ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

NOVEMBER II **1999**, PAGE 89

Astron. Astrophys. Suppl. Ser. **140**, 89–92 (1999)

Galaxy coordinates

II. Accurate equatorial coordinates for 17298 galaxies

G. Paturel[1], **C. Petit**[1], **Ph. Prugniel**[1], **and R. Garnier**[1]

CRAL-Observatoire de Lyon, F-69561 Saint-Genis Laval Cedex, France

Received July 30; accepted September 20, 1999

Abstract. Using images of the Digitized Sky Survey we measured coodinates for 17298 galaxies having poorly defined coordinates. As a control, we measured with the same method 1522 galaxies having accurate coordinates. The comparison with our own measurements shows that the accuracy of the method is about 6 arcsec on each axis (RA and DEC).

Key words: galaxies general — catalogs

1. Introduction

This series of papers is dedicated to the study of galaxy coordinates. In a first paper (Paturel & Petit 1999; Paper I) we calculated the mean error in right ascension (RA also designated as α) and declination (DEC also designated as δ) for the largest catalogues of galaxies. This was a preliminary step allowing us to judge the quality of individual catalogues. This is particularly important for cross-identifying new galaxies with galaxies catalogued many years ago. For instance, let us consider a new galaxy with good coordinates (say with a mean error of a few arcseconds). If it is cross-checked with a galaxy which has only coordinates from e.g. the Morphological Catalogue of Galaxies (MCG, Vorontsov-Velyaminov et al. 1963), for which we know that the mean error is 77 arcsec (Paper I), then a discrepancy of about 3 arcmin is acceptable at the 2-σ level. On the other hand, if it does not match a galaxy measured by Shectman et al. (1996) or Klemola et al. (1994) within about 5 arcsec, the identity of the galaxies cannot be accepted[1].

This knowledge is particularly important when we are managing large galaxy samples, as we are regularly doing with LEDA or HYPERCAT databases (for more information about these databases see http://www-obs.univ-lyon1.fr). The problem becomes crucial when we try to cross-check galaxies from different databases or when we intend to cross-identify more than one million of galaxies in an automatic process.

Unfortunately, many galaxies have not yet received accurate measurement of their coordinates. This pressing need for accurate coordinates has led some groups to measure positions for their own work. Examples include Condon et al. (1982), Schneider et al. (1990), Giovanelli & Haynes (1993) and Corwin et al. (1998). In this paper we use the tools developed in HYPERCAT to measure coordinates from images of the Digitized Sky Survey (DSS). These images were retrieved from the http server of the European Southern Observatory in Münich.

In Sect. 2 we describe the process of measurement. In Sect. 3, we make an evaluation of the external accuracy. In Sect. 4 we give the results for a list of galaxies extracted from the LEDA database. The tables are presented but only a short part of them are printed. The entire tables are available in electronic form via the CDS archives.

2. Description of the method of measurement

Using approximate coordinates of the galaxies to be measured, DSS images are extracted from ESO in Münich. The size of frames is $5' \times 5'$ for galaxies larger than 0.9 arcmin and $3' \times 3'$ for smaller galaxies. If the galaxy is clearly identified, the position of the galaxy center is estimated visually and the

Send offprint requests to: G. Paturel

Tables 1 and 2 are also available in electronic form at CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdweb.u-strasbg.fr/Abstract.html

[1] Of course, the problem is more complex because we have also to consider diameter, axis ratio and position angle of both galaxies.

Table 1. Beginning of the control table. For each galaxy the new J2000.0 coordinates are given first. The second coordinates are those extracted from LEDA and known to be accurate. The full table is available in electronic form

PGC	Name		RA - DEC (2000) This paper	RA - DEC (2000) LEDA
PGC 0000038	UGC	12893	000028.2 + 171309	000028.0 + 171310
PGC 0000186	UGC	3	000246.4 + 185310	000246.4 + 185311
PGC 0000205	UGC	5	000305.7 − 015450	000305.7 − 015447
PGC 0000263	NGC	7816	000348.9 + 072847	000349.0 + 072845
PGC 0000286	UGC	20	000414.5 + 801721	000413.7 + 801705
PGC 0000305	UGC	27	000429.2 + 055046	000429.5 + 055035
PGC 0000364	IC	1529	000513.3 − 113009	000513.2 − 113012
PGC 0000382	ESO	193-19	000528.8 − 501612	000529.0 − 501612
PGC 0000485	NGC	7832	000628.5 − 034258	000628.4 − 034257
PGC 0000499	UGC	48	000637.0 + 475242	000636.9 + 475243
PGC 0000564	NGC	1	000715.9 + 274230	000715.9 + 274232
PGC 0000645	NGC	12	000844.8 + 043645	000844.8 + 043647
PGC 0000654	UGC	79	000904.4 + 253708	000904.3 + 253708
PGC 0000679	NGC	20	000932.7 + 331831	000932.8 + 331835
PGC 0000690	NGC	22	000948.3 + 274956	000947.5 + 274948
PGC 0000800	ESO	293-45	001124.6 − 412353	001124.1 − 412349
PGC 0000875	NGC	43	001300.9 + 305455	001300.9 + 305457
PGC 0000926	ESO	50-6	001358.9 − 700122	001359.4 − 700119
PGC 0000929	NGC	48	001402.2 + 481405	001402.1 + 481407
PGC 0000982	NGC	53	001443.1 − 601941	001441.8 − 601943
...				

corresponding pixel position (X and Y) is interactively determined and converted into Right Ascension and Declination using the polynomial astrometric plate solution given in the header of the FITS file.

3. Evaluation of the accuracy of the method

About 100 galaxies were measured twice using the procedure described in the previous section. The internal accuracy is high, the deviation never exceeding three arcsec in one coordinate. The accuracy is not limited by the polynomial plate solution which gives an uncertainty of a few arcseconds but by the visual estimation of the galaxy center.

In order to quantify this uncertainty, we extracted a list of 1522 galaxies, with accurate coordinates in LEDA and apparent diameter in the range $[1.6' - 1.8']$. This relatively large mean diameter will give an upper value of the standard deviation because the center is more difficult to determine for large galaxies. Besides, it guarantees a better identification because there is generally only one galaxy of that size in a $5' \times 5'$ field. Even if there are two objects, our selected object should be close to the center of the frame owing to the fact that it already has accurate coordinates.

In Table 1 we present this control sample of 1522 galaxies. All the coordinates are given for the equinox 2000 in hours minutes, seconds and tenths for the Right ascension and degrees, arcmin and arcsec for the Declination. This notation (HHMMSS.T ± DDMMSS) will be adopted throughout this paper. For each galaxy the following data are given:
Column 1: PGC number according to LEDA.
Column 2: Alternate name according to LEDA (Paturel et al. 1989).
Column 3: 2000-RA and DEC. from the present paper.
Column 4: Previous 2000-RA and DEC. from LEDA.

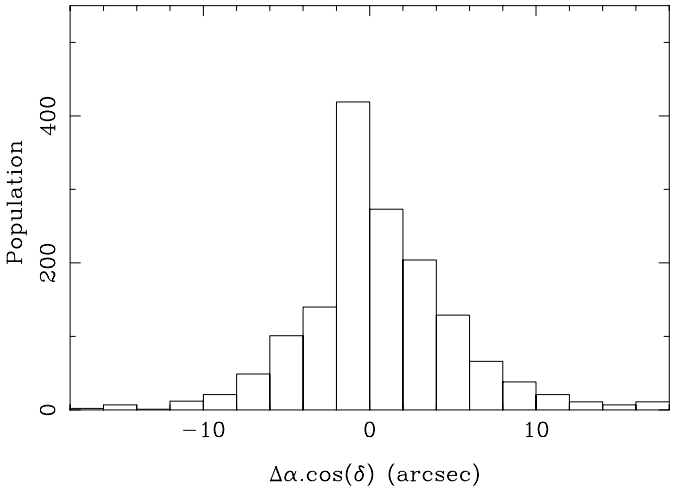

Fig. 1. Histogram of deviations between RA from LEDA and the present measurements

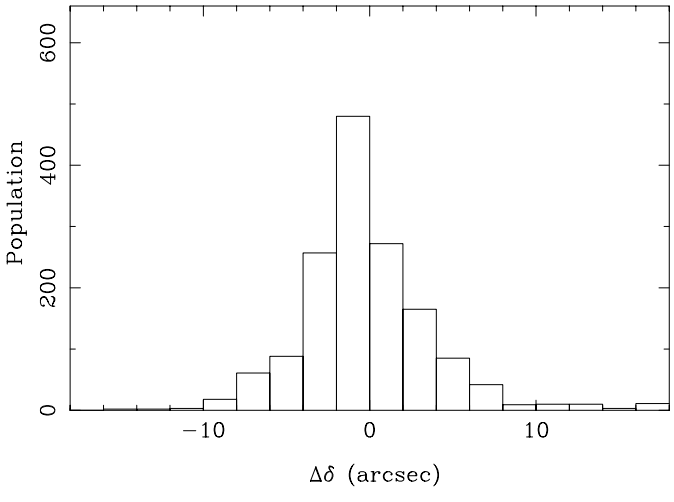

Fig. 2. Histogram of deviations between DEC from LEDA and the present measurements

The full sample is available in electronic form at the CDS.

Figures 1 and 2 present the histograms of the differences between our measurements and those available in LEDA. The following results are obtained:

$$\Delta\alpha \cos\delta = 0.3'' \pm 0.2 \quad \sigma = 7.2'' \quad (n = 1522) \tag{1}$$

$$\Delta\delta = -0.2'' \pm 0.1 \quad \sigma = 5.2'' \quad (n = 1522). \tag{2}$$

There is no significant systematic deviation. The final accuracy on the position is defined from the square root

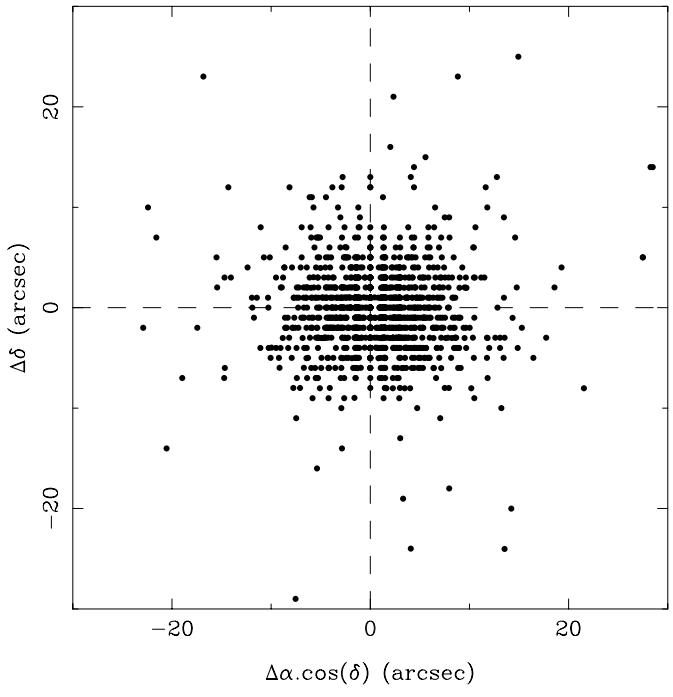

Fig. 3. Distribution of deviations in both RA and DEC by comparing accurate coordinates from LEDA and from the present measurements. Note that the horizontal strips are due to the discretization of values with a 1 arcsec step. This does not appear on x-axis because of the $\cos\delta$ function

Table 2. Beginning of the final table of galaxy coordinates. The full table is available in electronic form

PGC	Name	RA - DEC (2000) This paper
PGC 0000016	MCG -1- 1- 17	000011.3 − 050931 H
PGC 0166785	IRAS23576+6945	000014.3 + 700159 L
PGC 0000025	UGC 12891	000019.2 + 225928 H
PGC 0000031	FAIR 1061	000023.6 − 470107 H
PGC 0000039	UGC 12892	000025.2 + 075118 H
PGC 0000042	FAIR 1062	000026.8 − 423250 H
PGC 0000038	UGC 12893	000028.0 + 171310 H
PGC 0000038	UGC 12893	000028.2 + 171309 L
PGC 0089491		000029.2 − 604050 H
PGC 0000055	UGC 12898	000037.4 + 333605 H
PGC 0000081	NGC 7802	000100.4 + 061436 H
PGC 0000077	MCG 6- 1- 4	000103.7 + 343911 L
PGC 0000080	IC 5375	000104.9 + 043231 H
PGC 0000096	UGC 12903	000108.4 + 062017 H
PGC 0000095	MCG 6- 1- 6	000115.7 + 365810 L
PGC 0000103	UGC 12907	000127.3 + 181128 H
PGC 0000110	UGC 12910	000128.4 + 052322 L
PGC 0000118	MCG 2- 1- 14	000134.0 + 150450 H
PGC 0000148	UGC 12917	000152.4 + 402012 H
PGC 0000147	CGCG 456- 16	000158.0 + 213715 H
PGC 0000094	UGC 12905	000200.4 + 803832 H
PGC 0100355		000201.2 + 145837 L
...		

of the quadratic sum of RA- and DEC-standard deviations, i.e., about 8.9 arcsec. Figure 3 illustrates the distribution of relative deviations. This shows that coordinates in LEDA, classified to be more accurate than 10 arcsec are probably better than this limit. Assuming that they have the same precision as our own measurements gives a standard deviation of 6 arcsec ($8.9/\sqrt{2}$) for both LEDA and the present measurements, i.e., less than 5 arcsec in each direction (RA and DEC). In any case our method gives coordinates which can be classified as accurate according to LEDA's criterion.

4. Results

From the LEDA database we extracted galaxies having coordinates less accurate than 10 arcsec and having a known apparent diameter. The procedure described in Sect. 2 was applied. Sometimes, the galaxy could not be identified in a secure manner, either because several objects were in the field or because of the absence of a visible galaxy. This last case was explained by a discrepancy larger than 3 arcmin or by a poor quality of the image which made the identification difficult. Nevertheless, the identification of the galaxy was made easier by sorting them according to decreasing diameters: the right galaxy has nearly the same diameter as the previous one. Further, we were guided by the axis ratio and position angle extracted from LEDA. The skipped galaxies will be analyzed later in a more detailed manner (larger field and measurement of all galaxies in the field). Finally, 6771 galaxies were measured. In addition, another sample of 9322 galaxies was measured with a similar method with the purpose of checking the master list of galaxies indexed in HYPERCAT. When coordinates come from both sources (L and H) a simple mean can be used because both methods are assumed to have the same weight.

In Table 2 we present the final list of 17615 accurate coordinates for 17298 galaxies. The sources are the following: 1522 galaxies come from our control sample, 6771 galaxies come from the LEDA index and 9322 from HYPERCAT. 317 galaxies are in common between the two lists. The following data are given:
Column 1: PGC number according to LEDA.
Column 2: Alternate name according to LEDA (Paturel et al. 1989).
Column 3: 2000-RA and DEC. from the present paper.
Column 4: label L for galaxies from LEDA, H for HYPERCAT.

After having loaded these coordinates, 162702 galaxies have accurate coordinates in our LEDA database among the 184431 ones (i.e. 88%). Another campaign of measurement will be needed.

Acknowledgements. We thank H.G. Corwin for his careful reading of the manuscript.

We made use of the ESO facility in Münich for retrieving images from the Digitized Sky Survey produced at the Space Telescope Science Institute under US Government grant NAG W-2166. It is based on photographic data obtained using The UK Schmidt Telescope and the Palomar Sky Survey.

The UK Schmidt Telescope was operated by the Royal Observatory Edinburgh, with funding from the UK Science and Engineering Research Council, until 1988 June, and thereafter by the Anglo-Australian Observatory. Original plate material is copyright (c) the Royal Observatory Edinburgh and the Anglo-Australian Observatory. The plates were processed into the present compressed digital form with their permission.

References

Condon J., Condon M., Gisler G., Puschell J., 1982, ApJ 252, 102

Corwin H.G.Jr, Pesenson I., Schmitz M., et al., 1998, PASP 110, 779

Giovanelli R., Haynes M., 1993, AJ 105, 1271

Klemola A.R., Hanson R.B., Jones B.F., 1994, Bull. Am. Astron. Soc. 26 (2), 898 (NPM)

Paturel G., Fouqué P., Bottinelli L., Gouguenheim L., 1989, A&AS 80, 299

Paturel G., Petit C., 1999, A&A (in press)

Schneider S., Thuan T.X., Magri C., Wadiak J., 1990, ApJS 72, 245

Shectman S.A., Landy S., Oemler A., 1996, ApJ 470, 172

Vorontsov-Velyaminov B.A., Arkipova V.P., Kranogorskaja A.A., 1963-1974, Morphological Catalogue of Galaxies, Trudy Sternberg Stat. Astr. Inst. 32, 33, 34