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Spectral study of peculiar galaxies

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Abstract. A study of five peculiar galaxies (SPRC-69, SPRC-100, SPRC-260, SPRC-269, and SPRC-136) from the new catalog of polar ring galaxies (Sloan-based Polar Ring Catalog, SPRC). Panoramic (3D) spectral data were obtained with the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences with the using the Fabry–Perot interferometer. The large-scale velocity fields, velocity dispersion fields, and monochromatic images of objects in the Hα emission line were analyzed in detail. All galaxies showed the complex structure and kinematics of their gaseous components. The "tilted-ring" method was used to analyze the velocity fields. It was concluded that all the objects studied belong to are classical polar ring galaxies, with the exception of SPRC-100.

Keywords: galaxies: peculiar, structure, kinematics and dynamics, individual (SPRC-69, SPRC-100, SPRC-260, SPRC-269, SPRC-136)

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1 Introduction

One of the most unique and beautiful types of peculiar objects is a polar ring galaxy (PRG), which is a system consisting of a disk of the main galaxy and an outer ring of gas, dust, and stars rotating approximately in the perpendicular plane. This paper is devoted to the results of the spectral study of five peculiar galaxies (SPRC-69, SPRC-100, SPRC-260, SPRC-269, and SPRC-136) that are candidates for PRGs, selected from the Sloan-Based Polar Ring Catalog (SPRC, Moiseev et al. 2011).

The observations of the objects under study were performed at the primary focus of the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences using the Fabry–Perot interferometer (FPI) (Afanasiev et al. 2005; Moiseev 2015). The large-scale velocity fields, velocity dispersion fields and monochromatic images of the ionized gas were constructed by gaussian fitting of the Hα emission line profiles. The "tilted-ring" method (Begeman 1989) was used to analyze the velocity fields.

2 Results and discussion

2.1 SPRC-69

Optical images from SPRC-69 (II Zw 092) show that an outer, highly inclined ring surrounds the central body.

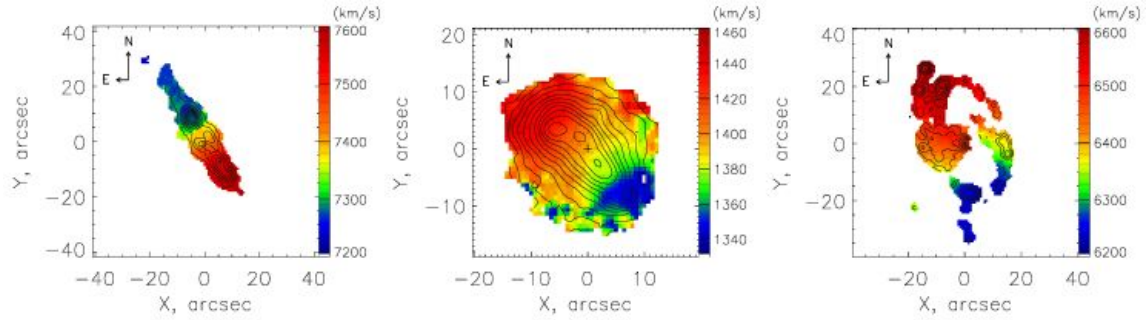

Fig. 1. Line-of-sight velocity fields in the Hα line with contours of the Hα image of the galaxies: SPRC-69 (left), SPRC-100 (centre), SPRC-260 (right).

The velocity field in the Hα emission line (Fig. 1, left) is typical of disk structures: lines of equal radial velocity (isovels) indicate rotation around the major axis of the galaxy. The stellar velocity field (obtained from the MaNGA[1] survey) has also been

[1] https://www.sdss4.org/surveys/manga/

analyzed using the "tilted-ring" method. An angle between the planes of the ionized gas of the ring and the stellar disk of the main body was estimated: $\Delta i \approx 83°$. Our study of SPRC-69 using 3D spectral data confirmed the conclusion that SPRC-69 belongs to the PRG, which was made in Moiseev et al. (2011) using long-slit data. The maximum rotational velocity ($V_{\max} = 104$ km/s), the stellar velocity dispersion (≈ 100 km/s), the mass of the stellar disk ($\geq 5.2 \cdot 10^9 M_\odot$), and the gas of the main body is concentrated in its central part allowed us to suggest that the main body of SPRC-69 is a lenticular galaxy (S0).

2.2 SPRC-100

The optical images of SPRC-100 (CGCG 124-041) show a slightly curved, central galaxy surrounded by an elliptical, roughly perpendicularly elongated envelope. The velocity field in the Hα emission line (Fig. 1, centre) is typical for disk galaxies: isovels indicate rotation of the ionized gas around the minor axis of the galaxy. Analysis of the 3D spectral data for SPRC-100 has shown that no kinematically decoupled subsystems are observed in it, and therefore, SPRC-100 most likely does not belong to the PRGs. The value of $V_{\max} \approx 77$ km/s and the mass estimate ($\geq 1.7 \cdot 10^9 M_\odot$) are in agreement with the results of Ciesla et al. (2014), where it is assumed that this object is a BCD (Blue Compact Dwarf) galaxy.

2.3 SPRC-260

The optical images of SPRC-260 (CGCG 068-056) show a disk-shaped central body with an extended ring around it. The velocity field in the Hα line (Fig. 1, right) shows the rotation of the ring structure: the southern side is approaching the observer, while the northern side is moving away. The analysis of photometric and spectral data for SPRC-260 has shown that at least two systems are observed in it. One of them is associated with a central stellar system elongated in the E-W direction. The second is associated with a gaseous ring rotating at an angle of 62° or 112° to the stellar system. So SPRC-260 can probably be classified as a PRG. The disky shape of the central body and the small amount of gas allowed us to suggest that the main body of SPRC-260 is an S0 type galaxy.

2.4 SPRC-269 and SPRC-136

SPRC-269 and SPRC-136 (Fig. 2, left) form a pair of interacting galaxies, VV328. Both objects are candidates for the PRG. The velocity field of the gaseous component of SPRC-269 (Fig. 2, centre) shows the general direction of rotation of the ring: the southern side is moving away from us, and the northern side is approaching

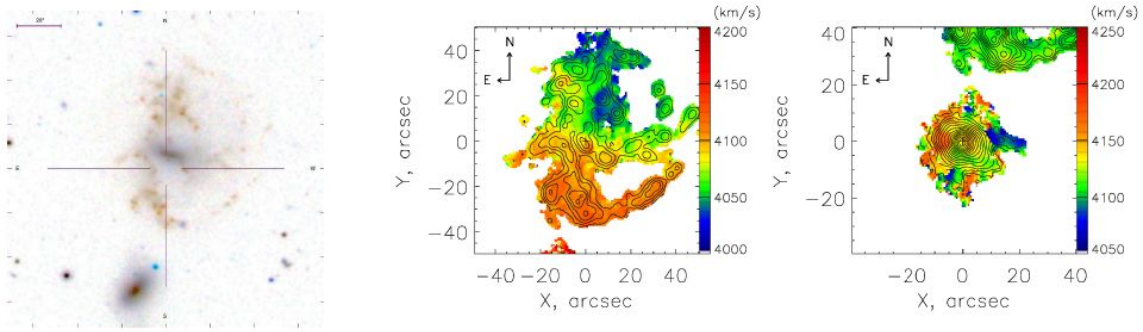

Fig. 2. Left: the *gri* composite image of SPRC-269 and SPRC-136 from the SDSS (http://www.sdss.org/). Middle: the line-of-sight velocity field of SPRC-269 in the Hα line with contours from the Hα image. Right: the line-of-sight velocity field of SPRC-136 in the Hα line with contours from the Hα image.

us. Analysis of the photometric and spectral data for SPRC-269 has shown that it contains at least three systems are observed in it: 1) a central stellar disk with $PA_{kin} = 75°$, 2) a central gaseous disk, inclined relative to the stellar disk with $PA_{kin} = 215°$, 3) an outer warped gaseous ring with PA_{kin}, varying from 155° to 175°; and the angle between the stellar disk and the gas ring is 55° or 102°. Therefore, SPRC-269 can probably be classified as a PRG. Almost the entire velocity field of SPRC-136 (Fig. 2, right) was described with two models. The kinematic parameters ($PA_{disk} = 328°$, $i_{disk} = 40°$ and $PA_{ring} = 55°$, $i_{ring} = 55°$) indicate for the presence of a polar ring rotating around the major axis of the main body.

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