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The dynamics in the inner kpc of the lenticular galaxy IC 676

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Abstract. Lenticular galaxies play an important part in the morphology classes. Their detailed study provides important information with regard to the formation and evolution of the different morphological types of galaxies. Here we investigated a barred lenticular galaxy IC 676, which has double nuclei in its inner kpc region. Based on the integral-field spectroscopy data, we presented the dynamics in the central region of IC 676, and tried to explore the nature and formation of its double nuclei.

Keywords. galaxies: kinematics and dynamics, galaxies: structure

1. Introduction

It is known for a long time that lenticular galaxies (S0s) present an intermediate morphology on the Hubble tuning fork diagram. They appear to be armless disk galaxies, but show smooth appearance like ellipticals. In addition, they also have little signs of star formation and limited amount of gas (Caldwell *et al.* 1993). However, the evolution mechanisms of S0s is still matter of debate. Recent observations have revealed that the properties of these galaxies are not as simple as those was identified by early visual classifications, they actually span a wide range in properties of star formation, stellar populations, and kinematics (Gao *et al.* 2018).

In order to assess the physical processes in the evolution of S0 galaxies, we use optical integral field spectroscopic observations to investigate IC 676, a barred S0 galaxy with Hubble type (R)SB0(r). There is active star formation in the central region of IC 676, and it has a high HI-based star formation efficiency (Zhou *et al.* 2018), while it appears as early-type morphology (Contini *et al.* 1998). Furthermore, this galaxy harbors double nuclei in its central region, while it is not likely to be a merger candidate in group or pair environment (Yuan *et al.* 2010). Therefore, an analysis of IC 676 would set important constraints to the evolution of S0 galaxies.

2. Method and results

We use the data archived from ATLAS^{3D} project (Cappellari *et al.* 2011). The data were observed with SAURON integral-field spectrograph (IFS) mounted on the William Herschel Telescope on La Palma.

Figure 1 illustrates the continuum image, flux maps of Hβ and [OIII] emissions for IC 676. The continuum image is reconstructed directly from the SAURON data cubes. The double nuclei are marked with "+" (for the southern nucleus) and "×" (for the northern nucleus). The southern nucleus shows obvious more continuum luminosity than the northern one, while has much less luminosity of the Hβ and [OIII] emission lines, which may indicate more active star formation in the northern region.

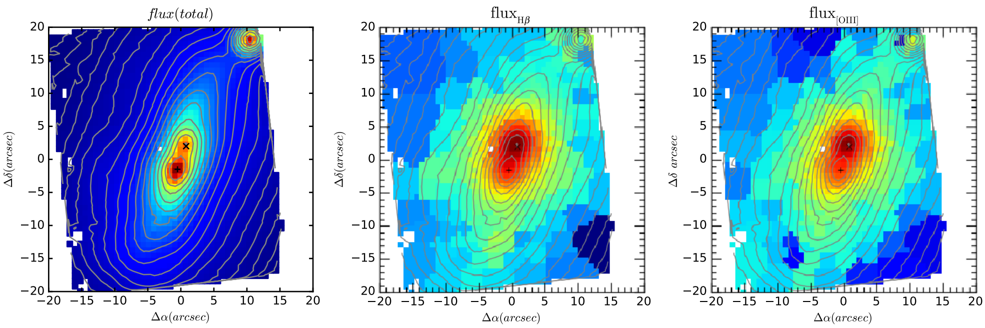

Figure 1. Flux maps for IC 676. From left to right: the continuum image reconstructed from the SAURON data cubes, Hβ emission map, and [OIII] emission map. The contours derived from the continuum image are overlapped on the three panels. The double nuclei are marked with "+" (for the southern nucleus) and "×" (for the northern nucleus).

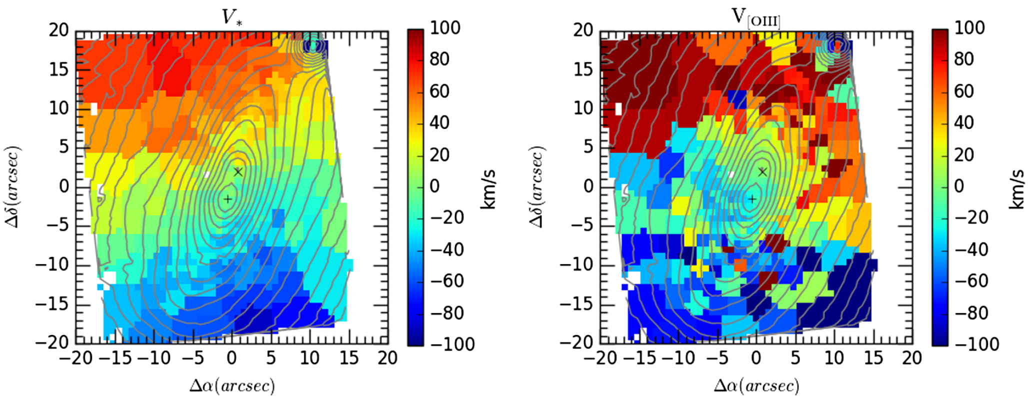

Figure 2. Stellar and gas kinematics for IC 676. Left: stellar velocity map. Right: gas velocity map from [OIII] emission line. The contours overlapped are derived from the continuum image. Two nuclei are marked with "+" and "×", respectively.

Figure 2 presents the stellar and gas kinematics for IC 676. The gas velocity is derived from [OIII] emission line. The centroid velocities range from -100 to 100 km s^1 for both stars and gas in IC 676. There are nevertheless significant misalignment between the kinematic and photometric axes. The stellar velocity map shows a position angle of about 45 degree with respect to the galactic bar, while the gas kinematic axe is likely perpendicular to the stellar bar. The triggering process for the misalignment is not clear, and further analysis is still needed.

Acknowledgements

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