Photometry of bright objects in the M31 bulge

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Abstract. We present precise BVR photometry of ∼100 bright objects (foreground Galactic stars, globular clusters and M31 stars) with the aim to establish a standard system over $\sim 5\times 5$ arcmin^2 central field of the M31 bulge. On R-band images the aperture photometry was carried out in two independent regimes: with and without subtracted GALFIT model of the bulge unresolved light. Accounting for the bulge brightness gradient improves twice the photometric accuracy. We compare our results with a recent comprehensive photometry from Local group galaxy survey and found systematic differences less than 0.06 mag in all pass-bands.

Key words: bulge, M31, standard stars, photometry [3]

Фотометрия на ярки обекти в балджа на галактиката М31

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Представена е прецизна BVR фотометрия на ∼100 ярки обекта (звезди от Галактичния фон, кълбовидни купове и звезди от галактиката М31) с цел създаване на система от стандарти в поле с размер $\sim 5\times 5$ arcmin^2, обхващащо централната област от балджа на галактиката М31. Изпробвани са два подхода за фотометрия в ивицата R: класически и с изваждане на непрекъснатата компонента на балджа. Сравнението на резултатите с представителна многоивична фотометрия от Обзора на Местната група галактики (LGGS) показва систематични разлики по-малки от 0.06 зв. вел.

Introduction

The central region of M31 galaxy provides the opportunity plenty of interesting astrophysical objects to be studied in the optical range: novae, Mirids and other variable stars, AGB stars, globular clusters, double M31 nucleus, etc. It's monitoring allows not only to check the photometric behavior of these objects but to address intriguing issues like identification of X-ray sources and novae search in globular clusters. Thus, a system of standards in this field will facilitate the photometry. Both high gradient and high surface brightness of the bulge, however, impede the precise photometry.

Fortunately, by the means of the two-dimensional image decomposition program GALFIT (Peng et al. 2002), we are able to achieve better accuracy via fitting and subtraction of the continuous bulge profile.

[3] This investigation is based on observing material and facilities of the Rozhen NAO, operated by the Institute of Astronomy of the Bulgarian Academy of Sciences

1 Observational data and photometry

We examined numerous CCD-images covering a $\sim$5$\times$5 arcmin^2 area in the central region of M31 bulge and standard fields of Stetson (2000), obtained in two seasons (2004-2005) with 2m telescope at NAO Rozhen, through BVR filters (the data were taken with two different CCD detectors - Photometrics AT200A and VersArray 1300B). Aperture photometry and astrometry for all objects with signal to noise ratio >5 were performed with standard routines in IRAF. The complete number of detected objects on the "rough" images (left panel in Fig.1) with BVR photometry is 105 and their magnitude limits are $B_{lim}\sim20^m$ and $R_{lim}\sim19^m$. Part of the results is shown in Table1, available entirely in electronic form upon a request.[4]

Table 1. Photometry of 105 bright objects in M31 bulge (sample).

Number of object	RA(J2000.0) *(deg.)*	Dec(J2000.0) *(deg.)*	B *(mag.)*	σ_B *(mag.)*	V *(mag.)*	σ_V *(mag.)*	R *(mag.)*	σ_R *(mag.)*
....								
11	10.732841	+41.237871	20.62	0.09	19.44	0.06	18.88	0.08
12	10.737950	+41.238908	19.75	0.03	18.66	0.03	17.86	0.03
13	10.653603	+41.239498	18.50	0.02	17.38	0.02	16.67	0.02
....								

In order to check and to avoid the influence of the strong gradient we modeled (middle panel in Fig.1) the R-band bulge surface brightness distribution with GALFIT package using de Vaucouleurs profile as an initial approximation and subtracted it from the "rough" image. Thus, many details of the dust component of the bulge became prominent (right panel in Fig.1). The aperture photometry on this image reveals 39 bright objects in common with 105 objects, detected earlier.

2 Results and discussion

Comparison between the R-band photometry performed on the "rough" and subtracted images is shown in Fig.2. On the left panel, where the magnitudes are compared, the lack of any systematic difference between these two samples is obvious. In the same time, the right panel reveals that the photometric errors are twice smaller for the photometry performed on the image where the unresolved bulge component has been accounted for.

Deep photometry of the resolved stellar content of M31 has been carried out on CCD mosaic images by Massey et al. (2006). We compared the BVR magnitudes from the two photometric studies in Fig.3. Since (i) the LGGS stars closest to bulge center are detected at $\sim$1.5 arcmin distance and (ii) 16 stars seems to be resolved blends by Massey et al. (2006) we were limited to only 21 common objects. The mean systematic differences are 0.006 in B-band, –0.003 in V-band and 0.059 in R-band.

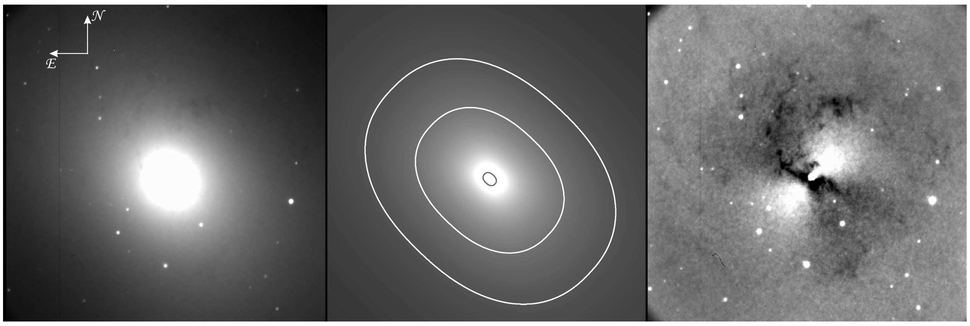

Fig. 1. "Rough" R-band image 5×5 arcmin^2 centered on M31 bulge after basic reduction (left panel), GALFIT model with isophotes superimposed (middle panel) and difference "image-model" (right panel). The outermost isophote corresponds to $\mu_R \sim 17^m/\Box''$, the next - $\mu_R \sim 16^m/\Box''$ and the innermost - to $\mu_R \sim 15^m/\Box''$. The surface brightness at the center of the model is $\sim 14.5^m/\Box''$.

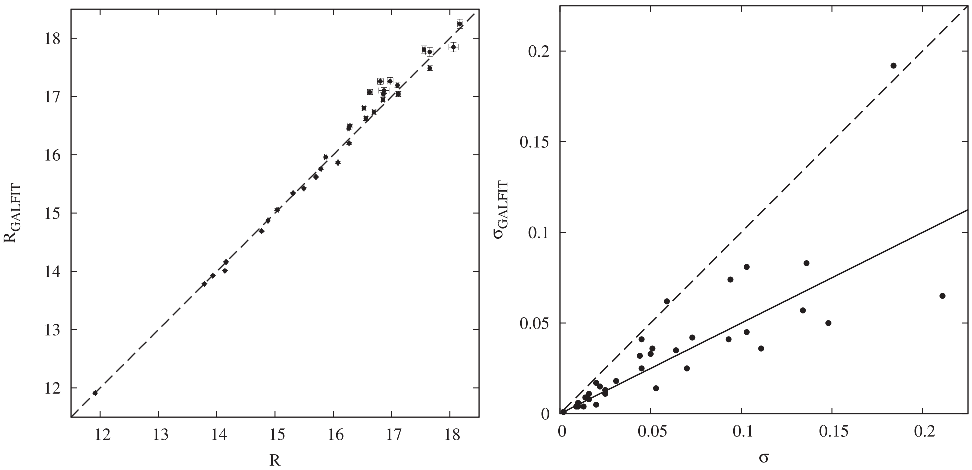

Fig. 2. Comparison between the R-band photometry performed on the "rough" and subtracted images.

Our survey results in 105 bright individual objects with BVR photometry in the bulge of M31 which can be used as standards. The comparison with an external photometry of Massey et al. (2006) confirms the reliability of our data. One way to improve the photometric accuracy is to account for the brightness distribution of the bulge by making use of GALFIT package.

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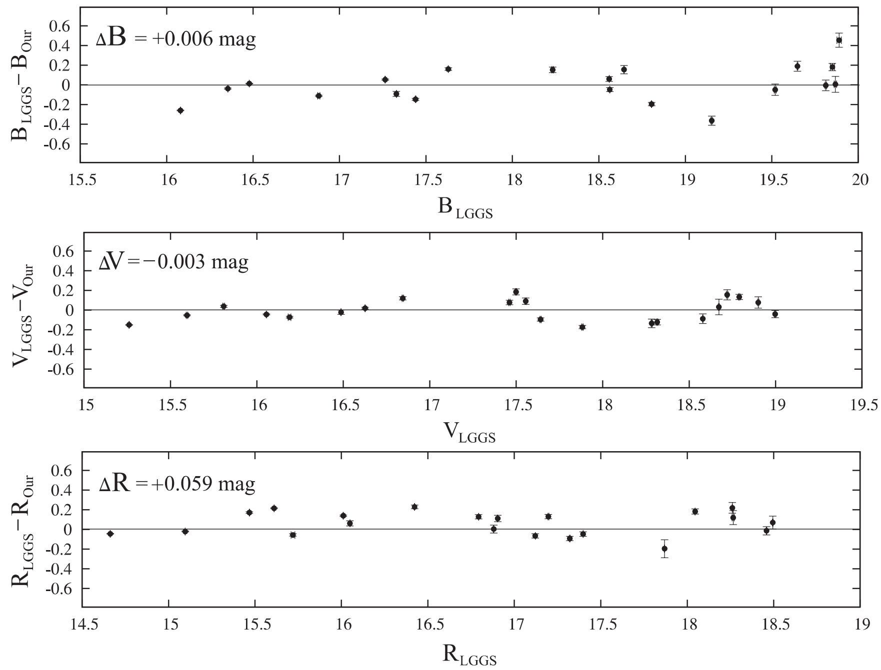

Fig. 3. Comparison between our photometry, performed on unprocessed with GALFIT CCD images and that of Massey et al. (2006) of M31 in B- (top panel), V- (middle panel) and R-bands (bottom panel). The mean systematic differences are shown.

References

de Vaucouleurs G., 1958, *ApJ, vol. 128, p. 465*
Massey et al., 2006, *AJ, vol. 131, p. 2478*
Peng et al., 2002, *AJ, vol. 124, p. 266*
Stetson P., 2000, *PASP, vol. 112, p. 925*