because of random fluctuations in the data stream, and (b) sources arising by fluctuations in X-ray sky brightness, i.e. chance groupings of weak sources (probably not far below the Survey limit) which, together, have the intensity of a stronger source. We have estimated the importance of these effects as follows:
(1) The 2 A catalogue is compiled from some 10000 orbits contained in about 350 data sets, and with our collimator FWHM we expect $\sim 0.5$ peaks at $3 \sigma$ per data set due to
counting statistics (analysis of a sky area of $\sim 0.9 \mathrm{Sr}$ actually produced 11 unmatched lines of position, with SNR $>3$, arising from the equivalent of nine data sets across the area). This leads to a probability of $\sim 10^{-5}$ of a single point crossing of three lines of position being generated from such random peaks.
(2) The source-confusion problem is the converse of the problem concerning the extent to which the diffuse X-ray background results from the combined contribution of discrete X-ray sources. This can be investigated by studying the point-to-point fluctuations in counting rate in X-ray detectors in which the X-ray background dominates over the particle background (e.g. Fabian 1975). The background due to sources may be considered as noise with a standard deviation $\sigma_{\mathrm{s}}$ which is a function of the effective instrumental beamshape of the X-ray detector. Then, as long as we take the minimum source strength in the catalogue as $>3 \sigma_{\mathrm{s}}$, we can be sure that there is a suitably small chance that any source is merely a giant fluctuation (Cavaliere \& Setti 1976). We have calculated $\sigma_{\mathrm{s}}$ from the integral
$\sigma_{\mathrm{s}}^{2}=R \int_{S=0}^{S=S_{\mathrm{u}}} S^{2} d N(S)$,
where $d N(S)$ is the average number of sources in the range $S$ to $S+d S$, and $R$ is the ratio between the solid angle of our detector collimator and the total solid angle of sky outside $|b|=10^{\circ}$. We have truncated the integral at $S_{u}=3.33$ Ariel count $/ \mathrm{s}(\equiv 10$ Uhuru count $/ \mathrm{s}$ ), the limit to which the Uhuru catalogue was essentially complete for the whole sky. As a source distribution we have used
$N(>S)=33 S^{-1.5}$,
where $S$ is an Ariel count/s and $N(>S)$ refers to sources outside $|b|=10^{\circ}$. This distribution is consistent with our $\log N-\log S$ plot (Fig. 7), and with the distribution suggested as an upper limit by analysis of fluctuations in the X-ray diffuse background (Fabian 1975). The calculation yields a limiting strength for the 2 A catalogue of $S=0.63$ Ariel count/s above which we have $\sim 60$ 'beam-areas' per source.

We are confident, however, in adding to the catalogue sources which are less intense than this limit, since the approach above makes no allowance for the discrimination against confusion which must result from the requirement that a source is established by three independent lines of position with significantly different position angles on the sky. The overlapping area of three typical lines of position is only a small fraction (0.07) of the area of an individual line so that the three lines are almost independent samples of sky brightness.

The SSI collimator isolates an element of the sky and integrates the X-ray sources (plus diffuse emission) in that element, via the collimator transmission function. We have simulated this build-up of X-ray sky brightness in the SSI by randomly filling such an element with sources from the distribution above. We find that the probability of the element displaying a strength greater than 1 Ariel count/s above the average element brightness is only $8.4 \times 10^{-3}$. From the arguments above, the probability of three typical lines of position producing a spurious source, due to confusion, is approximately the cube of this.

Because of the large number of scans at different position angles included by the PST, the effective beam area will tend to the common overlap area. This is confirmed by the low correlation between points $\sim 1^{\circ}$ apart (see Section 8 ), and justifies the higher sensitivity of this technique.

A remaining confusion problem arises when trying to separate a close group of sources with intensities greater than the survey limit. We recognise several such 'confused regions', and their approximate boundaries are given in Table 3 and marked on the sky-coverage map.

Table 3. Coordinates defining approximately the areas of sky containing further possible sources and called 'confused regions' (see Section 9).
(RA, dec, deg., 1950.0 and $l b$, deg.)

| Region | RA $\mathrm{dec}$ | $\begin{aligned} & l \\ & b \end{aligned}$ | $\begin{aligned} & \text { RA } \\ & \text { dec } \end{aligned}$ | $\begin{aligned} & l \\ & b \end{aligned}$ | RA $\mathrm{dec}$ | $\begin{aligned} & l \\ & b \end{aligned}$ | $\begin{aligned} & \text { RA } \\ & \text { dec } \end{aligned}$ | $\begin{aligned} & l \\ & b \end{aligned}$ | Sources contained |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 280 | 90 | 320 | 107 | 300 | 118 | 250 | 96 | 2A $1705+786$ | $2 \mathrm{~A} 1854+683$ |
|  | 60 | 25 | 70 | 14 | 85 | 26 | 65 | 38 | 3U 1825+81 | 3U $1904+67$ |
|  |  |  |  |  |  |  |  |  | 3U 1956+65 | $3 \mathrm{U} 2041+75$ |
|  |  |  |  |  |  |  |  |  | $3 \mathrm{U} 2128+81$ |  |
| 2 | 300 | 6 | 315 | 34 | 340 | 49 | 330 | 10 | 2A 2151-316 |  |
|  | --35-29 |  | -15 | -36 | -15 | -58 |  |  |  |  |
| 3 | 140 | 149 | 140 | 138 | 200 | 120 | 200 | 118 | $\begin{aligned} & 2 \text { A } 0954+700 \\ & 2 \text { A } 1151+720 \end{aligned}$ |  |
|  | 65 | 40 | 75 | 36 | 75 | 42 | 65 | 52 |  |  |
| 4 | 15 | 204 | 358 | 32 | 358 | 73 | 13 | 128 | 2A 0101-242 |  |
|  | -27 | $-88$ | -27 | -77 | -15 | -72 |  |  |  |  |
| 5 | 333 | 317 | 340 | 320 | 82 | 272 | 98 | 274 | 3U 0055-79 A 0501-66 <br> 3U 0521-72 MX 0528-68 <br> 3U 0532-66 3U 0539-64 <br> 3U 0540-69  |  |
|  | -73 | -40 | -67 | -46 | -63 | -33 | -64 | -26 |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

* See Griffiths \& Seward (1977).

We are at present obtaining additional data for these regions and their analysis will be included in a subsequent paper. Meanwhile the presence of undetermined sources in these confused regions can produce some spuriously high points in the light curves of known sources in or near the regions. Those sources which would have been assigned any other variability code than $S(=$ steady) have been given no code but have an average intensity calculated as for a steady source.

## 10 Source identification

Historically the identification of cosmic X-ray sources has been an iterative procedure guided by a knowledge of the classes of objects already associated with X-ray sources. New associations must have a suitably low probability of occurring by chance and be consistent with a reasonable X-ray luminosity from the object. The Ariel $V$ SSI 90 per cent error boxes are typically of area 0.1 to 0.5 square degree, and usually the ratio between the axes is less than 3. The potential for associating a source with some astronomical object is thus much higher than for many of the weak 3 U sources, for which the boxes were large.

Since this catalogue of X-ray sources at high galactic latitudes is consistent with an isotropic spatial distribution (see Section 9), we anticipate identifications either with extragalactic objects or with galactic objects which are either nearby or far out in the galactic halo. All new identifications proposed in the catalogue (Table 1, column 9) are with extragalactic objects such as clusters (CLUSTER) and groups (GROUP) of galaxies and active galaxies. To obtain these identifications we have examined many of the error boxes and their close surroundings for coincidences with optical and radio objects from the catalogues listed in Table 4. In addition, we searched the corresponding areas on prints from the

Table 4. Catalogues and lists of interesting objects searched for possible coincidences with 2A error boxes.

Abell 1958
Dixon's Master list of Radio Sources (RA40 version)
Finlay \& Jones 1973
Klemola 1969
Markarian 1972
Markarian 1973
Sersic 1974
Sulentic \& Tifft 1973
Vidal 1975

Palomar Observatory Sky Survey and its southern extension, the ESO 'Quick-Blue' Survey and the UK Schmidt IIII J-plate Survey. Since the probability of finding a faint radio source in a 2 A error box is quite high, we have not considered these to be plausible identifications unless there is supporting evidence.

The scarcity of identifications of X-ray sources with high-latitude galactic objects may be partly due to a current lack of knowledge (or even relative absence) of faint halo sources or of nearby sources of low luminosity. However, we can be confident that none of the unidentified 2A sources are associated with luminous galactic sources similar to Her X-1 or Cen X-3 ( $L_{\mathbf{x}} \sim 10^{37} \mathrm{erg} / \mathrm{s}$ ), since the low intensities observed ( $<5$ SSI count $/ \mathrm{s}$ ) give extreme scale-heights above the galactic plane at the implied distances of $10-20 \mathrm{kpc}$. A number of objects, at high latitudes, have been detected in the soft X-ray region ( $E \leqslant 0.28 \mathrm{keV}$ ) and associated with normal stars (Mewe et al. 1975; Schnopper et al. 1976), flare stars (Heise et al. 1975), a hot white dwarf (Hearn et al. 1976) and U Geminorum systems (Rappaport et al. 1974; Hearn, Richardson \& Clark 1976). However, for only one system, AM Her, which may be in the last class, is the source visible in the energy range of the SSI. We have searched for coincidences of 2A sources against lists of $U$ Gem objects and of globular clusters without further success, but have not attempted to identify new 2A sources with any other type of stellar object. The earlier identifications of the brighter high-latitude X-ray sources with galactic objects were accomplished mainly by simultaneous observations of variability and, in particular, of periodicity (e.g. Her X-1). Such observations with X-ray telescopes of higher sensitivity in the future should assist in confirming or rejecting suggested associations of faint sources with galactic objects.

## 11 High-latitude transient sources

As well as very bright X-ray transients in the galactic plane (e.g. Elvis et al. 1975b), the SSI has also detected a number of faint transients at high galactic latitudes. Some of these have been described elsewhere (Ricketts, Cooke \& Pounds 1976; Cooke 1976) and have a wide range of characteristic timescales. No firm definition has yet been reached on what is to be called a 'transient' and what a 'sporadically variable X-ray source'. Single sightings of transients, yielding only one (but highly significant) line of position, have not been included in the catalogue.

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