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Research Note

Revised positions for CIG galaxies⋆

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Abstract. We present revised positions for the 1051 galaxies belonging to the Karachentseva Catalog of Isolated Galaxies (CIG). New positions were calculated by applying SExtractor to the Digitized Sky Survey CIG fields with a spatial resolution of 1.″2. We visually checked the results and for 118 galaxies had to recompute the assigned positions due to complex morphologies (e.g. distorted isophotes, undefined nuclei, knotty galaxies) or the presence of bright stars. We found differences between older and newer positions of up to 38″ with a mean value of 2.″96 relative to SIMBAD and up to 38″ and 2.″42 respectively relative to UZC. Based on star positions from the APM catalog we determined that the DSS astrometry of five CIG fields has a mean offset in (α, δ) of (–0.″90, 0.″93) with a dispersion of 0.″4. These results have been confirmed using the 2MASS All-Sky Catalog of Point Sources. The intrinsic errors of our method combined with the astrometric ones are of the order of 0.″5.

Key words. surveys – astrometry

1. Introduction

The evolutionary history of galaxies can be strongly influenced by the environment. Therefore a definition of "isolated galaxy" is needed before one can properly assess the history and properties of interacting or peculiar ones. This motivated us to assemble a well-defined and statistically significant sample of isolated galaxies to serve as a comparison template in the study of galaxies in denser environments (Verdes-Montenegro et al. 2001, 2002, 2003; Lisenfeld et al. 2002a,b). We will make public all obtained data for this sample via the web at http://www.iaa.csic.es/AMIGA.html where the results from this paper can be already retrieved. Our working sample is drawn from the Catalog of Isolated Galaxies (CIG, also referred as K73 in SIMBAD and KIG in NED databases) which originally contained $n = 1051$ galaxies and was selected on the basis of the distance to the nearest similarly sized galaxies (no other galaxy within 4 times its diameter and within a distance of 20 times their size; Karachentseva 1973; see also Sulentic 1989). Later the sample was reduced to $n = 893$ galaxies (Karachentseva 1980), the rest showing less strict degrees of isolation. During preparatory work on the survey we searched for CIG positions in the SIMBAD database and noticed shifts with respect to the central positions of the galaxies, reaching in some cases up to several tens of arcseconds. This fact not only prevents accurate pointings for reduced fields of view, but also makes cross-identifications with other available catalogs more difficult. We then searched the Updated Zwicky Catalogue (UZC; Falco et al. 1999) whose accuracy peaks at 1″ with a width of 1.″45, as estimated after matching with the FIRST 1.4 GHz catalog (White et al. 1997). Still in a preliminary exploration mode we found CIGs with positional errors larger than 10″ in the UZC (see Sect. 2). This motivated us to revise the positions of the entire CIG in a systematic way. We decided to provide positions for the entire catalog without consideration of any isolation criterion. In Sect. 2 we explain our method and compare our results with other surveys and in Sect. 3 we give notes for individual galaxies. Our conclusions are presented in Sect. 4.

2. New CIG positions

We obtained Digitized Sky Survey (DSS) red images of all CIG galaxies in J2000 coordinates, with pixel sizes of 1.″2 and $6' \times 6'$ fields. The images were analyzed in an automatic procedure using the SExtractor software (Bertin & Arnouts 1996) for sources brighter than 4σ the background level. Those closer to the original CIG position were automatically selected but later revised visually in order to confirm that we had targeted

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⋆ Full Table 1 is only available in electronic form at the 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/411/391

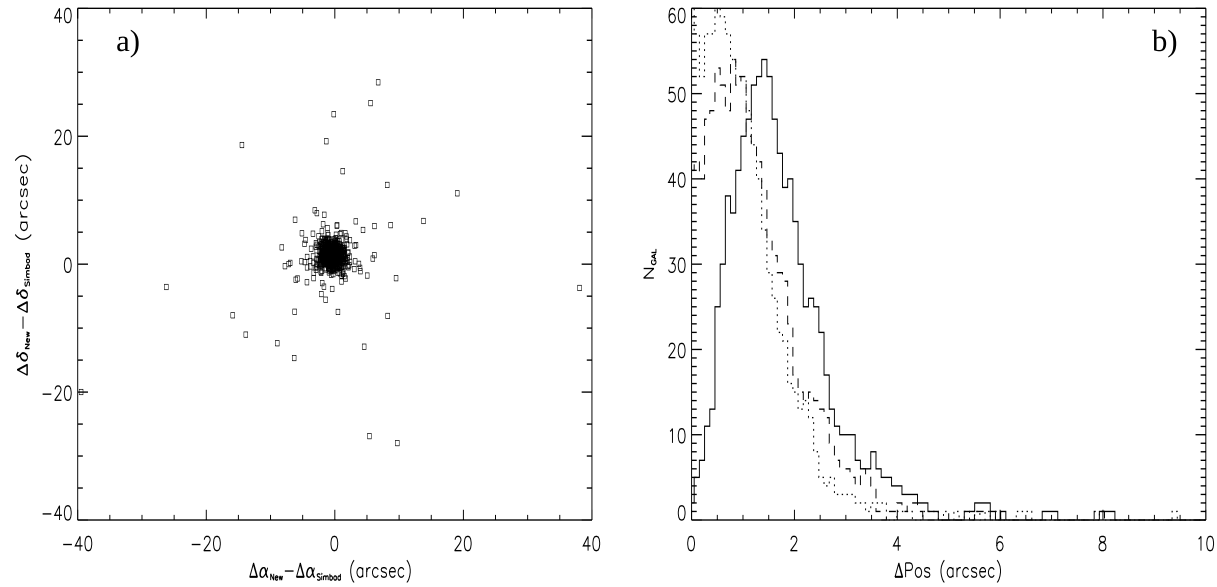

Fig. 1. a) Differences between our measured positions and those retrieved from SIMBAD for the CIG galaxies. **b)** Histogram of the difference between the new positions and the SIMBAD positions for the α (dotted line), δ (dashed line) coordinates and the total distance (solid line) in arcsec. The plotted range is restricted to 10″ for clarity of the plot.

the right galaxy. The internal error of the position fit is better than 0.″05.

Once the automatic process was done, a visual check of the SExtracted positions was performed for all the galaxies. In 118 cases we had to recompute the assigned positions due to one of the following problems: 1) 4σ isophote not indicative of the nucleus positions (e.g. distorted isophotes), 2) ill-defined (low contrast) nucleus, 3) presence of brighter off-centered regions (e.g. irregular/clumpy galaxies), a star superposed on the galaxy, and 4) in 3 cases the galaxy was in fact a misclassified globular cluster or a dwarf galaxy of the Local Group (CIG 388, 781 and 802, see Sect. 3) and we have excluded them from the statistics of our study. Problematic positions have been recomputed in a second iteration following one of two procedures: (a) changing the SExtractor parameters (σ threshold and background rms determination) in order to select the most regular isophote or the brightest central region according to the galaxy morphology/central brightness distribution; (b) visually in the five cases where a star was interfering with the galaxy image (see Sect. 3).

We calculated the differences found in α and δ between our estimated positions and those obtained from SIMBAD (see Fig. 1). The difference G in (α, δ) position is fitted by a 2D Gaussian as follows:

$$G(\alpha, \delta) = C + K * \mathrm{e}^{-\frac{1}{2}\left[\left(\frac{\alpha-\alpha_0}{\sigma_\alpha}\right)^2 + \left(\frac{\delta-\delta_0}{\sigma_\delta}\right)^2\right]}. \quad (1)$$

The dispersion in position differences relative to SIMBAD is isotropic with $(\sigma_\alpha, \sigma_\delta) = (0.''75, 0.''78)$, as can be seen in Fig. 1a. The histograms of the α, δ and total difference are shown in Fig. 1b: the total difference has a dispersion of 2.″96 with a maximum of 38″ between the two positions for CIG 239. We also find a shift between our estimates and SIMBAD positions of $(\alpha_0, \delta_0) = (-0.''76, 1.''01)$. We discuss below error sources including the possible origin of the found shift.

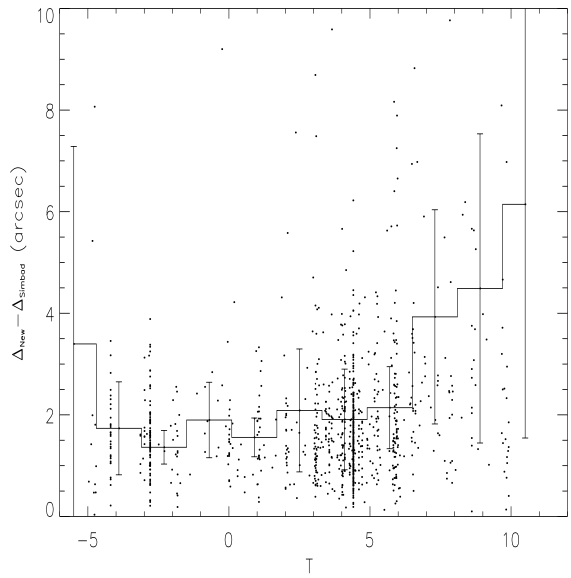

Fig. 2. Differences between our measured positions and those retrieved from SIMBAD for the CIG galaxies as a function of the morphological type T. A binned average (solid line) as well as 1σ dispersion (error bars) are also shown.

The internal positional error of SExtractor is <0.″05. The two larger sources of errors are associated with the optical morphology of the galaxies and the DSS astrometry. The dispersion introduced by the smaller bulge galaxies is evident when we compare (Fig. 2) the position differences between SIMBAD and this work against the morphological type T of the galaxies (de Vaucouleurs et al. 1991, with $-5 \leq T < 0$ for E/S0 galaxies, $0 \leq T < 9$ for the spiral galaxies and $T \geq 9$ for the irregular ones). The differences are clearly increasing from ∼1.″5 up to ∼4.″5 from the early type galaxies with a large bulge towards the irregular galaxies. The two extreme

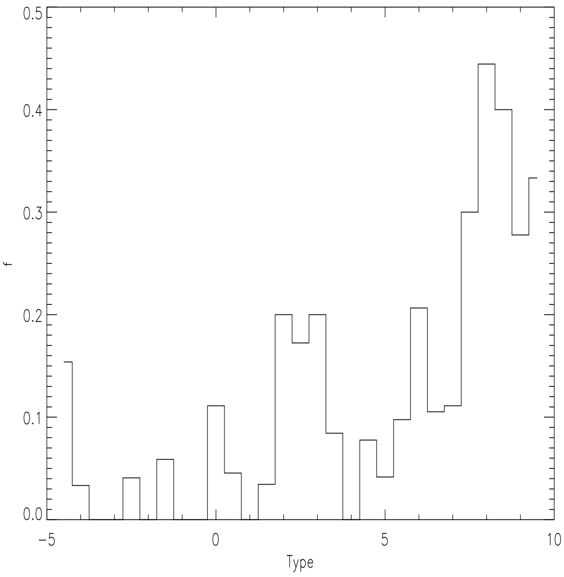

Fig. 3. Fraction of galaxies of a given morphological type that we had to reprocess due to the problems described in Sect. 2.

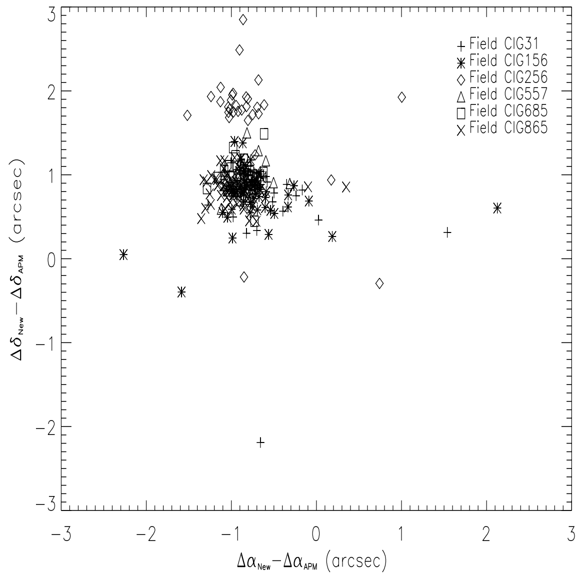

Fig. 4. Differences between our measured positions and those retrieved from the APM catalogue for the sources extracted in the six CIG fields indicated in the upper right corner of the plot.

values are highly dispersed mainly because of the low number of galaxies falling in the bin. In fact the majority of the 118 problematic galaxies that we had to reprocess have late morphological types (Fig. 3). The associated errors are difficult to estimate, but affect only 10% of the total sample.

In order to analyze DSS astrometry we selected 6 different CIG fields spread over the sky and compared the positions of 762 stars extracted from these fields with positions from the APM catalogue (Automated Photographic Measuring, Maddox et al. 1990) which was calibrated using more than 200 PPM (Catalogue of Positions and Proper Motions, Roser & Bastian 1991) astrometric standards per Palomar field, reaching an accuracy of 0.″5 (e.g. Arnouts et al. 1999). The differences in coordinates are shown in Fig. 4 for the 6 CIG fields. A mean offset, similar to the one found previously, is still present, with the exception of the CIG 256 field which has an extra offset in δ of ∼0.″7. We have fitted the mean offset (α, δ) as previously, excluding the CIG 256 field: a mean value of (–0.″90, 0.″93) is found with a dispersion of 0.″4. This value is consistent with the offset we found between SIMBAD and DSS extracted positions, suggesting that it was introduced by the DSS astrometry. We performed a complementary check using the 2MASS All-Sky Catalog of Point Sources via VizieR Service at CDS and found 931 sources closer than 3″ to the CIG corrected positions. The differences between our CIG measured positions corrected by the mean offset of (–0.″90, 0.″93) and those retrieved from the 2MASS catalog for these sources (Fig. 5) have a mean value of $(\alpha, \delta) =$ (–0.″16, –0.″00) with a dispersion of (0.″82, 0.″88). This comparison hence supports the applied astrometric correction and the mean error due to astrometry based on this analysis is estimated to be at the 0.″5 level.

After this correction we compared the new positions with the 749 galaxies in common with the UZC. Figure 6 shows the difference in (α, δ) coordinates between our revised positions and the UZC. The dispersion in both coordinates α and δ are small (3.″2, 2.″5) with a total dispersion of 20.″42. Nevertheless

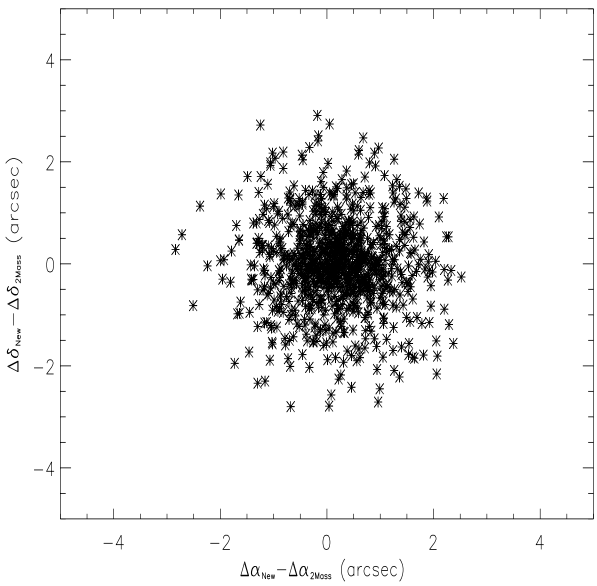

Fig. 5. Differences between our CIG measured positions and those retrieved from the 2MASS All-Sky Catalog of Point Sources after correcting for a mean offset of (–0.″90, 0.″93) for the (α, δ) coordinates (see Sect. 2).

the mean offset in the (α, δ) is only (–0.″17, 0.″06), negligible for the accuracy targeted. The maximum difference between our new positions and the UZC reaches 38″ for CIG 402 where a very bright star is interfering with the galaxy. In Fig. 7 we illustrate the differences found between our measured positions and the ones given in UZC with two examples.

The new positions are given in Table 1 for the first 10 galaxies and the rest are available in electronic form at the CDS or in our public database available from `http://www.iaa.csic.es/AMIGA.html`. Column (1) gives the CIG identification, Col. (2) alpha and delta in B1950

Table 1. CIG positions determined from DSS images.

CIG	α(1950)			δ(1950)			α(2000)			δ(2000)			σ threshold[1]
1	0	00	31.92	–2	11	33.8	0	03	5.63	–1	54	51.6	30
2	0	00	46.30	29	31	8.0	0	03	20.37	29	47	50.2	
3	0	00	47.77	30	30	13.4	0	03	21.86	30	46	55.7	
4	0	01	24.75	20	28	26.5	0	03	58.77	20	45	8.7	30
5	0	05	19.86	20	08	2.8	0	07	54.30	20	24	44.6	
6	0	06	20.00	23	32	21.1	0	08	54.70	23	49	2.8	29
7	0	08	32.54	2	23	59.5	0	11	6.39	2	40	40.8	
8	0	09	34.64	11	46	2.9	0	12	9.04	12	02	44.0	
9	0	10	4.23	5	13	38.2	0	12	38.26	5	30	19.2	
10	0	10	24.24	38	58	4.0	0	13	0.74	39	14	45.0	

[1] The σ threshold used in SExtractor for the source detection is indicated when different from the 4σ value chosen by default. A "V" appears when the positions was visually estimated and an "E" when the object was excluded from our study as explained in Sect. 2.

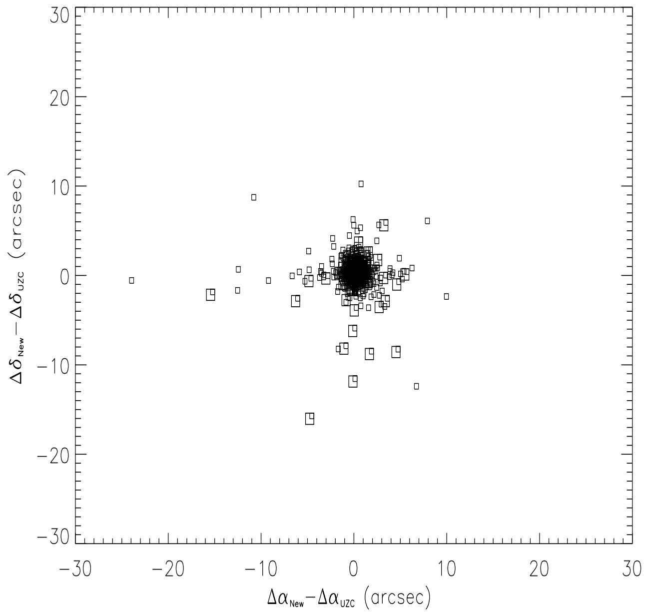

Fig. 6. Differences between our CIG measured positions and those retrieved from the UZC after correcting for a mean offset of (–0.″90, 0.″93) for the (α, δ) coordinates (see Sect. 2). We have excluded two points with larger differences in benefit of a clearer plot. Large squares correspond to visually inspected galaxies.

coordinates, Col. (3) alpha and delta in J2000 coordinates and Col. (4) the σ threshold for the source detection when different from the 4σ value chosen by default. *V* indicates a position estimated visually while *E* identifies the three excluded objects.

3. Notes on individual galaxies

CIG 63 - Center undefined, eccentric bright peak was chosen.
CIG 190 - Center obtained from a 5σ isophote since the galaxy appears faint with an ill-defined nucleus.
CIG 235 - Center obtained from a 20σ isophote due to the knotty morphology of the galaxy.
CIG 239 - Center undefined, fitted with a 25σ threshold on the optical peak of the bright eastern feature.
CIG 261 - Center fitted with a 30σ threshold on the offcentered bright peak.
CIG 388 - This is a Local Group member (Sextans B).
CIG 402 - Center defined visually because of a bright star close to the object.
CIG 523 - Center fitted with a 20σ threshold on the brightest central cluster.
CIG 530 - Diffuse galaxy, undefined center.
CIG 569 - Clumpy galaxy, center fitted with a 25σ threshold on the central bright cluster.
CIG 621 - Offcentered nucleus.
CIG 649 - Center defined visually because of a bright star close to the object.
CIG 781 - Not a galaxy but the globular cluster Pal 5.
CIG 802 - This is a Local Group member (Draco).
CIG 810 - Center defined visually because of a star overlapping with the center of this edge-on galaxy.
CIG 853 - Center fitted with a 40σ threshold on the brightest region on the west side.
CIG 883 - Center defined visually because of a star overlapped with this galaxy.
CIG 928 - Center fitted with a 20σ threshold on the northern object close since the Southern object appears to be a star.
CIG 947 - Offcentered nucleus, fit to the 22σ isophote.
CIG 959 - Center defined visually because of a star overlapped with this galaxy.
CIG 967 - Extended bright center, fit to the 20σ isophote.
CIG 977 - Center fitted with a 10σ threshold on the Northern bright region.
CIG 1036 - Center fitted with a 25σ threshold on bright region of this distorted galaxy.

4. Conclusions

The CIG galaxies' positions have been recomputed for the whole sample (1051 galaxies) using an automatic procedure of source extraction on the DSS images plus a visual check. The comparison with previous positions from the SIMBAD database shows an average offset of $(-0.''76, 1.''01)$ for the (α, δ) coordinates with a dispersion in the difference in position of $3.''0$. A check with the APM positions of stars in different CIG fields, and with sources in common with the 2MASS All-Sky Catalog of Point Sources shows that this offset is due to the

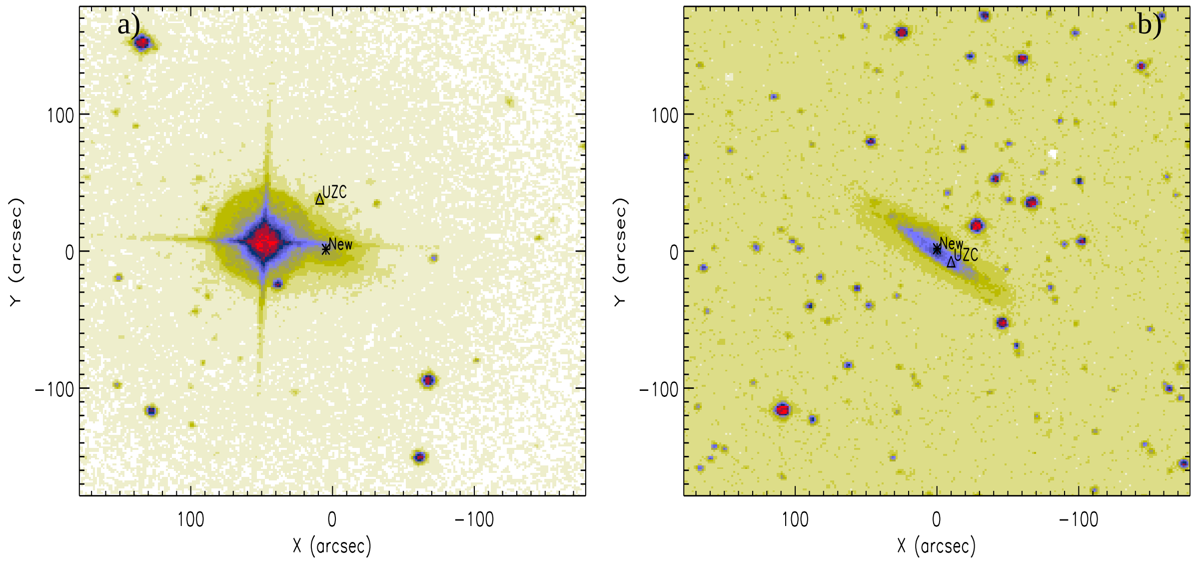

Fig. 7. DSS image of the **a)** CIG 402 field, where a bright star is superposed on the galaxy and **b)** CIG 828 field. The stars indicate our newly calculated positions, whereas the triangles correspond to the UZC position.

DSS astrometry. This mean offset has been corrected in our derived positions. The comparison with the UZC arcsec accuracy positions on 749 overlapping galaxies shows a negligible mean offset, with a dispersion of ~2.″4. Taking into account the internal error from SExtractor and the error from astrometry, these new positions are correct within an error of ~0.″5 for 90% of the CIG galaxies. For the rest of galaxies the errors are linked with late morphological types that required an interactive reprocessing of the data.

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