

# Deep Optical Photometry of Two Nearby Elliptical Galaxies: NGC 4473 and NGC 4697

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## Abstract

We present deep optical photometry of two nearby elliptical galaxies: NGC 4473 and NGC 4697, obtained with new 1.4m Milanković telescope, mounted at the Astronomical Station Vidojevica (Serbia). For both galaxies we derive surface brightness profiles up to 7 and 3 effective radii, respectively (limited solely by our field of view) to obtain deep color (B-V) gradients. Also, we perform 2D decomposition of galaxy images into Sersic components.

## Introduction

The problem of dark matter (DM) emerged from studies of galaxies and in the past decades a lot of effort has been put into constraining the amount of this invisible matter. Although it is firmly believed that DM dominates the mass of late-type galaxies, early-type galaxies (ETGs) presented more complicated picture. Samurović(2014) proposed there might be two classes of ETGs: one with negligible content of DM and the other with stellar matter dominated by DM in their outer parts.

In our paper (Samurović and Vudragović 2018, submitted) we test Newtonian and MOND methodologies on two nearby ETGs: NGC 4473 and NGC 4697. The motivation for obtaining deep photometry came from the fact that galaxy color is needed for comparison of the mass-to-light ratio from the stellar population synthesis (SPS) models to the estimated dynamical mass-to-light ratio. To that end, obtained the images of NGC 4473 and NGC 4697 in B- and V-band to infer their colors as far from the centre as possible. Previous B-V colors of these two galaxies were measured up to  $\sim 3R_e$  for NGC 4473 (Idiart et al. 2002) and  $\sim 1R_e$  for NGC 4697 (Poulain & Nieto 1994).

## Observations

- NGC 4473:  $\alpha=12h29m48.88s$   $\delta=+13d25m45.55s$
- NGC 4697:  $\alpha=12h48m35.89s$   $\delta=-05d48m02.50s$
- Observations carried out from 19 to 21 April 2018 in B- and V-band
- Telescope: 1.4m Milanković telescope + Apogee U40 CCD camera
- For NGC 4473: 24 (22) images were taken in B(V) bands
- For NGC 4697: 26 (23) images were taken in B(V) bands
- Exposure time in most of the images: 180s and in some 300s

## Photometric Calibration

- Data reduction: IRAF
- Astrometric solution: Astrometry.net (Lang et al. 2010)
- Photometric calibration  $\rightarrow$  UCAC4 catalog
  - IRAF's daofind: pixel stellar coordinates
  - WCSTools (Mink et al. 1997) xy2sky: celestial stellar coordinates
  - TOPCAT (Taylor 2005): UCAC4 (Zacharias et al. 2013) catalog of stars in the same FOV
- IRAF's ellipse: surface brightness profiles and color profiles

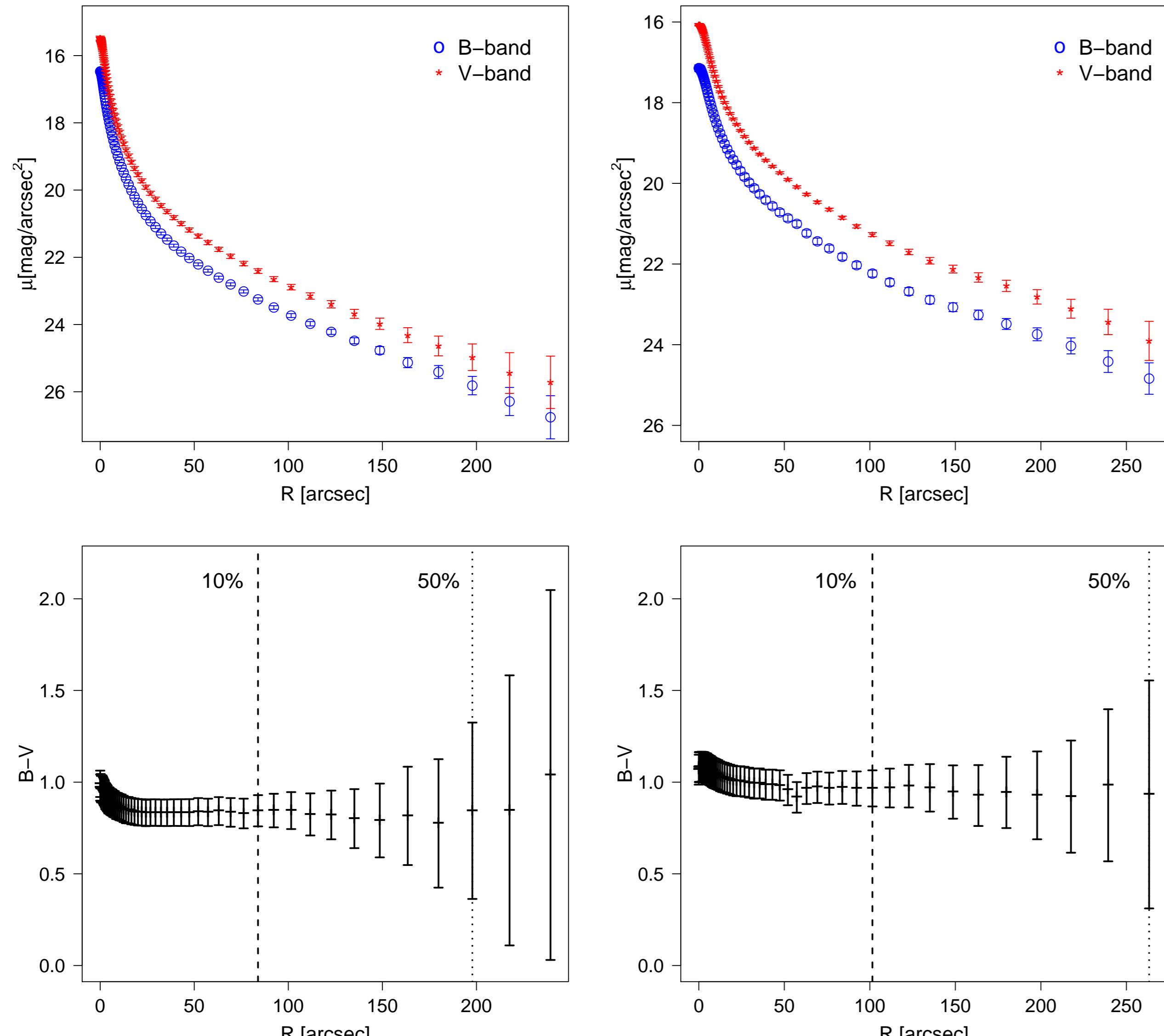


Figure 1: Upper panel: Surface brightness profiles of NGC 4697 and NGC 4473 galaxies, respectively. Both B- and V-bands are plotted. Lower panel: B-V colors of NGC 4697 and NGC 4473 galaxies, from left to right. The percentages indicated with vertical lines refer to the relative error in color.

## Results

We used Galfit code (Peng et al. 2010) to study the structure of our two galaxies in details.

- SExtractor (Bertin & Arnouts 1996): initial parameter setup and mask image
- IRAF's psf task: point spread function image creation

Component	$\mu_{eff}$ [mag $^{1/2}$ ]	$R_{eff}$ [ $''$ ]	n	b/a	PA
<b>NGC 4473</b>					$\chi^2 = 199$
Sersic1	22.14	68.85	1.00	0.56	-87.09
Sersic2	18.67	11.05	2.40	0.57	-85.26
<b>NGC 4697</b>					$\chi^2 = 12$
Sersic1	22.32	106.16	0.86	0.51	59.65
Sersic2	19.92	23.72	1.95	0.61	69.72

Table 1: Best fitting parameters are given for both galaxies. Multiple Sersic components are labeled with 1 and 2.

## 2D Image Decomposition

### NGC 4473

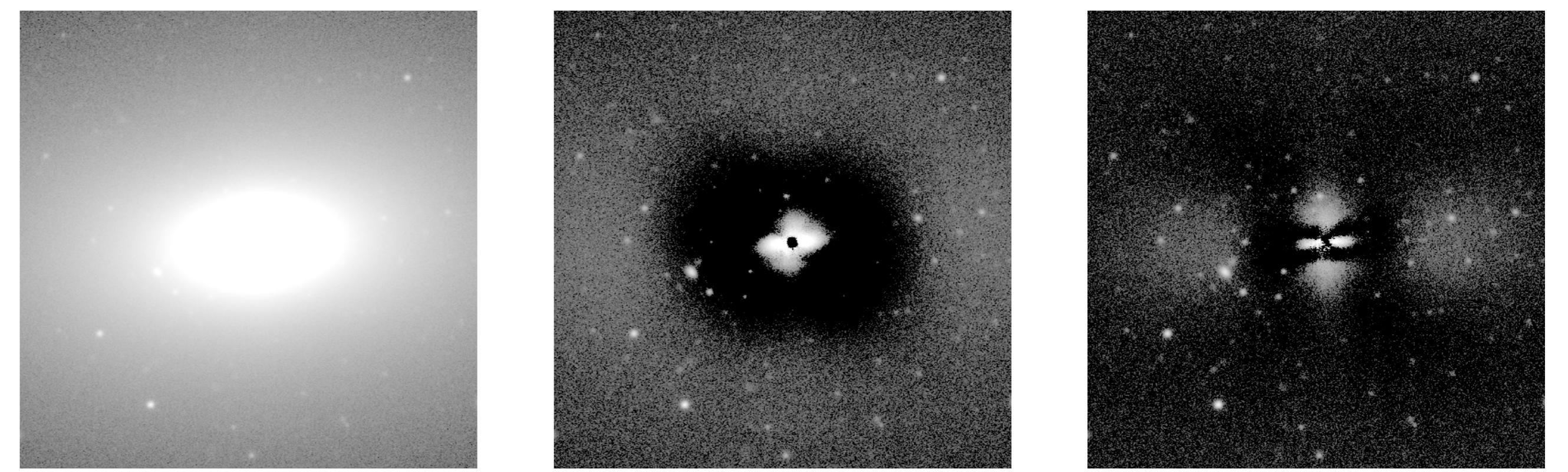


Figure 2: V-band image of NGC 4697 galaxy is given in the left, followed by the residual images resulted from fitting with: (center) single and (right) double Sersic components.

### NGC 4697

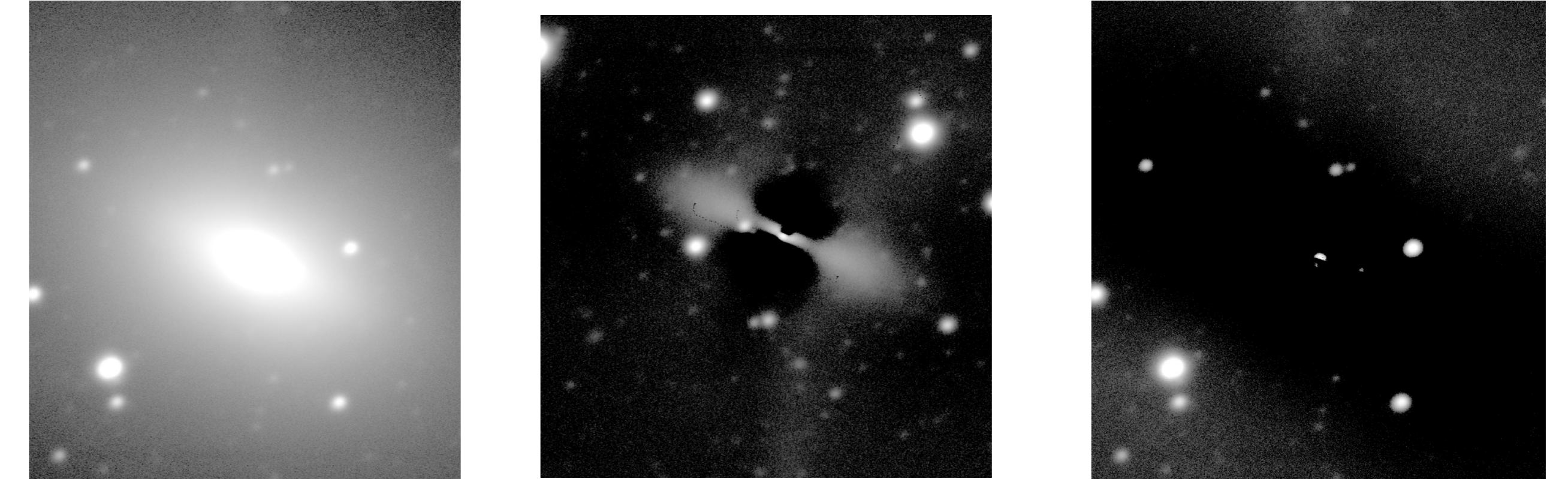


Figure 3: V-band image of NGC 4697 galaxy is given in the left, followed by the residual images resulted from fitting with: (center) single and (right) double Sersic components.

## Conclusions

- Colors of NGC 4473 and NGC 4697 galaxies are measured up to approximately  $\sim 7R_e$  ( $= 218''$ ) and  $\sim 2.7R_e$  ( $= 263''$ ), respectively.
- Both galaxies have Sersic indices  $n \approx 1$ , so they are disk-like, and they have bulges that are at the limit with Sersic indices  $n \approx 2$  to be classified as pseudobulges.

## References

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## Acknowledgements

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through project no. 176021, “Visible and Invisible Matter in Nearby Galaxies: Theory and Observations”. We acknowledge the financial support by the European Commission through project BELISSIMA (BELgrade Initiative for Space Science, Instrumentation and Modelling in Astrophysics, call FP7-REGPOT-2010-5, contract No. 256772) which was used to procure the “Milanković” 1.40 m telescope with the support from the MESTDRS. We thank the MESTDRS for the continued support of the ASV. We acknowledge use of computing resources of PARADOX supercomputing facility at the Scientific Computing Laboratory of the Institute of Physics Belgrade. We thank the technical operators at the Astronomical Station Vidojevica (ASV), Miodrag Sekulić and Petar Kostić for their excellent work.