

The Story of UGC 11919: An Unusual Spiral Galaxy Possibly Having a Warp and Peculiarly Low Mass-to-Light Ratio

A. S. Saburova,¹ G. I. G. Józsa,^{2,3} A. V. Zasov,¹ D. V. Bizyaev,^{4,1} and R. I. Uklein⁵

¹*Sternberg Astronomical Institute, Lomonosov Moscow State University, Moscow, Russia*

²*Netherlands Institute for Radio Astronomy, Dwingeloo, The Netherlands*

³*Argelander-Institut für Astronomie, Universität Bonn, Bonn, Germany*

⁴*New Mexico State University and Apache Point Observatory, Sunspot, NM, USA*

⁵*Special Astrophysical Observatory, Russian Academy of Sciences, Nizhniy Arkhyz, Russia*

Abstract. We present the results of a multi-wavelength study of the spiral galaxy UGC 11919 to verify that the galaxy has a peculiarly low dynamical mass-to-light ratio (M/L_B) and to study its kinematical structure in general. We obtained an H I data cube of UGC 11919 with the Westerbork Synthesis Radio Telescope parallel with photometric observations with the Apache Point 0.5-m telescope. Two complementary models of the H I data cube provide a reasonable fit to the data: a model representing a symmetric S-shaped warp and a flat disc model with the deviations from axial symmetry caused by noncircular or bar streaming motions. In both cases UGC 11919 appears to have a disk of unusually low dynamical mass-to-light ratio in spite of its red color and a dark halo of moderate mass. A bottom-light stellar initial mass function could explain the results. Stellar kinematic profiles derived from long-slit observations, with the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences, show a signature of kinematically decoupled nuclear disk in the galaxy.

1. Observations, Data Reduction, and Analysis

H I observations were conducted in August and September 2011 with the Westerbork Synthesis Radio Telescope (WSRT), and photometrical observations were carried out with the Apache Point 0.5-m telescope in September 2011 and May 2012 (see Saburova et al. 2013, for details). We constructed two complementary kinematical models of the resulting H I data cube using the Tilted Ring Fitting Code (TiRiFiC; Józsa et al. 2007), a software allowing for a direct fit of modified tilted-ring models to data cubes. In the first model the disk orientation, described by position angle and inclination, was allowed to vary with radius.

This model describes a strong warp in the inner part of the disk (Fig. 1). In the second model we considered a flat disk with the presence of non-circular motions in addition to morphological deviations from axial symmetry. To describe the gas kinematics

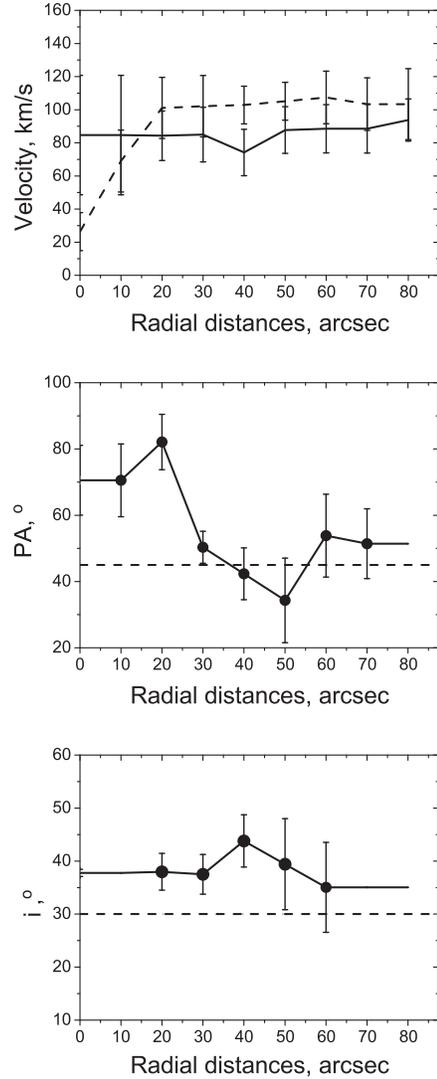


Figure 1. Results from the H I data cube modelling for UGC 11919 for warped model (solid line) and bisymmetric model (dashed line). Top panel: radial variation of rotation velocity. Middle panel: position angle. Bottom panel: inclination.

in this model, we introduced a bisymmetric potential distortion, following Spekkens & Sellwood (2007). Both models provided a reasonable fit to the data. We also conducted long-slit spectroscopic observations with the Spectral Camera with Optical Reducer for Photometric and Interferometric Observations (SCORPIO; Afanasiev & Moiseev 2005) with the Russian 6-m telescope in August 2013. Stellar and ionized gas kinematical profiles obtained from the long-slit spectra at $PA = 45^\circ$ are shown in Fig. 2. The stellar velocity dispersion reveals a central depression within $R \simeq 5''$ (corresponding to $R \simeq 1.8$ kpc at a distance of 74 Mpc) which could indicate a nuclear, kinematically decoupled, stellar disk.

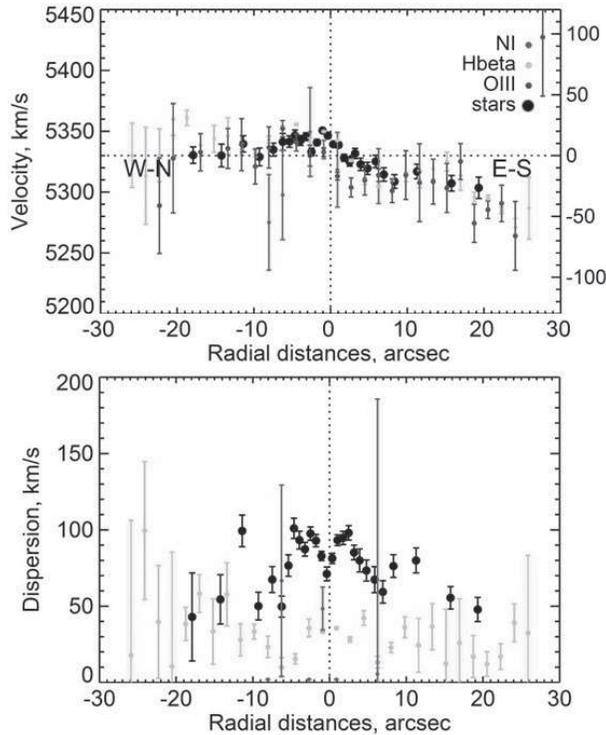


Figure 2. The kinematical profiles of stars (top panel) and ionized gas (bottom panel) obtained from the long-slit spectra at PA = 45°.

2. Conclusions

UGC 11919 has an exceptionally low dynamical mass-to-light ratio of the disk (and also of the bulge), $(M/L_B)_d = 0.5$ (for the bisymmetric model) in comparison to what is expected for its red color $(B - V)_0 = 0.74$, $(M/L_B)_d = 1.7$ for the scaled Salpeter initial mass function (IMF). For the warped disc model we derive an even lower value of $(M/L_B)_d$. We obtain a dark halo mass which is about 42% of the total mass of the galaxy. A bottom light IMF could explain the observations. In addition, kinematic data for UGC 11919 demonstrate that it possibly possesses a warped disk and a nuclear disk. This structure may originate from the gravitational interaction with companions, found in the HI data cube.

Acknowledgments. This work was supported by Dynasty Fund and RFBR (grant 14-02-31034).

References

- Afanasiev, V. L., & Moiseev, A. V. 2005, *Astron. Lett.*, 31, 194
 Józsa, G. I. G., Kenn, F., Klein, U., & Oosterloo, T. A. 2007, *A&A*, 468, 731
 Saburova, A. S., Józsa, G. I. G., Zasov, A. V., & Bizyaev, D. V. 2013, *A&A*, 554, A128
 Spekkens, K., & Sellwood, J. A. 2007, *ApJ*, 664, 204