

The QMW *IRAS* galaxy catalogue: a highly complete and reliable *IRAS* 60- μ m galaxy catalogue

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SUMMARY

A highly complete and reliable *IRAS* 60- μ m galaxy catalogue has been constructed covering 82 per cent of the sky. The excluded areas are the coverage gaps (3 per cent of the sky) and areas flagged as of high source-density (15 per cent of the sky). *IRAS* colour conditions have been used to exclude galactic sources, including the remaining cirrus sources. All sources flagged as extended, confused or having poor correlation coefficient with a point-source template have been examined with the raw *IRAS* data and accurate fluxes determined using mapping routines. The completeness, reliability and flux accuracy of the catalogue are discussed.

Identifications have been made with existing optical galaxy catalogues and with galaxy redshift surveys in the literature. We estimate that redshifts are available for 79 per cent of the galaxies in the catalogue with $V < 5000 \text{ km s}^{-1}$ and the three-dimensional distribution of such galaxies is displayed. The dipole component of the surface-brightness distribution of galaxies in the catalogue is discussed in detail.

An algorithm for extending the catalogue into regions flagged as of high source-density at 100 μ m (a further 11 per cent of the sky) is discussed.

1 INTRODUCTION

Soon after the publication of the results of the *IRAS* all-sky survey, the potential of the 60- μ m survey for cosmological studies was recognized. Rowan-Robinson *et al.* (1986) showed that high-latitude source-counts and identifications were consistent with most 60- μ m sources being galaxies. Lawrence *et al.* (1986) carried out the first redshift survey of *IRAS* 60- μ m sources and found that, after elimination of obvious stars, >99 per cent of the sources at $b > 60^\circ$ were galaxies. Yahil, Walker & Rowan-Robinson (1986, YWR) analysed the surface brightness distribution of *IRAS* 60- μ m sources in spherical harmonics and found that the direction of the dipole component agreed well with that of the cosmic microwave background. These conclusions have been confirmed in many subsequent studies.

In this paper we describe a highly complete and reliable *IRAS* 60- μ m galaxy catalogue constructed from the *IRAS* Point Source Catalog (PSC), Small Scale Structure Catalog (SSS) and Large Galaxy Catalog (LGC), covering 82 per cent of the sky. *IRAS* colour conditions are used to exclude galactic sources, the most important being the constraint on the 25/60- μ m flux ratio introduced by Lawrence *et al.* (1986). Harmon *et al.* (1987) have also constructed an *IRAS* galaxy catalogue, but we believe the catalogue presented here is both more complete (in the sense that a higher propor-

tion of *IRAS* galaxies have been included) and more reliable (in that the exclusion of galactic sources is more effective). For all sources flagged as extended, confused, or having a poor correlation with a point-source template, we have obtained accurate fluxes from the ADDSCAN or COADD mapping routines applied to the raw data. We discuss in detail the flux accuracy, completeness and reliability of our catalogue in Sections 3, 4 and 5. An algorithm for extending the catalogue into regions flagged as of high source-density at 100 μ m is discussed in Section 7.

Sources in the catalogue have been associated with existing optical galaxy catalogues and with galaxy redshift surveys in the literature (Section 6). We argue that about 80 per cent of galaxies with $V < 5000 \text{ km s}^{-1}$ have known redshifts and present three-dimensional distributions for these. We also give a detailed discussion in Section 8 of the dipole component of the surface brightness distribution of sources in the catalogue.

2 A COMPLETE AND RELIABLE ALL-SKY 60- μ m GALAXY CATALOGUE

The goal of this study is to create a 60- μ m galaxy catalogue which covers a large fraction of the sky and which, within the area covered, is highly complete and reliable. Specifically the aim is that the fraction of true *IRAS* galaxies brighter than

the completeness limit which are excluded, and the fraction of sources included which are not galaxies, should be less than 1 per cent. The catalogue will be subject, in addition, to any incompleteness in the *IRAS* Catalogs.

We first design an exclusion mask, based on the standard $1^\circ \times 1^\circ$ 'lune bins' defined, in ecliptic coordinates, in appendix X.1 of the *IRAS Explanatory Supplement* (Beichman *et al.* 1988). The mask is therefore a list of excluded bin numbers. The excluded area obviously includes the 3 per cent of the sky which failed to achieve 2 hours-confirmed coverages. In addition we have excluded areas flagged as of high source-density in any band. There are two reasons for this. Within such areas it was found necessary, during the preparation of the *IRAS* Point Source Catalog (PSC), to introduce additional constraints for acceptance of a source into the Catalog (*IRAS Explanatory Supplement* 1988), with the result that the completeness limit in such regions varies in a complex way with the environment. The high figures for completeness and reliability quoted for the *IRAS* PSC, and on which the possibility of cosmological studies depends, apply only outside regions of high source-density. The second reason is that the majority of 60- μm sources in such areas are clearly galactic. The total area of the sky remaining in the present study is 10.28 sr (81.8 per cent of the sky). Only 31 per cent of the sky at $|b| < 5^\circ$ lies in the unmasked area. The excluded area includes 11 $1^\circ \times 1^\circ$ bins in which the high source-density flag has been set in the 100- μm band due to a high density of galaxies. These are discussed further in Section 7.

The galaxy catalogue is then prepared from Version 2 of the Point Source Catalog, the Small Scale Structure (SSS) Catalog (Helou & Walker 1988), and the *IRAS* Large Galaxy (LGC) Catalog (Rice *et al.* 1988) as follows.

2.1 Point Source Catalog sources

Sources in the PSC which do not have counterparts in the SSS Catalog are included provided they are detected at 60 μm (flux-quality flag > 1), have $S_{60} \geq 0.5$ Jy, and satisfy the following.

(i) $\log(S_{60}/S_{25}) > -0.3$. If the source is not detected at 25 μm , the condition is imposed with the quoted upper limit in place of S_{25} . No catalogued galaxies violate this condition, while the overwhelming majority of stars do. This condition deleted 4361 sources.

(ii) If the source is detected at 25 μm , then $\log(S_{25}/S_{12}) < 1.0$, unless the source is identified with a catalogued galaxy. If the source is not detected at 12 μm , the condition is imposed with the quoted upper limit in place of S_{12} . This condition is need to exclude planetary nebulae at low galactic latitudes. Only two catalogued galaxies violate it, Arp 220 and NGC 4418 (both obviously interesting and unusual objects). This condition deleted 110 sources, of which 22 (mostly catalogued planetary nebulae) were at $|b| > 10^\circ$.

(iii) If the source is detected at 25 μm , then $\log(S_{100}/S_{25}) > -0.3$. This excludes a few (47) additional stellar/planetary nebulae sources, but no catalogued galaxies.

(iv) If the source is detected at 12 μm , then $\log(S_{60}/S_{12}) > 0$. This condition deleted a further 331 stars.

(v) $\log(S_{100}/S_{60}) < 0.6$, unless the source is identified with a catalogued galaxy. If the source is not detected at 100 μm , the condition is imposed with the quoted upper limit in

place of S_{100} . This condition excludes cirrus sources very effectively (3593 sources were deleted, of which 408 were at $|b| > 10^\circ$). However, many nearby, low-luminosity galaxies have cool 60–100 μm colours similar to the cirrus in our Galaxy and it is clearly important not to exclude these normal galaxies. A total of 206 cool galaxies were retained in the catalogue by this condition. From consideration of the range of 60- μm to blue luminosity ratios for such galaxies (Rowan-Robinson, Helou & Walker, 1987), we estimate that few such galaxies will have $m_{\text{pg}} > 15.5$ so that virtually no cool, normal galaxies will fail to be in an optical galaxy catalogue and therefore have been excluded by the above condition, except at low galactic latitudes. Incompleteness caused by this condition is discussed in Section 5.1.

(vi) PSC sources are excluded if their sole identification is with a catalogued star, planetary nebula, H II region or star cluster (661 sources excluded, of which 253 were at $|b| > 10^\circ$).

(vii) Finally, PSC (and SSS and LGC) sources are excluded if they are associated with Local Group galaxies, or with individual structures within Local Group galaxies (8 PSC sources excluded).

We believe that no galaxies have been excluded by conditions (i), (ii), (iii) (iv) and (vi). As discussed below, incompleteness due to condition (v) is estimated to be < 0.7 per cent.

2.2 SSS Catalog sources

Sources in the PSC flagged as confirmed small extended sources at 60 μm , and with corresponding entries in the SSS Catalog, have been included provided there is an association with a catalogued galaxy. Sources at $|b| > 5^\circ$ which appear in the SSS Catalog and which have an association with a catalogued galaxy are also included even if there is no corresponding PSC entry (a total of 25 sources). However, SSS Catalog sources with no galaxy association are not included. A source must be at least 1 arcmin in diameter to be flagged as extended at 60 μm by *IRAS*. Since no cases are known of galaxies with infrared diameters greater than their optical diameters, and since all galaxies with optical diameters > 1 arcmin should be in existing galaxy catalogues, we conclude that very few of the unidentified 60- μm sources in the SSS Catalog are galaxies.

There are 10 cases where more than one point source is associated with an isolated, large, nearby, non-Local Group, galaxy (Table 1). We have assumed that these are a consequence of the point-source recognizer splitting the extended

Table 1. Deleted multiple sources associated with nearby galaxies.

0	13	29.6	-39	32	41	N55
2	19	30.1	42	09	08	N891
2	24	04.0	33	21	19	N925
2	24	26.1	41	46	35	N923
3	40	33.0	67	53	49	IC342
3	41	17.5	67	59	45	IC342
3	43	24.5	67	57	43	IC342
12	14	02.6	69	47	14	N4236
12	14	36.9	69	41	13	N4236
12	47	52.7	25	45	21	N4725
13	02	48.7	-49	09	09	N4945
14	00	42.9	54	30	41	N5457
14	01	13.8	54	28	52	N5457
19	04	45.5	-63	57	29	N6744
19	05	09.8	-63	57	47	N6744

source into two or more parts, and have retained only a single source, with the LGC or SSS Catalog fluxes.

We have extracted accurate fluxes for all SSS galaxies in our sample by coaddition of raw *IRAS* data and the results are discussed in Section 4 below. All sources in the PSC which are flagged as confirmed small extended sources at 60 μm but which do not appear in the SSS Catalog have also been examined in raw coadded *IRAS* data using the IPAC ADDSCAN and, where necessary, COADD packages (see Section 4).

2.3 Galaxies in the *IRAS* Large Galaxy Catalog

Rice *et al.* (1988) have estimated fluxes from coadded raw *IRAS* data for 83 galaxies with optical diameters > 8 arcmin. Where their 60- μm fluxes are greater than 0.5 Jy, we have used the LGC fluxes in preference to either PSC or SSS fluxes. Six galaxies from the LGC not present in the PSC have been included.

The criteria for exclusion of sources differ slightly from those discussed by Rowan-Robinson (1988).

3 STATISTICS OF THE QMW *IRAS* GALAXY CATALOGUE

The 60- μm galaxy catalogue derived as described above consists of 17 664 sources, of which, after correction of fluxes using ADDSCAN and COADD packages as discussed in Section 4 below, 17 567 are brighter than 0.5 Jy, a source-density of 0.52 deg^{-2} . 14 319 have $S_{60} \geq 0.6$ Jy, the completeness limit (Rowan-Robinson *et al.* 1986), i.e. a source-density of 0.42 deg^{-2} . 80 per cent of sources also have detected fluxes at 100 μm . Differential 60- μm source-counts for different ranges of galactic longitude are summarized in Table 2 (see also Fig. 1). These show considerable uniformity over the sky. In particular for $|b| > 10^\circ$ there is no evidence for galactic latitude dependence either of completeness or of the photometric calibration. However, if the $|b| > 60^\circ$ counts are split into $b > 60^\circ$ and $b < 60^\circ$ then the anisotropy reported by Rowan-Robinson *et al.* (1986) remains. The latter has been confirmed to deeper flux levels using the *IRAS* Faint Source Catalog by Lonsdale *et al.* (1990) and appears to be the consequence of cosmological structure on scales of at least $100 h^{-1} \text{ Mpc}$.

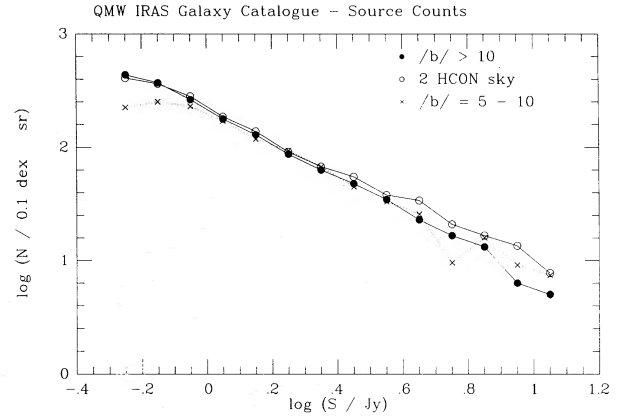


Figure 1. 60- μm source-counts for $|b| > 10^\circ$ (filled circles), the 2 HCON sky (open circles) and $|b| = 5\text{--}10^\circ$ (x).

We have used fig. I.C.1 of the *IRAS Explanatory Supplement* (Beichman *et al.* 1988) to define the area of the sky which received only 2 hours-confirmed coverages. The counts for this area are also shown in Table 2 and are in excellent agreement with the average for the whole sky for $0.5 \leq S_{60} \leq 2$ Jy, showing that there is a negligible increase in incompleteness in the 2 HCON area. Brighter than 2 Jy, the source-density in the 2 HCON area is higher than average because this area includes the Virgo cluster.

The counts given in Table 2 also show that (i) there is about a 20 per cent incompleteness at 0.5–0.6 Jy at all galactic latitudes, (ii) there is contamination by galactic sources at $|b| < 5^\circ$, $S_{60} > 2$ Jy (mostly at $|b| < 2^\circ$), and (iii) there is incompleteness at $|b| < 10^\circ$ in the range 0.6–1 Jy. We estimate that 240 spurious galactic sources brighter than 2 Jy are present in the catalogue at $|b| < 5^\circ$, and that 140 sources are missing at $|b| < 10^\circ$, $0.6 < S_{60} < 1$ Jy. Section 7 discusses a strategy for compiling *IRAS* galaxy samples at low galactic latitudes and in areas of high infrared source-density.

Table 3 shows the distribution of the 60- μm PSC correlation coefficient with a point-source template, *CC*, as a function of the cirrus flag, *CIRRI*, which measures the number of sources detected only at 100 μm in a 1-deg² area around the source, for sources in our catalogue which are not in the SSS or LGC Catalogs. The lack of correlation of the *CC* distribution as a function of *CIRRI* shows that there is no evidence

Table 2. Differential 60- μm source-counts.

	log S															area (sr)
	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	
log N(per 0.1 dex, per sr) =																
$ b > 60^\circ$	2.61	2.55	2.42	2.28	2.16	1.93	1.87	1.78	1.57	1.47	1.32	1.31	1.12	0.90		1.524
$ b = 40 - 60^\circ$	2.63	2.58	2.43	2.26	2.08	1.93	1.74	1.69	1.52	1.33	1.22	1.12	1.14	0.85		2.686
$ b = 30 - 40^\circ$	2.65	2.60	2.43	2.26	2.11	1.89	1.77	1.70	1.56	1.41	1.16	0.82	0.92	0.68		1.666
$ b = 20 - 30^\circ$	2.62	2.57	2.44	2.27	2.16	2.04	1.83	1.66	1.52	1.26	1.13	1.20	0.71	0.79		1.766
$ b = 10 - 20^\circ$	2.59	2.54	2.40	2.26	2.15	2.01	1.79	1.70	1.54	1.41	1.29	1.04	0.78	0.69		1.652
$ b > 10^\circ$	2.62	2.57	2.43	2.27	2.13	1.96	1.79	1.70	1.54	1.37	1.23	1.13	0.99	0.80		9.294
	± 0.007	0.007	0.009	0.010	0.012	0.015	0.018	0.020	0.024	0.028	0.033	0.037	0.044	0.054		
2 HCON area	2.61	2.56	2.45	2.27	2.14	1.96	1.83	1.74	1.58	1.53	1.32	1.22	1.13	0.90		2.671
$ b = 5 - 10^\circ$	2.33	2.39	2.32	2.22	2.13	1.98	1.90	1.68	1.35	1.48	1.22	1.18	1.02	0.88		0.664
$ b < 5^\circ$	2.18	2.32	2.11	2.22	2.12	2.09	2.07	1.85	1.90	1.92	1.77	1.51	1.72	1.62		0.340
HSD, $ b > 10^\circ$	2.15	2.64	2.58	2.37	2.34	2.10	2.00	1.72	1.58	1.49	1.07	1.21	1.12	0.86		0.691

QMW All-Sky IRAS Galaxy Catalogue

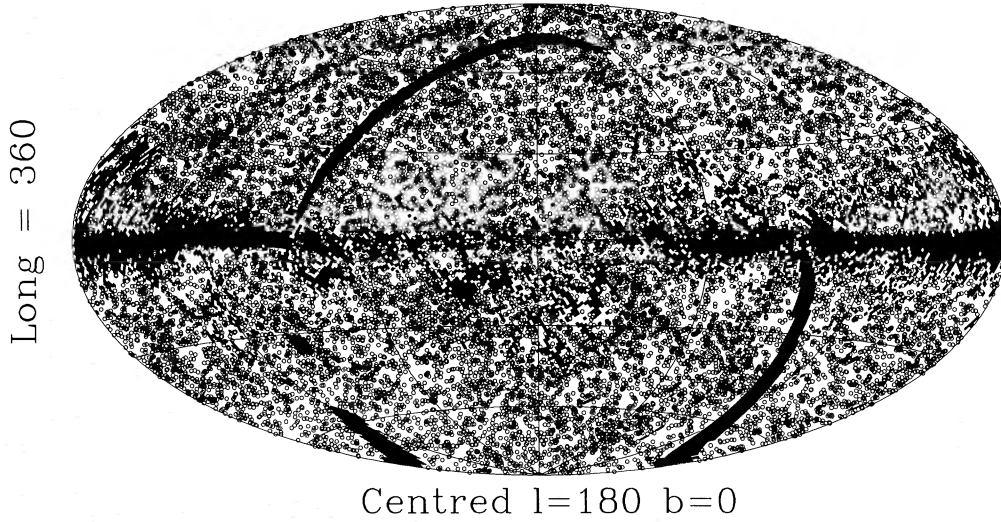


Figure 2. Aitoff sky distribution of masked bins (filled squares) and catalogue sources (open circles) in galactic coordinates, centred on the galactic anticentre, with longitude increasing from right to left.

for degradation of the 60- μm data in cirrus regions for our catalogue. Only 347 sources (2 per cent) have $CC < 0.97$, indicating noisy or extended data, and of these 241 have $CIRRI \leq 1$ and so are not in regions of bad cirrus. For all these 347 sources we have examined coadded raw *IRAS* data using the IPAC ADDSCAN and, where necessary, COADD packages (see Section 4).

Fig. 2 shows the distribution of the 17 664 catalogue sources on the sky and the distribution of the masked areas.

4 ACCURACY OF THE FLUXES IN OUR GALAXY CATALOGUE

4.1 Sources with LGC fluxes

The accuracy of the fluxes for these galaxies, derived from coadded maps, is quoted by Rice *et al.* (1988) as ± 15 per cent.

4.2 Sources from the SSS Catalog

We have analysed the *IRAS* raw data using the IPAC ADDSCAN package for all SSS sources in our catalogue, and, where sources are > 4 arcmin in size on the ADDSCAN profiles, we have made coadded maps. The results are summarized in Table 4. On average the fluxes quoted in the SSS Catalog appear to be about 20 per cent high compared to the add-scanned or coadded fluxes used in the present catalogue.

4.3 Sources flagged as confirmed extended sources (SES2) at 60 μm but not in SSS

We have also studied these sources with ADDSCAN, and where necessary, COADD packages and the results are summarized in Table 4. On average the PSC 60- μm fluxes for these sources were underestimated by 25 per cent compared to the add-scanned or coadded fluxes used here. Since extended sources

whose integrated flux is only slightly greater than 0.6 Jy may fail to appear in the PSC with $S(60) \geq 0.5$ Jy or in the SSS with $S(60) \geq 1$ Jy, we may expect some incompleteness at fainter flux levels. Fig. 3 shows the distribution of $\log(S_{\text{ADDSCAN or COADD}}/S_{\text{PSC or SSS}})$ as a function of $(S_{\text{PSC or SSS}})$ for sources flagged as confirmed extended sources at 60 μm . The zone of incompleteness of our catalogue lies in the wedge above the sloping broken line ($S_{\text{ADDSCAN or COADD}} = 0.6$ Jy) and below the horizontal broken line ($S_{\text{PSC or SSS}} = 0.6$ Jy). Table 5 gives the combined counts of all sources flagged as confirmed extended sources at 60 μm . The SSS *Explanatory*

Table 3. Distribution of 60- μm correlation coefficient, CC , as a function of $CIRRI$.

		CC=										
		1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	
CIRRI	total no.											
0	7986	%=35.8	40.6	16.7	5.4	1.2	0.2	0.1	0.	0.	0.	
1	3755	35.3	41.2	15.3	5.8	1.8	0.4	0.1	0.	0.	0.	
2	1770	36.1	40.5	16.1	5.6	1.3	0.2	0.	0.1	0.1	0.	
3	1097	34.6	41.3	15.8	5.9	1.1	0.6	0.2	0.4	0.1	0.	
4	782	33.9	40.4	18.4	5.4	1.2	0.6	0.	0.1	0.	0.	
5	531	39.7	37.9	15.8	4.5	1.3	0.6	0.2	0.	0.	0.	
6	430	41.6	38.4	14.7	3.0	1.6	0.2	0.2	0.2	0.	0.	
7	310	34.5	36.8	19.0	6.1	2.3	0.6	0.3	0.	0.3	0.	
8	224	38.4	38.4	14.7	2.7	2.7	1.8	0.4	0.4	0.	0.4	
9	524	35.1	39.3	14.9	7.1	1.7	1.3	0.2	0.2	0.2	0.	

Table 4. Ratio of ADDSCAN/COADD fluxes to PSC fluxes for extended and problem sources.

$y = \log \{S_{\text{Addscan,Coadd}}/S_{\text{PSC,SSS}}\} =$																
	-0.4		-0.2		0.0		0.2		0.4		0.6		0.8		<y>	
SSS	4	7	10	32	104	69	5	2	1	0	0	0	1	0	-0.08	
confused	0	0	2	5	28	127	99	19	8	4	5	1	1	0	0.04	
extended,																
not SSS	0	0	2	2	19	126	232	151	46	18	8	3	0	0	0.10	
poor CC	2	3	6	12	70	112	78	30	15	12	7	2	2	0	0.00	
confused																
only	0	0	0	0	7	87	64	8	2	1	2	0	1	0	0.04	
poor CC																
only	0	2	6	9	62	94	69	19	8	10	2	1	2	0	0.00	

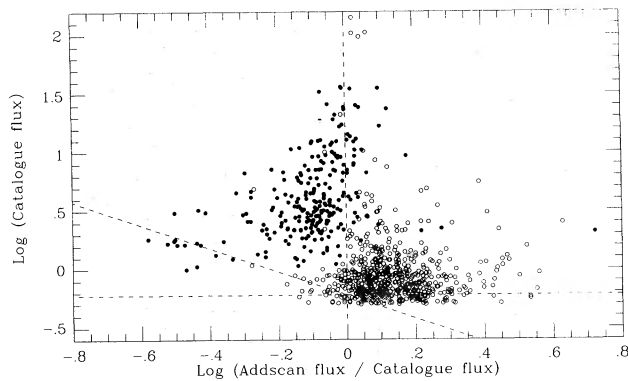


Figure 3. $\log(S_{\text{PSC or SSS}})$ versus $\log(S_{\text{ADDSCAN or COADD}}/S_{\text{PSC or SSS}})$ for SSS Catalog sources (filled circles) and for sources flagged as confirmed extended sources at $60\ \mu\text{m}$ but not in the SSS Catalog (open circles). The horizontal and inclined broken lines correspond respectively to the PSC (or SSS) flux and the ADDSCAN (or COADD) flux being $0.6\ \text{Jy}$.

Table 5. Differential counts of sources flagged as extended.

$\log S_{\text{true}} =$	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
number	27	56	62	60	51	45	29	25	15	16	6	10	13	

Supplement makes only modest claims about completeness, but Table 5 suggests that a $-1.5 \log N - \log S$ slope applies for sources flagged as extended down to $1.6\ \text{Jy}$. From extrapolation of these counts at $> 1\ \text{Jy}$ to fainter levels, and from consideration of the distribution of sources in Fig. 3, we estimate that no more than 100 such sources have been omitted from our catalogue.

4.4 Sources with poor correlation with a point-source template at $60\ \mu\text{m}$

Table 2 indicates that the percentage of $60\text{-}\mu\text{m}$ sources in our catalogue with correlation coefficient with a point-source template worse than 0.97 is < 2 per cent. Some of these are extended sources, already discussed above. For the remainder, we have used the ADDSCAN and COADD packages to determine their total fluxes (see Table 2) and conclude that the majority are bona fide point sources, with their fluxes on average correctly recorded. Only five sources at $|b| > 5^\circ$ could not be located on coadded maps.

4.5 Sources flagged as confused

For sources flagged as confused in any band, but excluding sources flagged as confused only at $100\ \mu\text{m}$ (most of which are due to the presence of cirrus nearby), we have studied the *IRAS* raw data to see if any are true double sources which have been merged together by the PSC software. In most cases a second source was found nearby, but ADDSCAN or COADD software was able to separate the correct $60\text{-}\mu\text{m}$ flux. On average the PSC fluxes for these sources were underestimated by 10 per cent (Table 4).

4.6 $60\text{-}\mu\text{m}$ point sources without any of the above problems

For these the *IRAS Explanatory Supplement* quotes a photometric accuracy of ± 10 per cent.

To summarize, for 93 per cent of the sources in our catalogue, the photometric accuracy is ± 10 per cent. For the remaining 1400 sources (7 per cent) in the categories discussed in Sections 4.2–4.5, fluxes have been derived from addscanned or coadded maps, for which the accuracy, in the majority of cases, is ± 15 per cent (Rice *et al.* 1988).

From the discussion of the source counts given in Section 3, there is no evidence of any significant variation in photometric calibration with galactic latitude or with the number of hours-confirmed coverages (HCONs).

5 COMPLETENESS AND RELIABILITY OF THE QMW IRAS GALAXY CATALOGUE

5.1 Completeness

The *IRAS Explanatory Supplement* (Beichman *et al.* 1988) gives a detailed discussion of the reliability and completeness of the *IRAS* PSC for those areas of the sky which received 2 or 3 HCON coverage. At high galactic latitudes this completeness is better than 95 per cent for sources brighter than $0.6\ \text{Jy}$: this is consistent with the level at which the source-counts start to fall away. This completeness can be verified both by comparison with the Serendipitous Source Catalog, which was based on pointed observations going a factor of 5 deeper than the main survey, but only in selected areas, and with the Faint Source Catalog, which is derived by coaddition of the survey data and has been released for $|b| > 50^\circ$ so far. Both comparisons confirm a better than 95 per cent completeness for version 2 of the PSC at $S_{60} \geq 0.6\ \text{Jy}$ (Moshir *et al.* 1989). The incompleteness of extended sources amounts to no more than 0.7 per cent of the total catalogue (Section 4.3).

The goal of the present catalogue is to include 99 per cent of the galaxies detected by *IRAS*. As discussed in Section 2, we do not believe that our colour conditions have excluded *any* galaxies. However, the two categories of source which required identification with an optical catalogue galaxy (cool sources and sources detected only as SSS sources) may suffer some incompleteness: (i) if there are cool or extended galaxies fainter than the limits of existing optical catalogues, for example at lower galactic latitudes where the optical galaxy catalogues suffer from the effects of extinction; (ii) in the strip $-2.5^\circ > \delta > -17.5^\circ$ the poor positions in the MCG catalogue may lead to some cool galaxies failing to be identified with the corresponding *IRAS* source; (iii) in regions of cirrus where a distant galaxy may acquire a spuriously high $100\text{-}\mu\text{m}$ upper limit, or (iv) a spurious $100\text{-}\mu\text{m}$ detection. Saunders (1990) estimates the 2σ limits to the numbers of galaxies omitted due to (i), (ii), (iii), to be 38, 24 and 28 respectively. Only 10 per cent of the sources rejected on the basis of their $100/60\text{-}\mu\text{m}$ colour have $60\text{-}\mu\text{m}$ correlation coefficient > 0.97 and we therefore estimate that at most 30 of these sources at $|b| > 10^\circ$ are galaxies. The combined incompleteness due to (i–iv) at $|b| > 10^\circ$ is therefore < 0.7 per cent. To define a sample which does not suffer from even this low level of incompleteness, the categories of cool and extended galaxies may simply be excluded.

5.2 Reliability

The reliability of $60\text{-}\mu\text{m}$ sources in the *IRAS* PSC, away from regions of high source-density, is estimated to be very

high, >99.9 per cent (*IRAS Explanatory Supplement*), regardless of their nature. The colour constraints we have imposed are extremely effective at removing stars, planetary nebulae and cirrus sources from the sample. The majority of star-forming regions lie in the excluded high source-density areas.

The very high identification and redshift rate achieved in the one-in-six random sample studied by Rowan-Robinson *et al.* (1990) (Lawrence *et al.*, in preparation), confirms that a very high proportion of the sources in this catalogue at $|b| > 10^\circ$ are galaxies. Only 29/2163 sources (1.3 per cent) were found to be galactic. For $|b| > 20^\circ$ this percentage drops to 0.5 per cent and for $|b| > 30^\circ$ to 0.1 per cent.

For the 122 sources in our one-in-six sample at $|b| < 10^\circ$, $l = 40\text{--}240^\circ$, 96 (79 per cent) have galaxy identifications (we have measured redshifts for 59), 11 (9 per cent) were clearly galactic and for 15 (12 per cent) the identification was ambiguous.

To summarize we believe that for $|b| > 10^\circ$ our catalogue achieves our goals that 99 per cent of the sources should be galaxies and that 99 per cent of the galaxies detected by *IRAS* should be included. We are not able to give accurate estimates of completeness and reliability at $|b| < 10^\circ$ (but see Section 7 for discussion of a strategy for extending the catalogue into regions of high source-density).

6 ASSOCIATIONS AND REDSHIFTS

The 60- μm galaxy catalogue has been cross-correlated with an all-sky optical galaxy compilation (CATX) based on the CGCG, UGC, MCG and the ESO Catalogue. The search radius used for potential matches is 120 arcsec or 60 arcsec + (optical major diameter)/2, whichever is the larger. The *IRAS* error ellipse was not taken into account, being typically much smaller than the uncertainty in the optical position.

All matches at > 120 arcsec were checked on the SERC or POSS plates, and 23 sources were found to be associated with Local Group galaxies or to be additional components of nearby galaxies already included in the *IRAS* LGC or SSS Catalogs: these sources were deleted from the catalogue, as discussed in Section 2.

Where there was a single catalogued galaxy match within 90 arcsec, this was accepted as the true identification; for galaxies with poorly known optical positions (to 0.1 min in RA and 30 arcsec in dec only) this was relaxed to 120 arcsec. Where there were multiple identifications, the true identification was selected on the basis of the nearest/brightest/largest/latest type, in that order of priority. Where there was no obvious preference, the source was identified on the POSS or SERC plates and a decision made accordingly. The interactive nature of many *IRAS* galaxies means that a significant proportion of the matches are with multiple systems.

The surface density of CATX galaxies is of order 1.5 deg^{-2} : for a search radius of 120 arcsec there is then a 0.5 per cent chance of misidentification for each of the 10 000 *IRAS* galaxies in our catalogue not actually contained in CATX. There will then be about 50 sources in our catalogue with incorrect identifications.

Redshifts were obtained from the 1990 version of the Harvard-Smithsonian galaxy redshift catalogue, kindly made

available by John Huchra (1990). The cross-correlation was done as above, and cases where the best match was uncertain or discrepant with that found above were again checked by hand. Where there are multiple comparable components, all with known redshifts, these have been averaged. Where a redshift has been measured but is still unpublished, its existence is noted.

This cross-correlation with the Harvard-Smithsonian galaxy redshift catalogue was supplemented by an extensive search through the literature, and we believe that all significant redshift information published or preprinted before 1989 December has been included. In addition there have been a number of specifically *IRAS*-based redshift surveys, e.g. Lawrence *et al.* (1986), Leech *et al.* (1988), Strauss & Huchra (1988), the 2-Jy survey of Strauss *et al.* (Strauss & Davis 1988a-b; Yahil 1988) and the QMW-Durham-Oxford-Toronto (QDOT) sparse-sampled survey (Rowan-Robinson *et al.* 1990; Lawrence *et al.*, in preparation), and the southern survey of Allen *et al.* (1991). Redshifts from these have been included where available.

Where several redshifts are available, we have taken the one with the smallest quoted uncertainty. For catalogued galaxies this is typically 40 km s^{-1} or less; for the Faint Object Spectrograph redshifts in the QDOT survey, the uncertainty is 300 km s^{-1} , but very few of these velocities (2 per cent) are less than 3000 km s^{-1} . We intend to update the redshift information in the QMW *IRAS* Galaxy Catalogue periodically.

Overall 8649 sources (49 per cent) have been identified with previously catalogued galaxies. Published redshifts are available for 5572 sources in the catalogue (32 per cent): a further 1593 redshifts have been measured by ourselves and our collaborators (Rowan-Robinson *et al.* 1990; Lawrence *et al.*, in preparation) and 1394 redshifts have been measured by other workers but not yet published.

During the redshift survey of Rowan-Robinson *et al.* (1990), only 109 redshifts less than 5000 km s^{-1} had to be measured and a further 46 were supplied from unpublished redshift surveys (in all 21 per cent of the sample at $|b| > 10^\circ$), suggesting that redshift information is about 80 per cent complete for the catalogue within that volume. Plots of the three-dimensional projected distribution of *IRAS* galaxies within 5000 km s^{-1} are shown in Fig. 4(a-c), in galactic coordinates, and 5(a-c), in supergalactic coordinates, for an adopted H_0 of 100 $\text{km s}^{-1} \text{Mpc}^{-1}$. Positions in these figures are derived from velocities corrected only for galactic rotation.

The distribution shown in Fig. 4 is in good agreement with that derived from the QDOT one-in-six sparse-sampled survey (Rowan-Robinson *et al.* 1990) and the structures identified in the sparse-sampled survey are apparent in this almost complete sample. In particular the Eridanus-Fornax cluster can be seen at $x_G = (-8, -4, -12)$, the Virgo cluster at $(1, -3, 10)$, the Centaurus cluster at $(14, -22, 11)$, the Pavo cluster at $(33, -16, -17)$, the Hydra cluster at $(0, -30, 17)$ and the N1600 cluster at $(-38, -14, -26)$. These cluster centre positions are taken from Rowan-Robinson *et al.* (1990, column 8 of table 4), defined either from earlier optical studies or as centres of the local flow derived from *IRAS* galaxies. One obvious additional structure seen here is the Grus group seen at $x_G = (6, 1, -14)$ in Fig. 4.

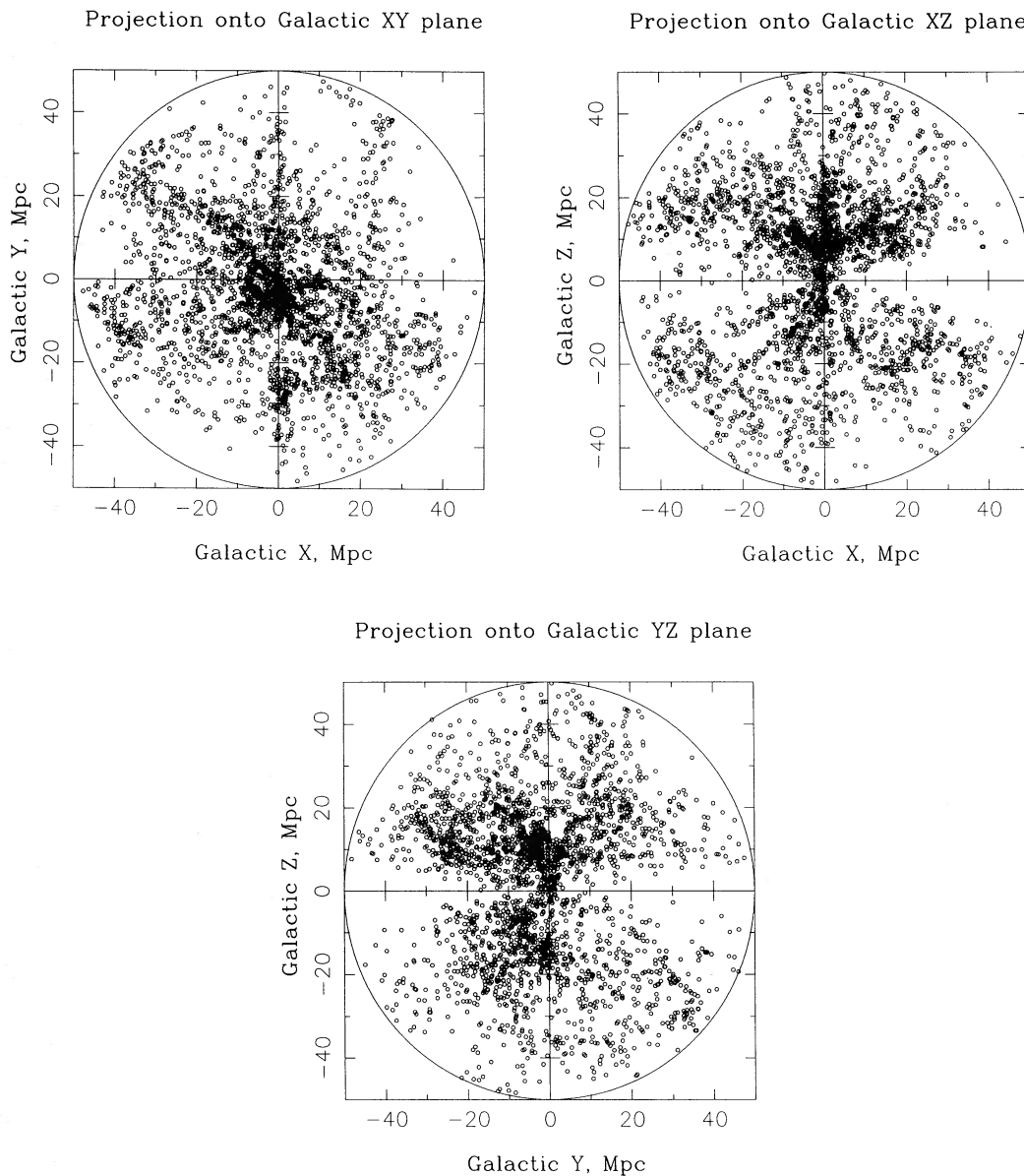


Figure 4. (a–c) 3D distribution of *IRAS* galaxies with $V_0 < 5000 \text{ km s}^{-1}$. The x axis is towards the Galactic Centre and the z axis towards the galactic pole.

Fig. 5(a–c) may be compared with fig. 2(a–c) of Faber & Burstein (1988) derived from $D_n - \sigma$ and Tully–Fisher galaxy studies. The most striking feature of Figs 5(b) and (c) is the supergalactic plane, seen even more clearly here than in the Faber & Burstein plot, stretching from $X = -8$ to $+6 \text{ h}^{-1} \text{ Mpc}$ in Fig. 3(b) and from $Y = -3$ to $+15 \text{ h}^{-1} \text{ Mpc}$ in Fig. 3(c). In Fig. 3(a), a bridge can be seen linking Virgo at $X_{\text{SG}} = (-3, 10, -1)$ to Centaurus at $(-25, 11, -6)$ and Hydra at $(-20, 19, -20)$.

7 STRATEGY FOR EXTENSION OF THE CATALOGUE TO HIGH SOURCE-DENSITY AREAS

As discussed in Section 2, 3 per cent of the sky failed to receive 2 HCON coverage and a further 15 per cent of the

sky was excluded from our catalogue by the exclusion of areas of high source-density in any band. To try to extend the sky coverage at least for qualitative cosmographic studies, we have investigated whether an algorithm can be devised which is successful in identifying galaxies within areas of high source-density like the Milky Way, Orion and Ophiuchus.

The algorithm we have devised is the following:

- (i) Allow sources which have high source-density at $100 \mu\text{m}$. This permits a further 11 per cent of the sky to be used, mostly at $|b| > 5^\circ$. Areas of high source-density at $60 \mu\text{m}$ have typically more than ten times the average source-density due to galaxies, and it is at present impractical to try to extract the small percentage of galaxies from them. Only the region in the galactic plane close to the Galactic Centre has high source-density only at 12 and $25 \mu\text{m}$, and this is

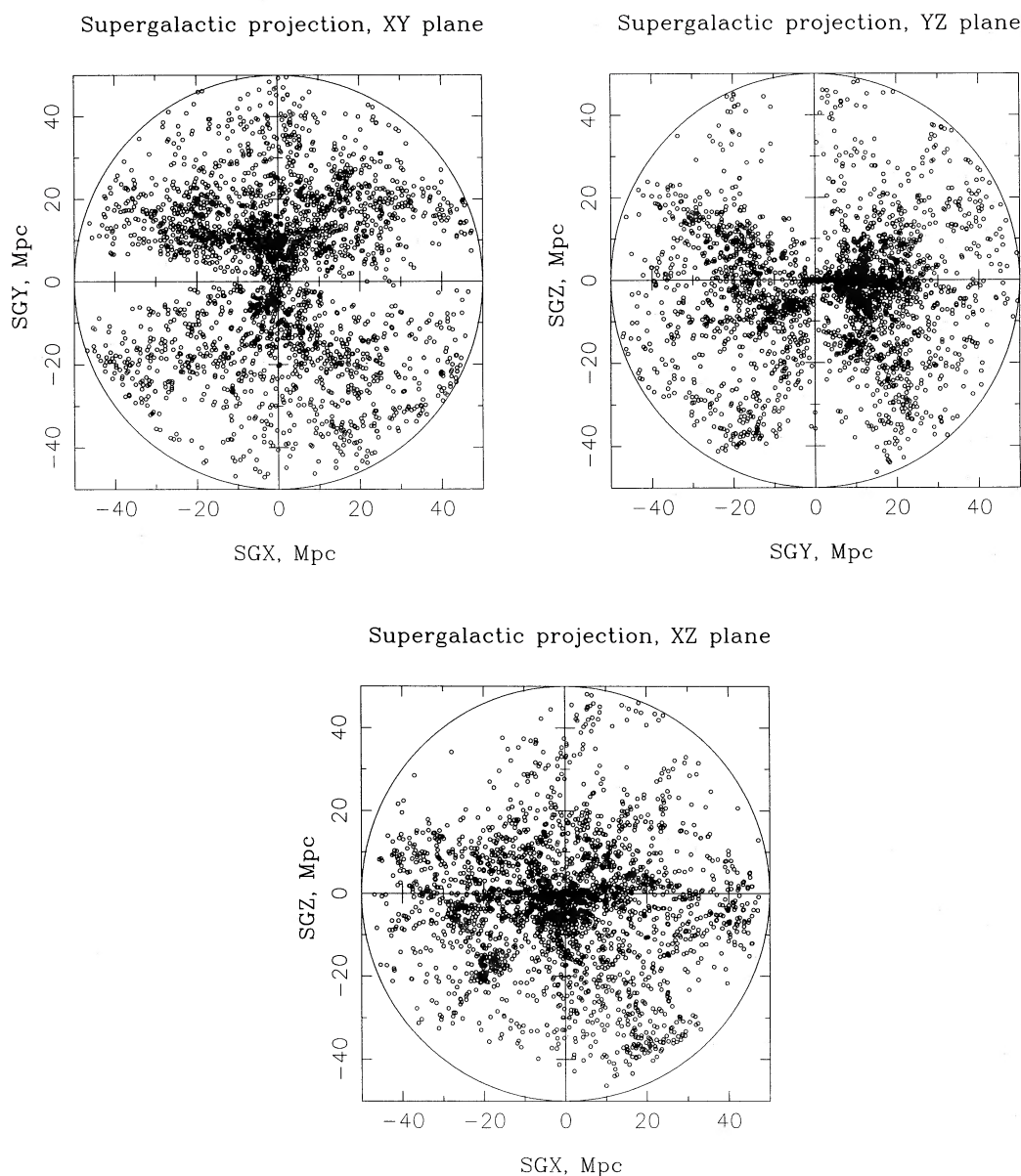


Figure 5. (a–c) 3D distribution of *IRAS* galaxies with $V_0 < 5000 \text{ km s}^{-1}$ in supergalactic coordinates.

also a hopeless area for any systematic extraction of *IRAS* galaxies. The area of the sky flagged as of high source-density at 12, 25 or $60 \mu\text{m}$ is 1506 deg^2 (3.6 per cent of the sky).

(ii) Exclude sources flagged as extended at $60 \mu\text{m}$. Only a small proportion of the extended sources in areas of high source-density are galaxies. From Section 2 above, 3 per cent of *IRAS* galaxies appear to be extended with respect to the *IRAS* beam at $60 \mu\text{m}$, so this fraction of true galaxies will be lost by this exclusion.

(iii) Exclude galaxies which have a $60\text{-}\mu\text{m}$ PSC correlation coefficient with a point-source template, $CC \leq 0.97$. From Table 3 we see that this excludes only 7 per cent of galaxies at high latitudes and is effective at rejecting galactic sources.

(iv) Exclude sources with stellar or cirrus colours and sources with stellar identifications as in Section 1. Exclude

also sources flagged as confused in any band (2 per cent of sources away from regions of high source-density). The combined effect of (ii–iv) is to exclude 7 per cent of Catalog sources (1160/16189) in the unmasked sky at $|b| > 10^\circ$.

At $|b| > 10$, where there are 2270 deg^2 flagged as of high source-density at $100 \mu\text{m}$, we then find a total of 1258 sources brighter than 0.6 Jy , a source-density of 0.55 deg^{-2} , compared with the average over the rest of the sky of 0.42 deg^{-2} . Examination of samples of these sources on the Palomar and SERC Sky Survey prints shows that a high proportion are galaxies (all 23 at $|b| > 40^\circ$). Our algorithm appears to be effective in finding most true *IRAS* galaxies [subject to the restrictions (ii–iv) above] in these high source-density areas. The counts of these sources (bottom line of Table 2) are consistent with a high proportion being galaxies.

A small number of 'lune bins' have been flagged as of high source-density at $100\ \mu\text{m}$ because of a high surface-density of galaxies. The exclusion of these areas might bias statistical studies of clustering, so we have been careful to identify these bins. The threshold for classification of a bin as of high source-density at $100\ \mu\text{m}$ was at least six $100\text{-}\mu\text{m}$ sources in the bin. Fig. 1 of Rowan-Robinson *et al.* (1986) shows that there are <0.1 galaxies deg^{-2} at high galactic latitudes detected at $100\ \mu\text{m}$ only. Thus bins classified as of high source-density at $100\ \mu\text{m}$ and in which the *CIRRI* flag is set to six or more are almost certainly so classified due to cirrus sources. Table 6 lists the lune bins classified as of high source-density at $100\ \mu\text{m}$ and containing four or more high-quality [in the sense of (ii-iv) above] sources, with an average value of *CIRRI* < 6 . Only for bin 35143, in which there are no $100\text{-}\mu\text{m}$ only sources, was the high source-density classification unambiguously due to galaxies. Most of the others had some assistance from cirrus sources in the same bin. All the sources in these bins satisfying our algorithm are associated with catalogued galaxies or are clearly galaxies on the Sky Survey prints.

There are two bins classified as of high source-density at $100\ \mu\text{m}$ which contain the nearby galaxies M81, M82 (both in lune bin 4319) and NGC 6946 (lune bin 1058) but no other galaxy candidates. Probably poor reconstruction of these large sources by the point-source detection algorithm was responsible for the high source-density classification in these cases.

To test the validity of our algorithm for recognizing galaxies in regions of high source-density, we have carried out identification programmes on the Sky Survey prints for two areas of the sky: (i) $l=60\text{--}240$, $|b|<10^\circ$, and (ii) $l=290\text{--}310$, $|b|<10^\circ$. Out of 189 sources examined in area (i) we were able to identify 62 with galaxies (33 per cent), even though the extinction was high. 22 of the sources (12 per cent) were obviously galactic. For the remainder we could either not see any galaxy candidate (though there were usually many stellar candidates) or there were extended optical images but it was not clear if they were galaxies. Out of 91 sources examined in area (ii) 57 (63 per cent) were identified with galaxies.

In 1987 December and 1988 August, during observing runs at the WHT and AAT as part of our all-sky *IRAS* galaxy redshift survey (Rowan-Robinson *et al.* 1990; Lawrence *et al.*, in preparation), we carried out a pilot programme of redshift measurements on a sample of sources at $|b|<10^\circ$. Redshifts were obtained for over 60 galaxies. This pilot study shows that, although it is much harder to find galaxies and measure their redshifts in high source-density areas, the algorithm described above is effective at finding galaxies in these areas. We hope to take this study further in the future.

8 SURFACE BRIGHTNESS DIPOLE

As we now have what we believe is the most complete and reliable *IRAS* galaxy catalogue compiled to date, it is of interest to repeat the calculations of YWR on the surface-brightness dipole. YWR have shown that the dipole moment of the surface-brightness distribution, $\sigma(S)$, of a population of sources with luminosity function, $\phi(L)$, in which the total space density of sources follows the total mass density, is

Table 6. Lune bins flagged as of high source-density at $100\ \mu\text{m}$, containing four or more high-quality $60\text{-}\mu\text{m}$ sources.

Bin 11434 (l,b) = (140.9, -18.3)			
RA	dec	CIRRI	ID
0220003	410837	2	UGC1840
0222553	415505	3	NGC914
0223375	413638	3	Z0223.6+4137
0223439	412754	2	Z0223.7+4128
Bin 22637 (l,b) = (187.0, -11.1)			
0516280	164928	8	UGC3286
0518216	170409	6	faint galaxy
0518551	170025	8	faint galaxy
0519231	172832	0	faint galaxy
Bin 38378 (l,b) = (245.5, -18.2)			
0636427	-363830	4	edge-on spiral
0636524	-371444	9	edge-on spiral
0637103	-363818	5	E366 - G5
0637296	-373237	4	galaxy with bright nucleus
Bin 35887 (l,b) = (276.9, 12.3)			
1025133	-425240	5	E263 - G37
1025429	-433856	4	NGC3256
1026564	-433532	5	NGC3256C
1027043	-435156	1	NGC3263
Bin 35143 (l,b) = (275.2, 15.0)			
1025311	-394448	0	NGC3250C
1025422	-394941	0	NGC3250B
1026485	-394937	0	NGC3250E
1027200	-393505	0	E317 - G36
1029236	-394158	0	NGC3278
1029355	-393010	0	E317 - G45
Bin 31795 (l,b) = (269.8, 26.4)			
1034513	-272529	1	bright peculiar galaxy
1037060	-264249	1	E501 - G70
1037555	-273059	1	E437 - G36
1038370	-264917	1	E501 - G75
Bin 35410 (l,b) = (290.3, 12.0)			
1132508	-484403	6	E216 - G20
1133230	-484519	6	E216 - G21
1135188	-485407	6	E216 - G24
1135286	-485828	6	E216 - G25
1137356	-484111	4	E216 - G31
Bin 31824 (l,b) = (301.2, 21.5)			
1240209	-410504	4	E322 - G59
1243309	-412557	1	NGC4672
1243311	-411008	1	E322 - G74
1244375	-405802	0	NGC4696B
Bin 32129 (l,b) = (306.0, 18.3)			
1304546	-441324	8	edge-on spiral
1306147	-443354	2	faint spiral with bright nucleus
1306413	-445225	0	galaxy with bright nucleus
1308129	-443946	2	galaxy with double nucleus
Bin 21346 (l,b) = (337.2, 36.8)			
1442032	-181018	2	galaxy with bright nucleus
1443505	-181816	3	E580 - G23
1444464	-175150	2	E580 - G30
1445068	-181012	2	faint galaxy with bright nucleus
Bin 13317 (l,b) = (43.4, -17.0)			
2008137	5813	3	galaxy with bright nucleus
2009233	10630	4	faint edge-on spiral
2009287	14209	2	faint galaxy
2009458	14828	2	UGC11525

related to the peculiar gravitational acceleration acting on the Local Group due to matter out to radius r , $G(r)$, by

$$4\pi S \sigma(S) = \int L^2 \phi(L) \frac{dG}{dr} dr, \quad (1)$$

$$\text{where } G(r) = (3/4\pi) \int D(r') \frac{r'}{r^3} d^3 r',$$

$$L = 4\pi r^2 S,$$

and $D(r)$ is the relative total mass density at r ,

i.e. $D(r) = \rho(r)/\rho_0$,

where ρ_0 is the total mass density.

To take account of the masked areas, the spherical harmonic components are calculated over the unmasked areas (YWR). The orthogonality matrix for the spherical harmonic components ceases to be diagonal. The true spherical harmonic components, on the assumption that the sky behind the mask is similar to that in the unmasked area, are then calculated by matrix inversion.

Table 7 gives the mean dipole amplitude and direction, with statistical uncertainties, calculated by weighting the values of the components in each flux bin by the inverse square of the uncertainties. The first line in Table 7 shows the dipole calculated for $0.63 < S < 31.6$ Jy, and areas with $|b| < 5^\circ$ added to the mask, which is our best estimate of the surface-brightness dipole for *IRAS* galaxies. Other lines in Table 7 show the effect of varying the extent of the mask and the flux range used: the variation of the dipole amplitude and direction with these assumptions is small. Going from the YWR data to that of the new galaxy catalogue, with the same *CIRRI* = 1 mask used by YWR, changes the dipole direction by only 2° . Extension of the sky coverage from 47 to 79 per cent changes the dipole direction by only 7.8° . Also shown is the deviation from the most recent microwave background dipole direction (Lubin & Vilella 1986). Our best estimate of the direction of the *IRAS* dipole differs from this by only 18° , within the combined uncertainties. Table 8 gives a compari-

Table 7. The *IRAS* 60- μ m dipole.

sample	mask ^a	area sr	flux- range Jy	no. of sources	dipole l amplitude Jy	b	^a CBR ^b ($^\circ$)
present ^c	basic	9.94	0.63-31.6	12597	1400	252.0 38.8	17.9
	+ $ b < 5^\circ$					$\pm 150 \pm 9.8$	± 9.1
present ^d	"	"	"	12448	1342	248.2 39.5	20.7
"	"	"	0.63-31.6 ^e	12448	1425	252.1 45.7	22.5
"	"	"	0.63-200 ^e	12495	1323	233.8 48.9	34.3
"	"	"	0.63-63	12480	1347	246.3 41.2	22.8
"	"	"	0.5-31.6	16694	1430	239.3 40.6	27.3
"	"	"	1.0-31.6	6126	1468	247.9 44.1	23.6
"	"	"	2.0-31.6	2285	1656	245.5 48.7	27.8
"	basic	10.28	0.63-31.6	12950	1320	241.2 40.6	26.0
"	basic	9.28	0.63-31.6	11715	1408	249.2 37.0	18.1
	+ $ b < 10^\circ$						
"	basic	7.63	0.63-31.6	9698	1375	256.9 37.7	14.2
	+ $ b < 20^\circ$						
"	<i>CIRRI</i> > 1	5.94	0.63-31.6	7089	1513	250.6 31.9	16.0
"	<i>CIRRI</i> > 1	5.94	0.5-31.6	9521	1518	248.8 38.1	19.6
YWR	<i>CIRRI</i> > 1	5.94	0.5-31.6	9903	1550	248 40	21.0

^abasic mask is coverage gaps + high source-density bins; ^bCBR direction is taken as $(l, b) = (268, 27)$ (Lubin & Vilella 1986); ^cfluxes for all problem sources derived from ADDSCAN or COADD maps; ^dfluxes from LGC, SSS or PSC (version 2); ^estraight average of flux bins (rest are error-weighted averages).

Table 8. Comparison with other measurement of *IRAS* surface-brightness dipole.

authors	IRAS version	PSC flux range	flux range	cirrus rejection	correction for extended sources	% of sky	no. of sources	(l,b)
Yahil et al (1986)	1	0.5-31.6 Jy		<i>CIRRI</i> > 1	none	47	9903	(248,40)
Meiksin & Davis (1986)	1	$S > 0.5$ Jy		worst areas excluded, unid. sources excluded	none	76		(235,44) ¹
Harmon et al (1987)	2	$S > 0.7$ Jy		colour selection	none	66	8985	(228,22) ²
Strauss & Davis (1988a)	1	$S > 1.936$ Jy		worst areas excluded	double PSC fluxes ³	76	2176	(255,54)
Strauss & Davis (1988b)	2	$S > 1.936$ Jy		worst areas excluded	LGC and ADDSCAN fluxes	76	2244	(231,48)
Rowan-Robinson (1988)	2	0.63-31.6 Jy		colour selection + HSD flag	LGC and SSS fluxes	79	12448	(248,40)
present paper	2	0.63-31.6 Jy		"	COADD or ADDSCAN fluxes	79	12597	(252,39)

¹number-weighted dipole; ²out of line with other studies, but number-weighted dipole agrees with CBR; ³Table 4 shows that this is an excessive correction.

Table 9. Spherical harmonic components.

component	magnitude (0.63-31.6 Jy)
1	8561 $\pm$ 92
cos b cos l	-384 $\pm$ 157
cos b sin l	-961 $\pm$ 153
sin b	854 $\pm$ 143
1.5 sin ² b - 0.5	557 $\pm$ 217
sin 2b cos l	615 $\pm$ 159
sin 2b sin l	-1092 $\pm$ 154
cos ² b cos 2l	632 $\pm$ 181
cos ² b sin 2l	-1636 $\pm$ 177

son of our results with other calculations of the *IRAS* surface-brightness dipole. The agreement between different authors is, in general, good, despite a wide range of approaches to the calculation. Table 9 gives the quadrupole components corresponding to the solution in the first line of Table 7. These are comparable in magnitude to the dipole component.

9 FURTHER WORK

The *IRAS* galaxy catalogue described here is highly reliable and complete, and has accurate fluxes, over the 82 per cent of the sky covered. It will provide the basis for a number of cosmological studies. Rowan-Robinson *et al.* (1990) describe a one-in-six sparse-sampled redshift survey based on this catalogue and use the survey to map the local gravitational field, concluding that the motion of the Local Group with respect to the microwave background is generated by some dozen superclusters within $150 h^{-1}$ Mpc. The three-dimensional distribution of *IRAS* galaxies is further discussed by Saunders *et al.* (1991) and Kaiser *et al.* (1991). Saunders *et*

al. (1990) have derived the 60- μ m luminosity function from this and other *IRAS* redshift surveys and found that the *IRAS* galaxy population is undergoing significant cosmological evolution. Efstathiou *et al.* (1990) have discussed the large-scale structure of the Universe derived from the sparse-sampled redshift survey. Rowan-Robinson *et al.* (in preparation) will present a list of clusters of *IRAS* galaxies derived by percolation analysis from the present catalogue. The redshift data for the one-in-six survey and for complete redshift surveys down to 0.6 Jy in the areas (i) $l < 110$, $b > 60$, (ii) $l = 120-180$, $b = 20-40$ and (iii) (down to 1.0 Jy) $l = 60-180$, $b < -60$, will be presented by Lawrence *et al.* (in preparation).

The catalogue can be obtained in machine-readable form by application to the authors.

After submission of this paper, we received a copy of the paper by M. A. Strauss, M. Davis, A. Yahil & J. P. Huchra (1990. *Astrophys. J.*, **361**, 49), which discusses a sample of 5014 *IRAS* sources with $S_{60} > 1.936$ Jy, of which 2649 are galaxies. It will clearly be of interest to compare their galaxy list with ours, for the flux-range in common.

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