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#### Photometric and spectral investigation of candidates for polar-ring galaxies

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# PHOTOMETRIC AND SPECTRAL INVESTIGATION OF CANDIDATES FOR POLAR-RING GALAXIES

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Some results of the observational investigation of four candidates for polar-ring galaxies (PRGs) are reported.

KEY WORDS Galaxies, peculiar, photometry, spectroscopy, UGC 4332, UGC 5600, ZGC 2315+03, NGC 6286

## 1 INTRODUCTION

During the last decade the observational program of studying the Northern objects from the 'Catalog of polar-ring galaxies, candidates and related objects' (Whitmore *et al.*, 1990) has been carried out at the Astronomical Institute of St. Petersburg University. All observations were obtained at the prime focus of 6-meter telescope of the Special Astrophysical Observatory. Photometry was carried out in  $B$ ,  $V$ ,  $R_c$  passbands; spectral data were obtained with the long slit spectrograph UAGS. In both cases a CCD was used as a detector.

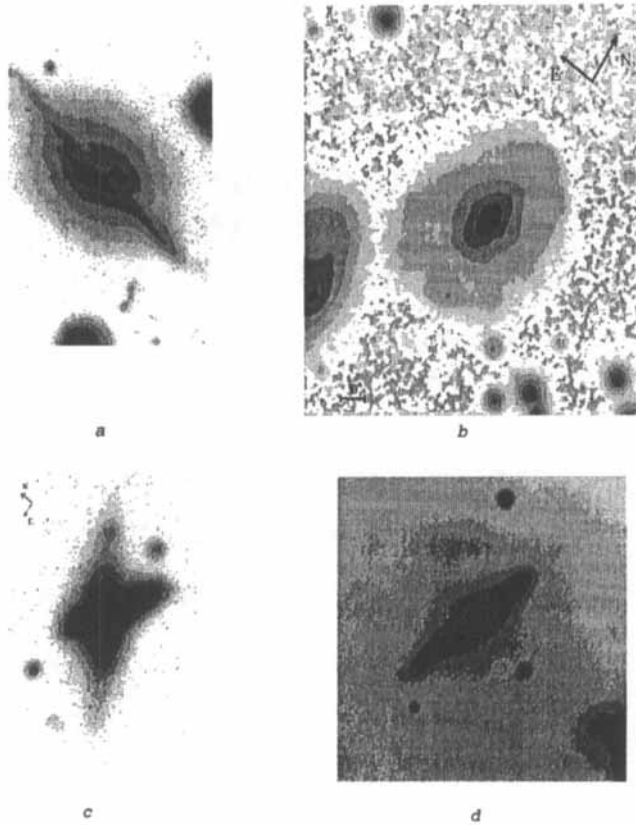
The reductions were carried out by the standard method using the ESO-MIDAS package.

Here we dwell on some results for four studied objects - candidates for PRGs. Their images in the  $B$  passband are given in Figure 1.

## 2 RESULTS

### 2.1 UGC 4332

Only detailed photometry was carried out by us for this galaxy. Though UGC 4332 has been included in the catalog of Whitmore *et al.* (1990) as a possible candidate



**Figure 1** Images of the four studied objects – candidates for PRGs: *a* – UGC 4332, *b* – UGC 5600, *c* – ZGC 2315+05, *d* – NGC 6286.

for a PRG, its form bears a strong resemblance to the edge-on ‘Sombrero’ galaxy with a dust lane. Analysis of isophotes confirms this resemblance. One can see an extensive bulge and weak spiral arms which were suggested by Whitmore *et al.* to be a possible polar ring. The only distinction of UGC 4332 from ‘Sombrero’ is the complex structure of its dust lane (see Figure 1 top-left picture).

The results of photometry show that according to luminosity and colors UGC 4332 may be related to early-type spirals.

The comparison of its photometric profiles and isophotes with the results of numerical calculations (Byun *et al.*, 1994) allows us to estimate its inclination ( $i \approx 85^\circ$ ) and the optical depth of dust layers ( $\tau \approx 0.5$ ). The estimation of extinction in  $B, V, R_c$  regions obtained from the asymmetry of photometric profiles along the minor axis allows us to conclude that for UGC4332 the reddening curve and, consequently, the characteristics of dust are the same as in our Galaxy. The details of investigation of this galaxy were published by Yakovleva *et al.* (2000).

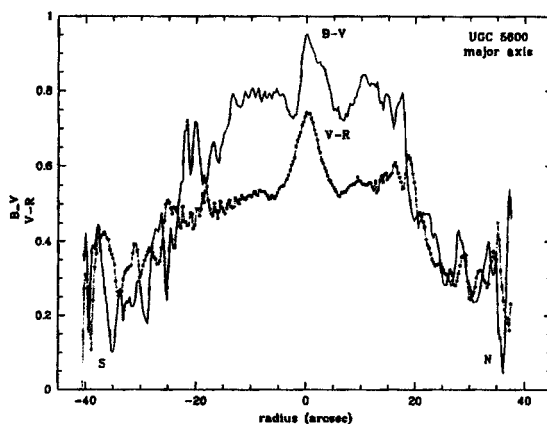


Figure 2 Color profile along the major axis of the galaxy UGC 5600.

## 2.2 UGC 5600

Included in catalog of Whitmore *et al.* (1990) as a good candidate for a PRG is UGC 5600 (Figure 1 top-right picture). According to our photometric investigation, it indeed has a blue inner polar ring seen nearly edge-on. It is visible as a ‘swelling’ of the isophotes along the minor axis of the main body of the galaxy and is even better seen in the color profile along the major axis of the galaxy (Figure 2) as minima at the distances  $\pm 5''$  from the center.

The main body of the galaxy seen nearly face-on is a stellar disk by brightness distribution and colors. It is surrounded by an extended outer envelope of knotty structure. In color properties and morphology this structure is, indeed, spiral arms. According to Reshetnikov and Combes (1994) UGC 5600 is rich in gas. The existence of a polar ring in a gas rich spiral galaxy is surprising. The results of detailed investigation of the galaxy are in press (Karataeva *et al.*, 2001).

## 2.3 ZGC 2315+05

This object, considered by Zwicky (1971) as posteruptive galaxy, was included in the catalog of Whitmore *et al.* (1990) as a possible candidate for a PRG. The results of our spectral observations and preliminary data of photometry show that both crossing structures are independent spiral galaxies. The first is bluer (this was suggested by Whitmore *et al.* (1990) as a polar ring) and the second (with a dust lane) redder. Our spectral data show that the dynamical centers of both don't coincide and the redshifts differ by  $40 \text{ km s}^{-1}$ . We think that the galaxy with a dust lane (its redshift is lesser) is projected onto the blue one. Undisturbed isophotes in uncrossed parts of the object and the good shape of the rotation curves confirm this suggestion. A paper devoted to this object is also in press (Karataeva *et al.*, 2000).

### 2.4 NGC 6286

NGC 6285/86 is an interacting double system with an angular distance between the components of  $1.5'$  (33 kpc). The results of its photometric investigation have been published in Reshetnikov *et al.* (1996) where it was supposed that NGC 6286 is a galaxy with a polar ring forming as the result of gas streaming from NGC 6285.

Preliminary results of our spectral observations carried out in 5 position angles (from  $34^\circ$  – major axis – to  $133^\circ$ ) show that in the North part the radial velocity curves probably reflect the gas rotation around the minor axis but in the South part there are non-circular motions. The dynamical and photometric centers of the galaxy don't coincide, which is not surprising because the brightness distribution is disturbed by dust extinction.

Variations of the relative intensities of emission lines  $H_\alpha$  and [N II] as well as a difference in the radial velocities of these lines point to the existence of several gas subsystems.

## 3 CONCLUSIONS

Thus, our results show that many candidates for PRGs from the catalog of Whitmore *et al.* (1990) are peculiar galaxies of different types, each in its own way. Further investigation of these galaxies is of great interest.

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