The provisional DENIS *I*-band catalog of galaxies revisited[★]

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Abstract. We present an extended and improved version of the provisional *I*-band catalog of DENIS galaxies. Galaxies not cross-identified with already known galaxies have been visually checked using the DSS1 images and, occasionally, the coordinates were remeasured. The typical accuracy of coordinates is about 2". The typical error on *I*-band magnitude is about 0.2 mag. The final catalog gives the most common names, the J2000 coordinates, the *I*-band magnitude, the diameter, the axis ratio and the position angle for about 43 000 galaxies. It covers roughly 67% of the southern hemisphere. It is homogeneously sampled up to $I = 14.5$ mag. It is available through the Centre de Données de Strasbourg (CDS). The data are also available via the LEDA database.

Key words. infrared: galaxies – catalogs – surveys

1. Introduction

In 1999 we published a provisional catalog of galaxies (Vauglin et al. 1999) giving 20 260 galaxies detected from the Deep Near Infrared Survey of the Southern Sky (hereafter DENIS; Epchtein 1998). This catalog was built from binned *I*-band images at 0.80 μm (Gunn-*i* system). In the present paper we present a larger and higher quality version of this catalog.

In Sect. 2 we briefly recall how the catalog was built and we explain what we did to improve the quality. In Sect. 3 we present the catalog itself and compare it with *J*, *H*, *K* magnitudes from the second release of the 2MASS survey.

2. Construction of the catalog

2.1. General procedure

The *I*-band images are flat-fielded and de-biased at the Paris Data Analysis Center (PDAC) following the general procedure of treatment of DENIS data (Borsenberger 1997). Then, a special program is applied in order to bin images $2'' \times 2''$ and to replace the uniformized sky background by a constant value. The compressed images are then automatically transferred to Lyon to be processed. The source extraction is made with a very conservative threshold (2σ above the sky background). The galaxy recognition is made with a Discriminant Analysis based on

seven parameters¹ and calibrated with a sample of 1146 DENIS objects visually classified as “galaxy”, “star” or “unknown”. A visual inspection of every galaxy candidate was made on the matrix of pixels. This control had to be improved because it did not allow us to check the accuracy of the coordinates. Further, the nature of the object was difficult to recognize.

The calibration is made using *I*-band magnitudes, diameters and axis ratios published by Mathewson et al. (1999).

2.2. Improvements

The use of DSS images for the quality control showed us that the accuracy of the first DENIS images was relatively poor. Our program makes two independent coordinate determinations: one from the fits header (i.e. the telescope position) and another one from a comparison with the GSC. The difference between both systems allows us to judge the quality of a given frame. In our first catalog we kept the header solution but rejected images only when the discrepancy was larger than 30". Recently, it has been revealed that some header positions were of poor quality. Thus, in the present catalog we keep only images for which the agreement between both coordinate determinations are better than 10". Further, all new objects not cross-identified with a LEDA galaxy were checked visually and, occasionally, their coordinates were interactively re-measured.

Another fact was revealed from the visual inspection of images. Some galaxy candidates were actually false detections caused by some features, like halos around stars or multiple faint stars assembled in a galaxy-like shape. In our first catalog

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★ Full Table 2 is available in electronic form at CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via <http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/405/1>

* Based on observations collected at the European Southern Observatory, La Silla, Chile.

¹ These parameters are: peak intensity over area, Mean surface brightness, Peak intensity, Axis ratio, Relative surface object/matrix, Elongation of the matrix, Diffraction Cross.

we removed these cases by inspection of the matrix of pixels. Our present control with DSS images gives better reliability.

Some images were obtained under poor photometric conditions. This leads to an uncertain photometry with discrepant zero-points. This is revealed by a bi-modal shape of the mean surface brightness $\mu = I + 5 \log D + 3.89$, where I is the total I -band apparent magnitude and D the external apparent diameter (in $0.1''$) roughly at the I -band limiting surface brightness of $23.5 \text{ mag arcsec}^{-2}$. On average, normal galaxies have $\mu = 22.8 \pm 0.5 \text{ mag arcsec}^{-2}$. In order to reduce the influence of poor nights we kept only objects with a mean surface brightness over the range $[22.3\text{--}23.3] \text{ mag arcsec}^{-2}$. This prevents us from finding extreme objects (LSB or compact) but also from having too many false detections.

3. The catalog

3.1. Presentation

Presently, 677 995 images have been processed, from which 125 435 galaxy candidates have been extracted. However, only 43 000 galaxies have been kept in the present version in order to insure reliability. The catalog covers roughly 67% of the southern hemisphere. It is homogeneously sampled up to $I = 14.5 \text{ mag}$. It is presented as follows:

Column 1: PGC number (LEDA database).

Column 2: Alternate name taken according to a hierarchy: NGC, IC, UGC, ESO, MCG, etc.

Column 3: Right Ascension and Declination for the equinox 2000. These equatorial coordinates are given in hours, minutes, seconds and tenths for the Right ascension and in degrees, arcminutes and arcseconds for the Declination.

Column 4: Total I -band magnitude. The zero-point of these magnitudes is adjusted to the Mathewson system (Mathewson et al. 1992)².

Column 5: Apparent diameter in log scale. D is in 0.1 arcmin . This diameter is converted to the Mathewson system (reference above) at the isophote $23.5 I - \text{mag arcsec}^{-2}$, using a linear log-log conversion.

Column 6: Axis ratio in log scale (log of major axis to minor axis).

Column 7: Position angle in degrees, measured from the North to the East. Its value covers the range $0\text{--}180^\circ$. A few values exactly equal to zero are taken as 180° .

3.2. Comparison with 2MASS

A comparison with 2MASS coordinates was made by T. Jarrett (private communication). He suggested to check 3660 galaxies not found in the 2MASS ALL SKY catalog. After a visual inspection, 968 coordinates were improved and 795 objects were removed because they were not confirmed as galaxies.

We then compared the coordinates by measuring the angular distance between the equatorial coordinates given by the

Fig. 1. Histogram of angular separation between positions given by DENIS and 2MASS.

Table 1. Standard deviations and mean colors for comparison of DENIS I -band with 2MASS J -, H -, K -band.

Comparison	σ	mean color	n
I vs. J	0.23	$\langle J - I \rangle = -0.89 \pm 0.23$	16 998
I vs. H	0.25	$\langle H - I \rangle = -1.60 \pm 0.25$	16 989
I vs. K	0.28	$\langle K - I \rangle = -1.95 \pm 0.28$	17 014

present catalog and those given by 2MASS³ (Fig. 1). From this histogram we see that most of the measurements are better than $2''$. This value is compatible with the size of our binned pixels ($2''$). The mean is more precisely $1.41''$ ($\sigma = 1.1$, $n = 20\,061$). A comparison of Right Ascension and Declination (Fig. 2) gives $\alpha_{\text{DENIS}} - \alpha_{2\text{MASS}} = -0.420''$ ($\sigma = 1.28$, $n = 20\,061$) and $\delta_{\text{DENIS}} - \delta_{2\text{MASS}} = -0.076''$ ($\sigma = 1.21$, $n = 20\,061$). This reveals small but systematic differences between 2MASS and DENIS astrometry. Nevertheless, the coordinates are typically better than $2''$ and allow an unambiguous identification.

For the photometry we also compared the present catalog with 2MASS. Although the I -band is not used by 2MASS, the comparison allows us to estimate roughly the standard deviation of our measurements. In Fig. 3 we show the comparison of the I -band with the J -band. In Table 1 we present the standard deviations of comparisons of DENIS I -band with 2MASS J -, H -, K -bands (with 2σ rejection of discrepant points). The mean colors are deduced from these comparisons. They are given in Table 1. If one assumes that our I -band measurements have the same accuracy as the 2MASS ones, we deduce that the accuracy of the our photometry is about 0.2 mag ($\approx 0.3 / \sqrt{2}$)⁴. The calibration with I -band measurements by Mathewson et al. (1992) gave a similar result ($\sigma = 0.22 \text{ mag}$; $n = 424$). The diameters and axis ratios are relatively poor. The standard deviation is $\sigma = 0.1$ for both $\log D_I$ and $\log R_I$.

The catalog is available through the Centre de Données de Strasbourg (CDS). The I -band magnitudes, combined with those from the literature, are available through the LEDA database (<http://leda.univ-lyon1.fr>).

² The genuine magnitudes are isophotal ones but they are (statistically) extrapolated to total magnitudes by the comparison with Mathewson's ones. This may induce a small type dependence.

³ Second Release of the 2MASS survey (Jarrett et al. 2000).

⁴ Without rejection, the standard deviation of $I(\text{DENIS})$ vs. $J(2\text{MASS})$ is 0.3 mag .

Table 2. Beginning of the catalog. The full catalog is available through the CDS.

PGC	Alternate name	RA Dec (2000) h mn s.t ° ' "	I_T	$\log D_I$ D_I in 0.1'	$\log R_I$	PA degrees
PGC0124374	LCRSB235726.1-414205	J000000.2-412522	15.18	0.49	0.03	7
PGC0143101		J000000.8-590047	14.82	0.60	0.11	140
PGC0130936		J000000.8-405412	13.62	0.90	0.35	18
PGC0129171		J000004.2-491652	15.23	0.63	0.37	127
PGC0000007	MCG0-01-014	J000004.5-000500	13.65	0.84	0.09	160
PGC0143106		J000004.8+004654	14.74	0.67	0.19	127
PGC0000010	MCG0-01-015	J000007.8-000226	14.48	0.64	0.10	171
PGC0130029		J000008.8-460450	15.02	0.62	0.22	140
PGC0143113		J000010.8-483126	14.92	0.64	0.14	111
PGC0000020	MCG0-01-016	J000012.7+010712	13.36	0.98	0.08	125
PGC0198787	DUKST409-58	J000013.1-273800	14.50	0.68	0.22	96
PGC0133624		J000013.8-251111	14.68	0.78	0.07	138
PGC0095112		J000014.1-470736	15.31	0.42	0.22	116
PGC0198096	DUKST537-31	J000014.3-251443	14.10	0.69	0.03	29
PGC0890148	NPM1G-17.0526	J000015.3-170048	14.67	0.62	0.11	72
PGC3080166		J000015.7-085328	14.74	0.71	0.33	54
PGC0000021	VIII Zw494	J000016.9-023821	15.47	0.43	0.01	51
PGC1093672	NPM1G-02.0535	J000017.7-022257	13.80	0.82	0.16	113
PGC0143122		J000017.7-400425	15.02	0.56	0.09	138
PGC0129157		J000018.1-472923	13.33	0.91	0.33	98
...	...	...	...	...	...	...

Fig. 2. Histogram of angular separation between DENIS and 2MASS, in Right Ascension and Declination. The differences are respectively $\alpha_{\text{DENIS}} - \alpha_{\text{2MASS}} = -0.420'' \pm 0.009''$ and $\delta_{\text{DENIS}} - \delta_{\text{2MASS}} = -0.076'' \pm 0.009''$.

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Fig. 3. Comparison of $I_T(\text{DENIS})$ vs. J_m magnitudes from 2MASS.

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