Surface Photometry of two Virgo Cluster Galaxies

Kārlis Bērziņš*and Eira Kotoneva†

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*VIRAC, e-mail: kberzins@acad.latnet.lv, †Tuorla Observatory, e-mail: eianko@astro.utu.fi

1 Introduction

Our task was to derive the surface photometry of two Virgo galaxies, NGC4459 and NGC4477, in Johnson $B-$ and $R-$bands. We have defined their effective radii, mean surface brightnesses, total magnitudes, colours and colour gradients.

The data was obtained in 1998 using the 1.8m telescope in McDonald Observatory, USA, with the total integrated exposure time of 308.9 and 183.58 sec in the $B-$ and $R-$ bands, respectively.

2 Photometrical Analysis

We have used CCD images that were already reduced and calibrated and our job was to mask other objetcs, eg. bright stars and galaxies from the images and fit the ellipses. This kind of fitting is possible because the assumption that elliptical galaxies are following the so called $r^{\frac{1}{4}}$ law (de Vaucoulers, 1948). The analysis was done using the IRAF program and packages within.

First we identified the objects on our images. After that we selected (masked) them in order to account their effect to the galaxy photometry. Especially, one should take care about nearby galaxies and close bright stars. For example although faint galaxies seem to have much less effects to a main galaxy than bright stars they actually do not, because galaxies are extended objects and stars are point sources.

After the masking procedure, we were modeling intensities of galaxies by fitting them with ellipses. This task was done by using *ellipse*-package inside IRAF. At the beginning of this procedure, one defines a center of galaxy and its size, then it was separated from the background. This was iteratively repeated.

To calculate the effective radius r_e and mean surface brightness $<\mu_e>$, the relation between the colour and $r^{\frac{1}{4}}$ was defined. Our selected results are represented in Fig. 1-4 and in the Table 1. The effective mean surface brightness is defined by (cf. Caon *et al.*, 1993)

$$<\mu_e>= A + c_n - 1.39, \tag{1}$$

where $c_n = 8.3268$ is some empirical constant, and the effective surface brightness radius as

$$r_e = \left(\frac{c_n}{B}\right)^n, \tag{2}$$

where $n = 4$ and the following equation was used for the surface profile fit:

$$\mu = A + B \cdot r^{1/n}, \tag{3}$$

where A and B are linear fitting coefficients, and r is projected radius from a center of galaxy. The total magnitude can be calculated as:

$$m_T =< \mu_e > +2.5\log(2\pi r_e^2). \tag{4}$$

The colour is defined as $\mu_B - \mu_R$, i.e. the difference between $B-$ and $R-$band surface brightnesses, respectively.

We have obtained the following values for the colour gradients (cf. Fig. 3): For NGC 4459 it is -0.07 ± 0.01 and for NGC 4477 it is -0.08 ± 0.005.

	A	B	$log(r_e)$	$< \mu_e >$	m_T	$log(r_e)^1$	$m_T{}^1$
NGC4459 B-band	14.17 ± 0.04	3.38 ± 0.01	1.59	21.11	11.18	1.55	11.32
NGC4459 R-band	12.57 ± 0.02	3.36 ± 0.01	1.58	19.51	9.63	$--$	$--$
NGC4477 B-band	14.06 ± 0.05	3.47 ± 0.03	1.52	20.99	11.37	1.58	11.38
NGC4477 R-band	12.27 ± 0.02	3.60 ± 0.01	1.45	19.21	9.93	$--$	$--$

[1] Values are taken from the internet NED database.

Table 1: Photometrical parameters for NGC4459 and NGC4477 in Johnson $B-$ and $R-$bands.

3 Disscussion

We had obtained quite nice galaxy surface models. The residuals, however, are not perfect because galaxies actually do not follow perfectly $r^{1/4}$ law. The residuals can be quantified in terms of Fourier transformation coefficients, which were calculated by the IRAF ellipse package. We see that NGC 4459 can be fitted very well by eliptical functions. However, NGC 4477 has large deviations indicating that its surface brightness can not easilly fit by elliptical functions at least at larger radii (cf. Fig. 4). Some other possible sources of uncertainties are introduced during the masking of other objects because this step can be done in many different ways. To obtain the best results, from the fitting procedure the very center of galaxies (which are effected by seeing) and their edges (that contain larger signal to bacground noise) were not used. Comparing our results to publicly available ones we conclude that they are in a good agreement (cf. Table 1).

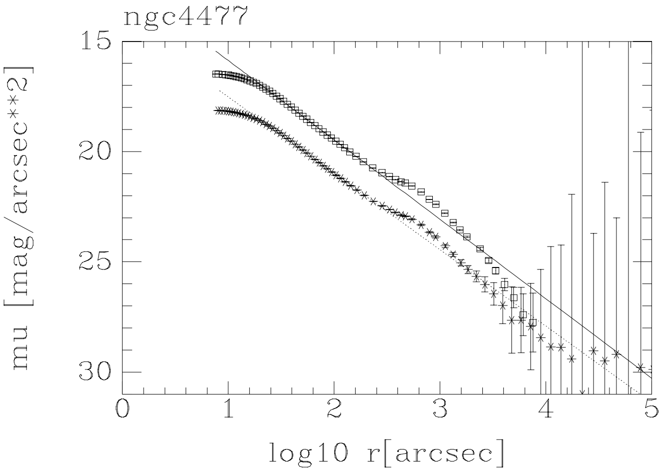

Figure 1: The local effective surface brighness vs. radius for NGC 4477. Boxes correspond for the $R-$ and stars for the $B-$ band.

References

[1] de Vaucouleurs, G., 1948, Ann. Astrop., 11,247

[2] Caon, N. *et al.*, 1993, MNRAS, 265,1013

[3] NED, http://nedwww.ipac.caltech.edu/

[4] Simbad Astronomical database http://simbad.u-strasbg.fr/Simbad/

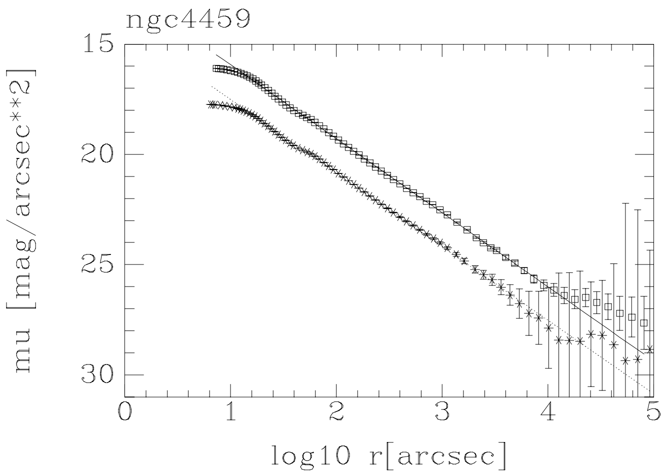

Figure 2: The local effective surface brighness vs. radius for NGC 4459. Boxes correspond for the $R-$ and stars for the $B-$ band.

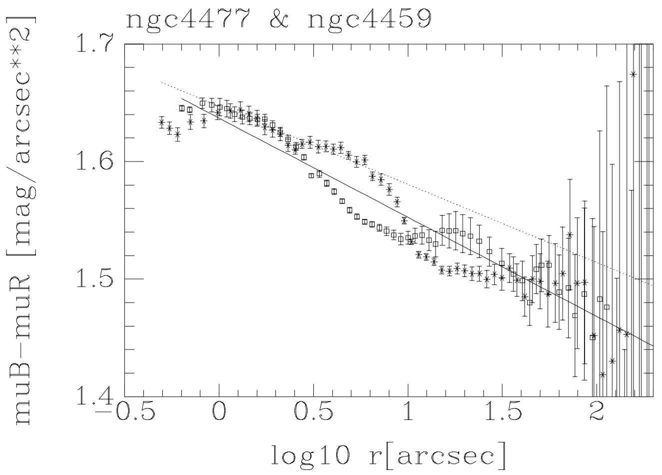

Figure 3: The color $\mu_B - \mu_R$ vs. radius for NGC 4459 (crosses) and NGC 4477 (boxes).

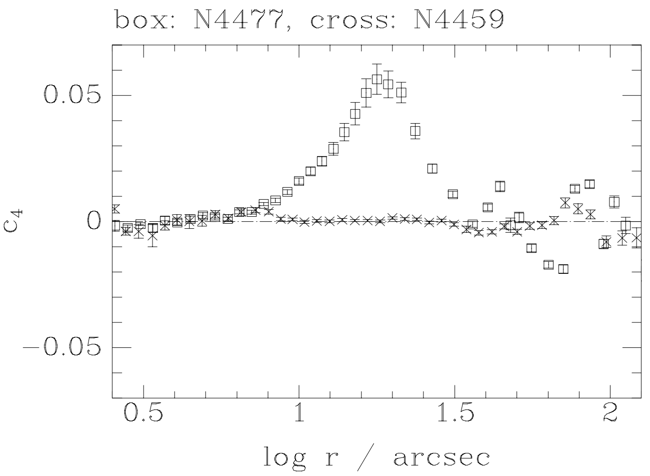

Figure 4: The Fourier c_4 coefficients (corresponding to the cos term) vs. radius show deviations from the elliptical mode for NGC 4459 (crosses) and NGC 4477 (boxes).