NASA

Technical Memorandum 79694

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(NASA-TM-79694) NEW HARD X-RAY SOURCES OBSERVED WITH HEAO-A2 (NASA) 25 p HC A02/MF A01 CSCL 03A

N79-23851

Unclas

G3/89 25905

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December 1978

National Aeronautics and
Space Administration

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ABSTRACT

A search for new hard X-ray sources using data from the first complete view of the sky with the HEAO-A2+ experiment has discovered 47 new sources, detected 7 sources recently discovered with other experiments, and significantly reduced the size of the error boxes for 6 previously known sources. Intensities and error boxes are given for each of these sources; identifications are suggested when an error box contains an object similar to known X-ray sources. The new identifications consist of seven Type 1 Seyfert galaxies, including two whose Seyfert characteristics were discovered due to their location in an X-ray error box; one intermediate Seyfert galaxy; three Abell clusters; five N-galaxies; two bursting radio sources; and an additional three nearby galaxies with bright nuclei and narrow emission lines.

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+ The HEAO-A2 experiment is a collaborative effort led by E. Boldt of GSFC and G. Garmire of CIT, with collaborators at GSFC, CIT, JPL, and UCB.

I. INTRODUCTION

The HEAO-A2 experiment provides a low background, high-sensitivity survey of the entire sky. In this paper, we present a list of the weak ($\lesssim$ 30 UHURU Flux Units (UFU)) sources seen by the A2 experiment which are not in either the 4U Catalog (Forman et al. 1978) or the 2A catalog (Cooke et al. 1978). Five of these sources were recently discovered by the SAS-3/RMC experiment; H0252+440 and H2235-378 were first found (Kent Wood, private communication) in data from the HEAO-A1 experiment. Also included are a few sources whose error boxes are significantly improved by the new observations. The intensity of the new sources is typically 1 to 2 UFU so most of these sources are below the sensitivity limit of the 4U and 2A catalogs. Although no detailed analysis of the completeness of the survey has been done, we estimate the list to be complete down to $\sim$2 UFU, except for regions near the galactic plane or near bright ($\gtrsim$ 5 UFU) X-ray sources. Work on a complete HEAO-A2 catalog, including previously discovered sources, is in progress.

II. EXPERIMENT

The HEAO-A2 experiment, which has been described in detail by Rothschild et al. (1978), consists of 6 mechanically-collimated, gas-filled, multi-layer, multi-wire proportional counters. In the nominal scanning mode counting rates for both layers and both fields-of-view (FOV) of each detector are recorded every 1.28 seconds. Two combinations of these rates, termed R15 and R30, are defined in Table 1. R15 and R30 use only $1.5^{0} \times 3^{0}$ FOV and $3.0^{0} \times 3.0^{0}$ FOV, respectively. These rates respond to X-rays from $\sim$ 2 to $\sim$ 60 keV; the full width half maximum quantum efficiency is from $\sim$ 3 to $\sim$ 17 keV. Since this energy interval extends to higher energies than either the UHURU, Ariel 5, or SAS-3/RMC experiments, comparison of intensities is spectrally dependent (see discussion below). R30 has only been used to confirm the existence of weaker sources. A power law spectrum with photon index 1.5 produces 1 count/sec in R15 for every 2.1 x 10^{-11} ergs/cm^2 sec in the 2 to 10 keV band.

Source Detection

The HEAO-A2 experiment scans great circles of the sky every ½ hour with its rotation axis pointed toward the sun. A point source at the ecliptic equator remains in each FOV for 6 days. Great circle scans have been summed for 3 days giving the convolution of the sky brightness of a strip of the sky with the collimator response. Such summed scans have been made covering the entire sky. Indications of new sources are then analyzed in detail.

First, scans are summed for those periods when a source at the estimated position of the new source would be in the FOV. The strip of the sky within $\sim 10^{\circ}$ in scan angle of the new source is then modelled as uniform sky brightness plus one or more point source. The intensity of the background and the position and intensities of the sources are then varied to produce the best fit to the observations in a least squares sense.

The statistical significance of the existence of the new source is then tested by determining the decrease in χ^2 when the new source is added to the model. The source is included in the present list (given in Table 2) if the change in χ^2 is at least 30. For a R15 counting rate of $\sim$ 1 sec, the A2 experiment can resolve sources if they are separated by $\gtrsim 1^{\circ}$. Thus, there are $\sim 10^4$ resolvable positions; while the probability of a decrease in χ^2 of > 30 for adding one parameter to the model is 4.3 x 10^{-8}. An additional 7 sources are included which do not quite meet the above requirement. Five of these sources, however, do reduce χ^2 by more than 30 for a similar analysis using R30. H1028+512 and H1801+698, which reduce χ^2 by 22 and 29, respectively, have also been included--although they cannot be confirmed using R30 because of their proximity to other sources.

III. RESULTS

The results of the survey are presented in Table 2, which is a list of error boxes, their sizes, source intensities, approximate times of observation, and suggested identifications.

(1) Source Name: The HEAO name corresponds to the 1950 right ascension and declination of the center of Error Box 2 if available, or the center of Error Box 1 if Error Box 2 is not available. The right ascension has been truncated to minutes and the declination truncated to tenths of degrees.

(2) Error Box 1: The 1950 right ascension and declination of the four corners of the error box are given in columns 3 to 7. One direction of Box 1 corresponds to the 95% confidence interval in the scan angle of the new sources and is determined by varying the scan angle in the model until χ^2 increases by 4 above the minimum value. The box is 6^o wide (the Full Width Zero Intensity (FWZI) of the collimator) in the perpendicular direction and is centered at the average day of the accumulation period.

(3) Error Box 2: This box uses the same scan angle interval as in Box 1, but the position in the perpendicular direction is determined by fitting a collimator response rather than using the FWZI. Since only one pass is made across the collimator in the perpendicular direction, variations on the scale of days in the source intensity will produce errors in the determination of the source position. Thus, the determination of Box 2 relies on the assumption that the source intensity is constant. Sources for which this assumption is clearly incorrect are noted in Table 2, and no Box 2 is determined. In addition, no Box 2 is determined for sources near the ecliptic poles. An Algebraic Reconstruction Technique is

being developed to study such sources (Szymkowiak et al. 1978). Error boxes for four sources are shown in Fig. 1. Systematic errors in the determination of the error boxes are estimated to be $\sim .05^{\circ}$, based on test cases using identified X-ray sources. These errors are small compared to the size of the boxes for the sources presented in Table 2.

(4) Error Box Sizes: The size in square degrees of Box 1 and Box 2.

(5) Intensities: Source intensities in counts/second for Rate R15 which are determined, when possible, from the fit to the collimator response in the perpendicular direction. If no fit was made, the peak intensity observed is given. Relative statistical uncertainties are $\lesssim$ 20%. The conversion from R15 to UFU or Ariel counts depends on the source spectrum; Table 3 compares rates for various sources whose spectrum is known. One HEAO R15 count is approximately equal to 1 UFU with R15 being relatively more sensitive to hard spectra.

(6) Time: The observations occurred during a period approximately centered at the given day of 1977.

(7) Identifications: The lists of objects given in Table 4 have been searched for positional coincidences with the new sources. A "**", "*", or "?" has been appended to the source name indicating the source lies within Box 2, Box 1 or near the error box, respectively. The new identifications are summarized in Table 5.

IV. DISCUSSION

A brief description of those objects suggested as X-ray sources follows; more detailed analysis of many of these sources is in progress and will be reported elsewhere. All of the identifications are with extragalactic objects; they include such diverse objects as individual stellar systems in a nearby galaxy, narrow emission line galaxies (NELG), broad line Seyfert galaxies, N galaxies, variable radio sources, and rich clusters of galaxies.

Two sources in a neighboring galaxy, SMC X2 and SMC X3, were discovered by SAS-3 (Clark et al. 1978) on days 284-289 of 1977 at 2-11 keV intensities of 16×16^{-11} and 11×10^{-11} ergs/cm^2 sec, respectively. SAS-3 observations on days 341-349 (Li and Clark 1977) set an upper limit of 2×10^{-11} ergs/cm^2 sec for these sources. HEAO-A2 observed these sources from day 300 to 315 of 1977, and found intensities of $\sim 10 \times 10^{-11}$ ergs/cm^2 sec for each source. No large variations in the intensities on time scales of days were observed by HEAO-A2. Thus, both sources remained in outburst for $\gtrsim$ 30 days and then reduced intensities by a factor of $\gtrsim$ 7 within $\lesssim$ 25 days. Although sparse, the data do not indicate the exponential decay typically seen in transient X-ray sources (cf. Kaluzienski et al. 1977). Preliminary analysis of the combined spectra of the two sources (the sources are not resolved in the A2 pulse height data) indicates a power-law form (photon index $\sim$ 1.0) with high energy cut off similar to known galactic binary sources (cf. Ulmer 1975).

The remainder of the identifications are with galaxies or systems of galaxies. Three of the sources in Table 2 are associated with bright ($\lesssim$ 12 magnitude) galaxies which have relatively bright nuclei and narrow emission lines. X-ray luminosities* (L_x) range from 1.1×10^{42} ergs/sec for NGC 5033 to 13×10^{42} ergs/sec for NGC 2110 .

*Unless otherwise noted, X-ray luminosities refer to the 2-10 keV band, assuming H_0 = 50 km/sec/Mpc, and a 1.5 number index power law spectrum.

The detection of NGC 2110 was made independently by both Marshall et al. (1978a), using HEAO-A2 and McClintock et al. (1978), using SAS-3 data. The modulation collimator position by SAS-3 secures the identification. Bradt et al. (1978) reported the optical spectrum of NGC 2110, to be indistinguishable from that of a Seyfert Type 2 galaxy.

Both NGC 5005 and NGC 5033 fall within the H1310+371 error box. Ford et al. (1971) have shown the nucleus of NGC 5033 to have Hα and (NII) in emission. Recent observations (D. Osterbrock and S. Grandi, private communication) show that the nuclei of both NGC 5005 and NGC 5033 have narrow permitted emission lines whose FWHM are $\sim$ 400 to $\sim$ 500 km/sec and $\lesssim$ 300 cm/sec, respectively. Lines of high ionization are relatively more intense in NGC 5033, making it the more likely candidate. Both galaxies are at $\sim$ 20 Mpc, implying L_x is $\sim 1.1 \times 10^{42}$ ergs/sec.

Another pair of galaxies, NGC 6221 and NGC 6215, may be associated with H1649-595 (NGC 6215 is just outside the error box). Both are 11th magnitude galaxies at a distance of 26 Mpc. Martin (1976) has reported narrow emission lines from NGC 6221. L_x for this system is $\sim 4 \times 10^{42}$ ergs/sec.

These identifications increase from 5 to 8 the number of narrow emission-line galaxies suggested as X-ray sources (Ward et al. 1978). Because of the large space density of optically-identified emission line galaxies, such galaxies could (Schnopper et al. 1978a) make a significant contribution to the X-ray background and also be consistent with the measured fluctuations in the background. An important test of the contribution is whether the spectra of this class of objects is similar to the spectrum of the X-ray background.

H0220+184 and H2158-321 may be associated with nearby galaxies, but their optical spectra make the identifications doubtful. The interacting chain of galaxies NGC7172-7173-7174-7176 lies within the H2158-321 error box, but observations by Rubin (1974) do not show the strong optical emission lines typical of active galaxies. Similarily, NGC0918 lies inside the H0220+184 err or box, but its optical spectrum does not indicate an active galaxy (Rubin, private communication).

The galaxy Anon 0636+53 falls within the error box for H0643+534. It is of interest because it is extremely compact and paired with Anon 0637+53. If this identification is correct, L_x is $\sim 10^{44}$ ergs/sec, comparable to Type 1 Seyfert galaxies. Optical observations are required to determine whether this galaxy has Seyfert characteristics.

Eleven of the sources in Table 2 are associated with Seyfert galaxies. Eight new identifications are suggested, and there are confirmations of the recent detections of NGC 3227 by Elvis et al. (1978), IIIZw2 by Schnopper et al. (1978b), and MGC-6-30-15 by Pineda et al. (1978). The new identifications include the recently discovered Seyferts ESO 140-G43 (West et al. 1978) and NGC 4593 (Lewis et al. 1978). NGC 4593 lies in the intersection of the error boxes for 4U1240-05 and H1238-049. In addition, the presence of ESO 103-G35 and NGC 7213 in the error boxes for H1834-653 and H2209-471 respectively has led to the discovery of their Seyfert characteristics. Optical observations by Phillips (1978) and Feldman et al. (1978) reveal the broad permitted emission lines characteristic of Type 1 Seyferts. Six Seyfert galaxies (cf. Ward et al. 1978) have now been discovered because of their locations in an X-ray error boxes. The position of NGC 7213 and the error box for H2209-471 are shown in Fig. 1.

All of the Seyfert galaxies are Type 1 Seyferts except the intermediate type Mkn 372, which has some characteristics of both Type 1 and Type 2 Seyferts (Koski 1978). Previously observed X-ray Seyfert galaxies have also been predominantly Type 1 (Elvis et al. 1978). The X-ray luminosities of the new identifications range from 0.3×10^{43} ergs/sec for NGC 7213 to 29×10^{43} ergs/sec for Mkn 464--a range comparable to that found for previously identified Seyfert galaxies by Elvis et al. (1978).

The three sigma upper limit on the intensity of Mkn 142 seen by Ariel 5 is $\approx$ 60% of the intensity observed by HEAO-A2, indicating possible long-term variability. Such variability has been previously reported for a few other Seyfert galaxies (Elvis et al. 1978; Tananbaum et al. 1978).

Temporal variability is of particular interest for III Zw2, which was first detected in X-rays by SAS-3 (Schnopper et al. 1978b) in August 1977 during a radio outburst. The 2-10 keV intensity reported by SAS-3 of 4.3 x 10^{-11} ergs/cm^2 is comparable to the 3.4 x 10^{-11} ergs/cm^2 sec seen by HEAO-A2 the last week of 1977. In view of the difficulty in comparing intensities between different experiments, we do not claim the difference to be significant. Thus, to date there is no strong evidence of variation in the X-ray luminosity associated with the radio outburst. Subsequent observations of III Zw2 will provide further tests of the connection between the radio emission and X-ray emission.

Two other X-ray sources are tentatively associated with the radio sources NRA0140, a QSO with a redshift of 1.258, and NRA0530. The sources were in radio outburst (Dent and Balonek, private communcation, 1978) during the time of X-ray observations. If the identification is correct, NRA0140 has an X-ray luminosity of 4 x 10^{47} ergs/sec (for the deceleration parameter q_0 = 0), by far the most luminous source of X-rays yet detected.

Compared to the 10 suggested Seyfert identifications, only 3 Abell clusters (Ab 151, Ab 1644 and Ab 2052) are suggested as identifications. In contrast, 48 clusters have been previously suggested (Jones and Forman 1978) and only 18 Seyfert galaxies (Tananbaum et al. 1978). Since the spectral response of the present HEAO-A2 survey extends to higher energies than that of previous surveys, this contrast indicates that Seyferts as a class have harder spectra than the 5 to 9 keV thermal bremsstrahlung spectra typical of clusters (Smith et al. 1978). This is known to be the case for NGC4151 (Mushotzky et al. 1978b), the best studied Seyfert galaxy.

Data on the new N galaxies seen by the A2 experiment have also been included. These sources are discussed in more detail by Marshall et al. (1978b).

V. CONCLUSION

The first survey of the sky by the HEAO-A2 experiment has significantly increased the number of known X-ray sources. Suggested identifications for the new sources have almost doubled the number of NELGs suggested as X-ray sources, led to the discovery of two new Seyfert galaxies, increased the number of known X-ray Seyferts by 8, and shown N galaxies to be a class of strong X-ray sources. The most distant source of X-rays, a variable radio source at $z = 1.2$, may have been detected, although a smaller error box is needed to confirm this identification. The relative abundance of new Type 1 Seyferts compared to the number of new clusters of galaxies indicates class Type 1 Seyferts typically exhibit harder spectra than do clusters of galaxies.

The long-term variability of these sources will be checked with subsequent scans of the sky by HEAO-A2. These scans will also enable the detection of additional weak sources.

ACKNOWLEDGMENTS

We thank A. Marscher of UCSD for suggesting a search for variable radio sources as X-ray sources, and providing a list of candidate objects. We are also grateful to D. Osterbrock and S. Grandi of UCSC, M. Phillips of CTIO, F. Feldman of Yale, and W. Dent and T. Balonek of U. of Mass. for communicating the results of their observations prior to publication.

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FIGURE CAPTION

Figure 1 - Error boxes for four X-ray sources. The solid lines enclose Box 1. Box 2 is the part of Box 1 between the dashed lines. The location of the suggested identifications are shown by an asterisk. A much smaller SAS-3 modulation collimator error box shows NGC 2110 to be the X-ray source.

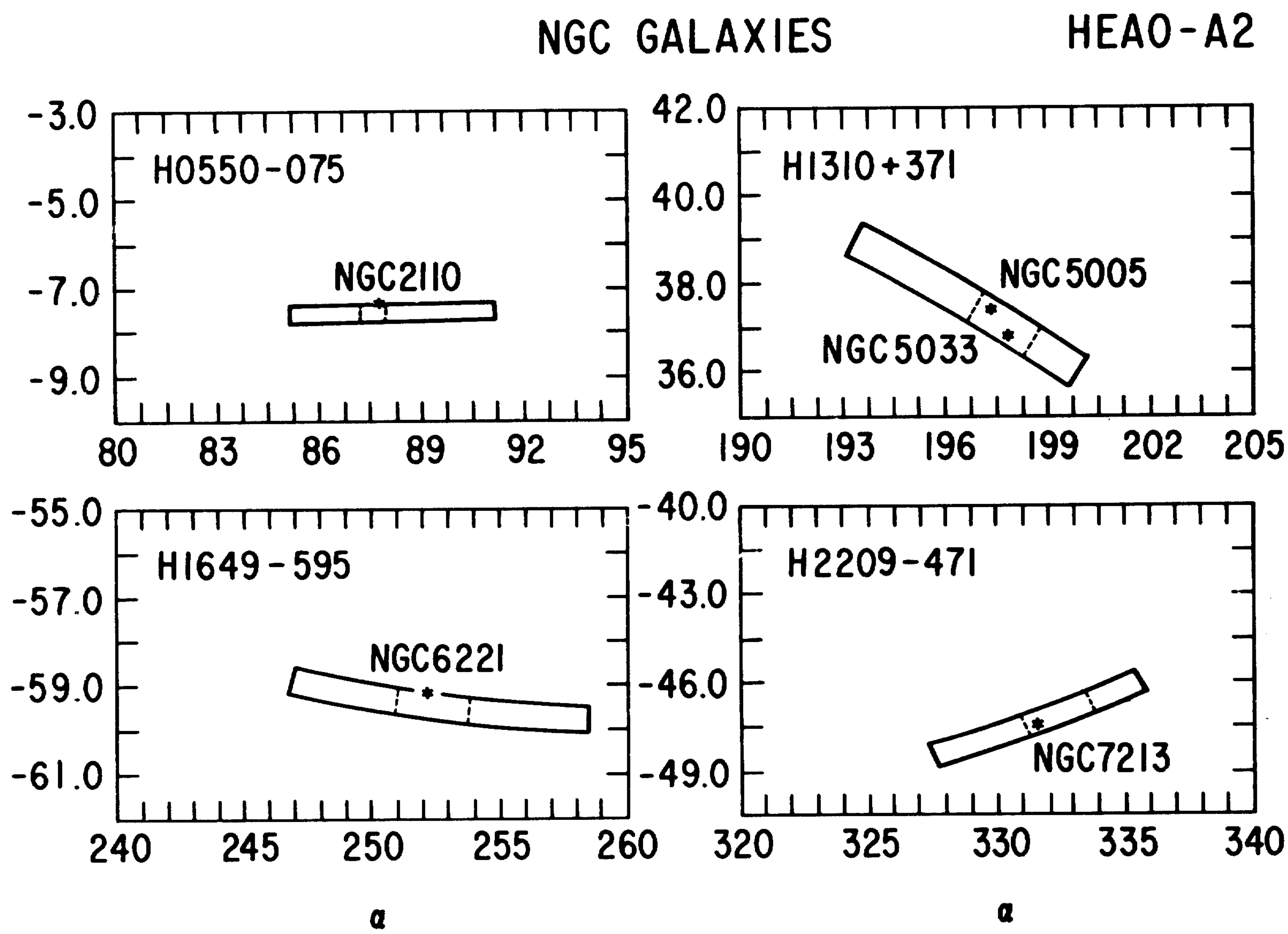
NGC GALAXIES
HEAO-A2
H0550-075
NGC2110
H1310+371
NGC5005
NGC5033
H1649-595
NGC6221
H2209-471
NGC7213
-3.0
-5.0
-7.0
-9.0
80
83
86
89
92
95
42.0
40.0
38.0
36.0
190
193
196
199
202
205
-55.0
-57.0
-59.0
-61.0
240
245
250
255
260
-40.0
-43.0
-46.0
-49.0
320
325
330
335
340
α
α

TABLE 1

DETECTOR	LAYER	FOV
	Combination R15	
HED3	1	$1\frac{1}{2}^{\circ} \times 3^{\circ}$
HED3	2	$1\frac{1}{2}^{\circ} \times 3^{\circ}$
MED	2	$1\frac{1}{2}^{\circ} \times 3^{\circ}$
	Combination R30	
HED1	1	$3^{\circ} \times 3^{\circ}$
HED1	2	$3^{\circ} \times 3^{\circ}$
HED2	2	$3^{\circ} \times 3^{\circ}$
MED	2	$3^{\circ} \times 3^{\circ}$
HED3	1	$3^{\circ} \times 3^{\circ}$
HED3	2	$3^{\circ} \times 3^{\circ}$

TABLE 2.
LIST OF SOURCES.

NAME (1)	RA DEC (2)	L B (3)	BOX1 (4)	BOX1 1950 RA/DEC (5)	BOX1 (6)	BOX1 (7)	BOX2 (8)	BOX2 1950 RA/DEC (9)	BOX2 (10)	BOX2 (11)	SIZE 1 SIZE 2 (12)	INT. (13)	DAY 1977 (14)	COMMENTS (15)
H0008+105	2.12	107.12	4.97	359.39	359.16	4.75	1.67	1.44	2.57	2.79	3.30	1.64	362.	IIIZW2**
	10.54	-50.81	11.45	9.04	9.54	11.95	10.05	10.55	11.04	10.53	0.64			SAS3 POSITION
H0048-731	12.11	303.06	10.68	7.75	5.64	15.02	12.39	10.48	11.88	13.70	3.60	4.40	308.	SMCX-3**
	-73.13	-44.27	-70.59	-76.02	-75.71	-70.36	-73.67	-73.41	-72.59	-72.85	0.54			SAS3 POSITION
H0053-739	13.46	302.54	18.96	10.71	7.75	16.68	14.48	11.76	12.52	15.15	4.80	4.70	307.	SMCX-2**
	-73.99	-43.41	-70.86	-76.39	-76.01	-70.59	-74.37	-74.06	-73.59	-73.91	0.40			SAS3 POSITION
H0111-149	17.87	146.87	15.35	21.03	20.77	15.11	17.10	16.84	18.65	18.90	3.60	1.49	367.	AB151*
	-14.93	-76.48	-16.31	-13.89	-13.34	-15.76	-15.59	-15.04	-14.27	-14.82	1.11			
H0123+075	20.81	137.56	24.08	18.47	18.30	23.91	0.00	0.00	0.00	0.00	4.20	3.84	378.	VARIABLE
	7.57	-54.06	8.47	6.25	6.67	8.69	0.00	0.00	0.00	0.00	0.00			
H0206-019	31.63	162.39	29.18	34.80	34.52	28.90	30.85	30.57	32.42	32.70	4.80	1.25	385.	MKN590*
	-1.93	-58.48	-3.27	-1.16	-0.43	-2.52	-2.65	-1.90	-1.21	-1.96	1.53			
H0220+184	35.06	151.31	38.53	32.56	32.30	38.28	33.68	33.42	36.45	36.70	4.50	0.96	395.	NGC0918**
	18.40	-39.14	19.10	17.16	17.86	19.81	17.55	18.26	19.25	18.54	2.21			NOTE 1
H0252+440	43.21	145.32	46.68	38.79	39.01	46.86	42.48	42.27	43.94	44.14	2.70	1.93	410.	VARIABLE?
	44.03	-13.15	45.04	43.09	42.67	44.61	43.61	44.04	44.45	44.02	0.56			
H0253+193	43.45	159.28	46.22	40.17	39.84	45.93	42.73	42.42	44.17	44.48	6.00	1.02	402.	MKN372*
	19.37	-34.32	19.61	17.87	18.82	20.57	18.64	19.60	20.10	19.14	1.67			
H0333+317	53.27	159.18	56.56	49.77	49.51	56.36	52.54	52.31	54.00	54.22	4.80	1.02	414.	NRAD140**
	31.76	-19.09	32.02	30.56	31.33	32.60	31.21	31.99	32.35	31.57	1.16			NOTE 1.
H0412+376	63.14	161.38	60.22	67.71	67.80	60.36	62.51	62.63	63.78	63.66	3.00	2.02	244.	3C111*
	37.83	-9.21	37.59	38.69	38.19	37.11	37.99	37.49	37.67	38.16	0.47			4U0407+37?
H0447-037	71.92	201.60	75.69	69.74	69.84	75.80	70.96	71.07	72.88	72.78	4.80	1.60	246.	
	-3.76	-28.52	-2.86	-3.64	-4.43	-3.65	-3.50	-4.29	-4.04	-3.24	1.49			
H0452-742	73.19	286.34	68.78	85.28	83.11	66.39	76.84	72.52	69.24	74.13	10.80	0.93	296.	
	-74.23	-34.06	-71.67	-75.49	-76.33	-72.33	-73.91	-75.30	-74.39	-73.21	2.04			
H0509+167	77.44	186.12	75.48	81.74	81.79	75.56	77.06	77.13	77.83	77.76	4.50	2.33	254.	3C138*
	16.74	-12.95	16.95	17.42	16.67	16.20	17.09	16.34	16.40	17.14	0.51			4U0517+17?
H0517-456	79.36	251.38	75.69	84.02	84.35	75.88	77.44	77.77	81.23	80.99	6.00	0.73	246.	PIC A**
	-45.66	-34.79	-45.56	-44.45	-45.42	-46.55	-45.45	-46.42	-45.93	-44.94	2.55			NOTE 1
H0534-581	83.69	266.49	88.84	77.94	77.76	88.53	82.77	82.49	84.65	84.85	2.70	1.05	423.	
	-58.12	-32.69	-57.38	-59.15	-58.71	-56.96	-58.51	-58.08	-57.75	-58.18	0.52			
H0550-075	87.60	213.06	91.15	85.11	85.12	91.16	87.26	87.27	87.94	87.93	2.40	2.35	264.	NGC2110 NEAR BOX
	-7.53	-16.44	-7.27	-7.36	-7.76	-7.67	-7.34	-7.74	-7.72	-7.32	0.27			SAS3 POSITION.

NAME (1)	RA DEC (2)	L B (3)	(4)	BOX1 1950 (5)	RA/DEC (6)	(7)	(8)	BOX2 1950 (9)	RA/DEC (10)	(11)	SIZE 1 SIZE 2 (12)	INT. (13)	DAY 1977 (14)	COMMENTS (15)
H0643+534	100.77 53.49	162.53 20.87	104.79 53.58	94.67 54.04	94.66 53.30	104.61 52.84	99.75 53.92	99.66 53.17	101.78 53.06	101.90 53.81	4.50 0.96	1.00	274.	ANON 0636+53* NOTE 1
H0700-563	105.05 -56.38	266.66 -21.05	101.41 -54.77	110.76 -57.74	110.36 -58.21	100.90 -55.20	104.34 -55.88	103.92 -56.34	105.73 -56.89	106.21 -56.45	3.12 0.59	1.09	309.	2 SOURCES ?
H0712-113	108.12 -11.35	225.76 -0.08	104.77 -10.54	110.81 -11.41	110.72 -12.01	104.67 -11.13	107.42 -10.94	107.33 -11.54	108.83 -11.76	108.92 -11.16	3.60 0.89	1.26	288.	
H0751+222	117.94 22.23	199.09 23.35	114.00 23.28	120.39 22.19	120.22 21.41	113.86 22.49	117.49 22.72	117.33 21.93	118.38 21.75	118.55 22.53	4.80 0.79	1.36	293.	
H0844-531	131.24 -53.14	271.14 -6.32	129.91 -51.94	137.52 -55.93	136.96 -56.32	129.34 -52.29	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.00 0.00	1.83	343.	VARIABLE
H0921-631	140.44 -63.14	281.91 -9.35	144.38 -65.21	137.31 -60.17	136.61 -60.37	143.60 -65.44	140.29 -62.75	139.74 -62.91	140.58 -63.53	141.15 -63.38	1.80 0.21	2.00	371.	
H1019+203	154.89 20.32	216.49 55.24	151.72 21.86	157.68 19.67	157.38 18.98	151.44 21.16	154.39 20.91	154.10 20.21	155.39 19.74	155.68 20.43	4.50 0.95	1.71	326.	NGC3227** A1021+198
H1028+512	157.11 51.29	161.20 54.41	151.08 53.78	159.79 50.99	158.84 49.96	150.28 52.68	156.22 52.26	155.32 51.19	158.00 50.31	158.90 51.37	7.20 2.23	0.94	314.	MKN142**
H1238-049	189.59 -4.95	298.05 57.55	192.45 -5.71	186.92 -3.36	186.61 -4.10	192.13 -6.45	189.18 -4.34	188.87 -5.07	190.00 -5.55	190.31 -4.82	4.80 0.95	1.71	367.	NGC4593** 4U1240-05
H1256-171	194.17 -17.13	305.62 45.44	197.34 -18.05	191.58 -15.71	191.32 -16.25	197.10 -18.61	193.62 -16.57	193.37 -17.13	194.72 -17.68	194.97 -17.12	3.60 0.82	1.37	376.	AB1644**
H1310+371	197.71 37.12	99.01 79.25	200.15 36.38	193.58 39.39	193.10 38.69	199.63 35.70	197.16 37.83	196.66 37.14	198.26 36.40	198.75 37.10	4.80 1.14	1.20	355.	NGC5033** NGC5005**
H1325-020	201.39 -2.04	321.10 59.27	203.69 -2.53	198.13 -0.29	197.83 -1.03	203.39 -3.27	200.88 -1.41	200.58 -2.15	201.90 -2.68	202.20 -1.93	4.80 1.10	1.49	377.	AB1750? 2 SOURCES ?
H1332-336	203.19 -33.70	313.31 28.03	199.91 -32.13	206.50 -34.49	206.23 -35.05	199.60 -32.67	202.81 -33.23	202.53 -33.78	203.57 -34.16	203.85 -33.61	3.60 0.55	2.12	390.	MCG-6-30-15** SAS3 POSITION
H1350+390	207.63 39.04	79.16 72.70	209.91 38.25	203.23 41.34	202.84 40.81	209.49 37.75	206.85 39.75	206.45 39.23	208.41 38.33	208.80 38.85	3.60 1.02	1.24	363.	MKN464** VARIABLE ?
H1513+070	228.36 7.09	9.09 50.22	225.60 8.39	231.38 6.65	231.11 5.79	225.34 7.52	227.60 7.79	227.34 6.93	229.13 6.40	229.39 7.26	5.40 1.62	1.51	399.	AB2052** 3C317**
H1623+659	246.00 65.95	97.85 39.36	248.43 63.15	244.92 68.97	242.93 68.77	246.82 62.98	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.50 0.00	0.80	349.	MKN876? NOTE 1
H1641-325	250.27 -32.60	349.27 8.52	253.24 -33.20	246.19 -32.36	246.31 -31.77	253.32 -32.61	249.54 -32.21	249.44 -32.80	251.01 -32.99	251.11 -32.39	3.60 0.82	1.44	249.	
H1645-284	251.25 -28.47	353.03 10.52	247.01 -28.18	253.77 -28.98	253.83 -28.49	247.02 -27.69	250.85 -28.18	250.78 -28.67	251.65 -28.77	251.72 -28.28	3.00 0.39	1.95	250.	

NAME (1)	RA DEC (2)	L B (3)	(4)	BOX1 1950 (5)	RA/DEC (6)	(7)	(8)	BOX2 1950 (9)	RA/DEC (10)	(11)	SIZE 1 SIZE 2 (12)	INT. (13)	DAY 1977 (14)	COMMENTS (15)
H1648-165	252.24 -16.58	1.59 15.92	255.93 -19.35	249.64 -18.64	249.75 -17.90	256.01 -18.61	250.92 -18.80	251.02 -18.06	253.55 -18.35	253.46 -19.10	4.50 1.85	1.30	249.	
H1649-595	252.37 -59.52	329.52 -9.92	258.42 -60.14	246.66 -59.25	246.93 -58.67	258.49 -59.55	250.94 -59.71	251.13 -59.11	253.80 -59.32	253.64 -59.92	3.60 0.84	2.40	255.	NGC6221** NGC6215?
H1734-127	263.56 -12.75	12.81 10.13	266.44 -13.26	260.30 -12.98	260.35 -12.19	266.47 -12.46	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.80 0.00	1.50	260.	NRAO530*
H1752-006	268.07 -0.88	25.57 12.15	270.99 -1.42	264.99 -1.33	265.01 -0.33	271.00 -0.42	267.15 -1.36	267.18 -0.36	268.96 -0.39	268.97 -1.39	6.00 1.82	1.26	264.	
H1800+682	270.12 68.21	98.28 29.77	278.12 67.69	262.20 68.04	262.14 68.33	278.26 67.98	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.80 0.00	0.50	265.	NOTE 2
H1801+698	270.25 69.83	100.15 29.71	278.84 69.06	261.91 69.43	261.74 70.18	279.28 69.79	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.50 0.00	0.30	265.	3C371* NOTE 2
H1824+644	276.22 64.42	94.16 27.09	273.43 62.23	281.53 67.13	281.13 67.25	273.07 62.33	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.20 0.00	0.68	320.	3C383? NOTE 2
H1829-591	277.40 -59.17	336.13 -20.90	284.18 -59.40	272.35 -59.82	272.39 -58.62	283.82 -58.21	276.38 -59.80	276.25 -58.61	278.40 -58.54	278.57 -59.73	7.20 1.34	1.55	271.	4U1830-60?
H1832+325	278.10 32.55	61.14 17.56	281.94 32.63	274.88 32.02	274.82 32.41	281.91 33.03	277.73 32.32	277.68 32.72	278.47 32.78	278.52 32.38	2.40 0.27	1.77	279.	3C382**
H1833-077	278.35 -7.74	24.33 -0.12	281.89 -7.56	275.86 -7.94	275.85 -7.84	281.88 -7.46	278.27 -7.80	278.27 -7.70	278.42 -7.69	278.43 -7.79	0.60 0.02	29.70	275.	
H1834-626	278.54 -62.64	332.75 -22.48	285.30 -62.55	272.21 -63.02	272.24 -62.42	285.06 -61.96	276.60 -63.00	276.52 -62.41	280.45 -62.27	280.57 -62.86	3.60 1.10	1.17	272.	ESO-140-G43**
H1834-653	278.68 -65.35	329.95 -23.28	286.45 -65.19	272.05 -65.71	272.09 -65.11	286.18 -64.61	277.34 -65.69	277.24 -65.09	280.01 -65.00	280.14 -65.59	3.60 0.70	1.36	272.	ESO-103-G35** NEW SEYFERT 1
H1836+629	279.70 62.92	92.79 25.32	277.46 60.97	285.86 65.62	284.96 65.96	276.61 61.25	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.00 0.00	0.52	320.	NOTE 2
H1843+797	280.86 79.74	111.46 27.17	295.08 78.10	264.73 80.07	264.92 80.56	296.46 78.52	282.98 79.33	284.08 79.79	278.43 80.13	277.75 79.64	3.00 0.52	0.84	258.	3C390.3** 4U1847+78
H1846-786	281.60 -78.70	315.07 -26.70	297.07 -78.16	266.73 -79.04	267.09 -78.42	295.93 -77.58	278.95 -79.08	278.61 -78.45	284.13 -78.30	284.69 -78.92	3.78 0.71	1.33	271.	4U1916-79?
H1926+503	291.55 50.32	82.23 15.22	287.07 48.64	295.50 51.17	295.26 51.54	286.78 48.99	290.97 49.92	290.70 50.28	292.11 50.72	292.40 50.36	2.40 0.40	1.22	311.	
H2058+417	314.65 41.73	83.89 -2.79	318.43 42.97	311.44 40.04	311.13 40.42	318.15 43.37	314.36 41.35	314.07 41.74	314.94 42.11	315.24 41.72	2.70 0.33	1.61	334.	
H2154-304	328.54 -30.45	17.67 -51.85	332.68 -29.22	326.19 -31.37	326.06 -31.04	332.53 -28.91	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.04 0.00	4.30	317.	VARIABLE, 2A2151-318?

NAME (1)	RA DEC (2)	L B (3)	(4)	BOX1 1950 (5)	RA/DEC (6)	(7)	(8)	BOX2 1950 (9)	RA/DEC (10)	(11)	SIZE 1 SIZE 2 (12)	INT. (13)	DAY 1977 (14)	COMMENTS (15)
H2158-321	329.64	15.12	333.60	327.01	326.74	333.29	329.26	328.97	330.01	330.31	4.20	2.00	317.	NGC7172**
	-32.11	-52.95	-31.12	-33.30	-32.65	-30.47	-32.61	-31.95	-31.61	-32.26	0.65			2A2151-318?
H2209-471	332.38	349.71	327.77	335.85	335.35	327.36	331.35	330.88	333.41	333.87	4.50	1.07	313.	NGC7213**
	-47.15	-53.21	-48.90	-46.38	-45.71	-48.21	-47.89	-47.20	-46.41	-47.09	1.39			NEW SEYFERT 1
H2215-086	333.87	52.95	337.20	331.55	331.33	336.98	333.40	333.19	334.33	334.55	3.60	1.50	329.	
	-8.67	-49.23	-7.72	-9.87	-9.30	-7.16	-9.17	-8.61	-8.17	-8.73	0.71			
H2216-027	334.09	60.29	337.55	331.96	331.79	337.38	333.60	333.44	334.57	334.73	2.70	1.55	332.	3C445* AB2440?
	-2.78	-46.01	-1.67	-3.85	-3.43	-1.25	-3.20	-2.78	-2.35	-2.77	0.53			2A2220-022
H2226+014	336.62	67.24	339.66	334.30	333.80	339.36	335.76	335.26	337.48	337.98	8.10	1.08	336.	AB2457?
	1.44	-45.22	2.01	-0.22	1.03	3.26	0.37	1.63	2.52	1.26	3.14			NOTE 1
H2233-376	338.27	4.07	341.30	334.34	333.95	340.86	337.54	337.12	338.99	339.41	4.80	1.17	322.	NOTE 1
	-37.67	-59.73	-37.16	-39.64	-38.90	-36.44	-38.57	-37.84	-37.17	-37.90	1.27			
H2252-035	343.20	68.01	346.07	340.53	340.37	345.92	342.90	342.75	343.50	343.66	2.40	2.36	340.	
	-3.52	-53.41	-2.55	-4.84	-4.47	-2.18	-3.86	-3.49	-3.18	-3.55	0.32			

COL 1: HEAD NAME USING 1950 RA & DEC.
COL 2: 1950 RA & DEC OF CENTER OF ERROR BOX.
COL 3: GALACTIC LONGITUDE AND LATITUDE.
COL 4-7: POSITIONS OF 4 CORNERS OF BOX 1.
COL 8-11: POSITIONS OF 4 CORNERS OF BOX 2.
COL 12: SIZE IN SQUARE DEGREES OF BOX 1/BOX 2.
COL 13: HIS COUNTING RATE.
COL 14: APPROXIMATE TIME OF OBSERVATION.
COL 15: SUGGESTED IDENTIFICATIONS.
'**', '*', '?' APPENDED FOR
IN BOX 2, IN BOX 1, NEAR BOX 1 RESPECTIVELY.

NOTE 1: THIS SOURCE CONFIRMED USING 3 DEGREE FOV.
NOTE 2: SOURCE NEAR NORTH ECLIPTIC POLE--NO BOX 2 DETERMINED.

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 3

Intensity Conversions

Source	R15	UFU/R15 (1)	Ariel Cnts/R15 (2)	Spectrum	Reference
Coma Cluster	15.0	0.99	0.45	8.8 keV	Mushotzky et al., 1978a
Perseus Cluster	37.5	1.26	0.49	6.8 keV	Mushotzky et al., 1978a
CAS A	38.9	1.37		3.9 keV	Pravdo et al., 1976

(1) UFU from 4U Catalog.

(2) Ariel from 2A Catalog.

TABLE 4

CATALOGS SEARCHED FOR IDENTIFICATION CANDIDATES

Seyfert galaxies	Weedman (1977)
	Weedman (1978)
BL Lac objects	Stein et al. (1976)
Clusters of galaxies	Abell (1958). Distance class 1 to 4.
Galaxies	de Vaucouleurs et al. (1976)
	Sulentic and Tifft (1973)
Radio Sources	Smith et al. (1976). Extragalactic identifications.
Globular clusters	Lang (1974)

TABLE 5

SUMMARY OF NEW IDENTIFICATIONS

NELG:	NGC2110*, NGC5033, NGC6221.
Seyferts:	Mkn142, Mkn372, Mkn464, Mkn590
	NGC4593, NGC7213
	ESO 140-G43, ESO 103-G35
N Galaxies:	3C111, 3C371, 3C382, 3C445
	Pictor A
Custers of Galaxies:	Ab151, Ab1644, Ab2052
Variable Radio Sources:	NRA0140, NRA0530
Others:	Anon0636-53 , NGC0918, NGC7172.

*independent SAS-3 RMC discovery