

The central region of the Seyfert 2 galaxy Mrk 3

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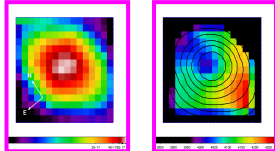
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Integral field data of Mrk3 have been obtained at the 6 m telescope of the Special Astrophysical Observatory (Russia) to investigate the inner 4 kpc of this Seyfert 2 galaxy. We present reconstructed maps of the principal emission lines to derive the morphology, kinematics and the physical conditions of the extended ionized region. We also show maps of the stellar kinematics and broad band optical images used to study the overall morphology of the galaxy. The main findings are kinematical decoupling of gas and stars at kpc scale and the presence of outer shells.

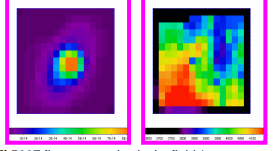
3D spectroscopy

MPFS DATA

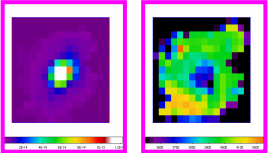


V-band map

Stellar velocity field



[OIII]λ5007 flux map and velocity field (component A)



[OIII]λ5007 flux map and velocity field (component B)

Mrk3, classified as S0 in NED, is a Seyfert 2 galaxy at $z=0.013$ with a hidden Broad Line Region (Miller & Goodrich 1990). High resolution HST imaging and spectroscopy have revealed a biconical configuration of the ionized gas in the inner 2" and an ensemble of clouds with a S-shape structure (Capetti et al. 1995) showing a complex kinematics (Capetti et al 1999, Ruiz et al 2001).

We observed Mrk 3 with the Multi Pupil Fiber Spectrograph (MPFS; Afanasiev et al. 2001) and the SCORPIO adapter (Afanasiev & Moiseev 2005), both mounted at the 6-m telescope of the Special Astrophysical Observatory (SAO-RAS, Russia).

With MPFS a 600 mm² grating was used to cover two overlapping spectral ranges: 3700-6300 Å and 4800-7400 Å, with a resolution of ~7 Å. The field-of-view (FoV) of the MPFS was 16"x15" with a sampling of 1"x1" per spatial element. SCORPIO was used in Fabry Perot Interferometer mode (FPI) centering the spectra on the [OIII]λ5007 (redshifted) line with a spectral resolution of ~2 Å and spatial resolution of 0.5".

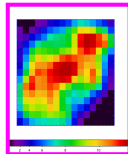
From MPFS data-cube we reconstruct a V-band image after convolution of the spectra with the transmission curve of a typical Johnson V filter.

Flux maps and velocity fields of almost all the emission lines visible in the extended ionized gas regions of Mrk 3 were obtained by fitting a single gaussian to the lines or when possible using multi-gaussian decomposition. Here we report results for Hβ, [OIII]λ5007, Hα, [NII]λ6584.

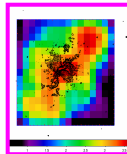
In order to perform more precise measurements of fluxes and emission line ratios we apply correction for Differential Atmospheric Refraction, reddening and underlying stellar contribution (See Ciroti et al. 2003,2005 for details).

We recovered for the first time the stellar kinematics by means of FXCOR an IRAF task based on the Tonry & Davies (1979) Cross Correlation method. We used as template three K type giant stars observed with MPFS on the same night of Mrk 3.

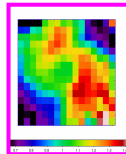
We derived flux map and velocity field of [OIII] also using the SCORPIO-FPI data set. Examples of double component gaussian fit appear in the figures at bottom of the page.



[OIII]λ5007/Hβ ratio

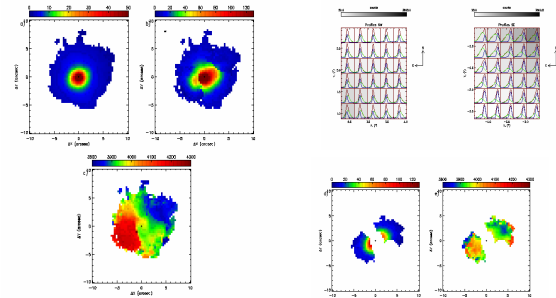


[OIII]λ5007/Hα ratio; overimposed contour of unsharp masked FW606 HST image



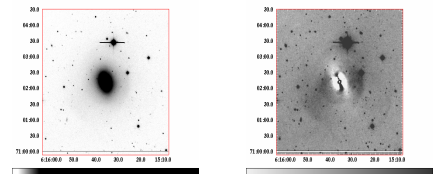
[NII]λ6584/Hα ratio

Fabry-Perot DATA



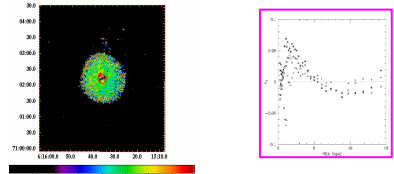
a) Continuum map b) [OIII] flux map c) velocity field
 Top: Example of gaussian fit in two region of the galaxy
 Bottom: [OIII] flux map and velocity field (component b)

IMAGING

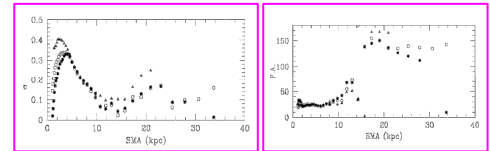


R band

Residual map



G-R image The red box is the MPFS Field of View



Broadband images obtained from the ING data archive. The scale is 0.33 arcsec/pix. We analyze these images using GALFIT and STSDAS-ELLIPSE.

In the figures we present the R-band image and the residual map derived by subtracting an R¹⁴ photometric model. Plots of ellipticity, position angle and c4 of the isophotes fitted with ELLIPSE are shown (open circle G-band, filled circle R-band, triangles I-band). The spatial scale at the distance of the galaxy is about 0.26 kpc/arcsec.

RESULTS

The main result of our investigation is the finding of a strong decoupling of gas and stars kinematics.

The stellar kinematics and the photometric analysis confirm the presence of a central inclined disk in Mrk 3 showing a non deprojected $\Delta V_{max} \sim 120$ km/s.

The ionized gas velocity field show strong deviation from a simple circular motion. Both MPFS an IFF data reveal two components in the [OIII] lines with maximum $\Delta V \sim 250$ km/s extended at ~ 2 kpc scale which suggest the presence of complex radial motions from the active nucleus.

The emission line ratio maps of [OIII]λ5007/Hβ and [OIII]λ5007/Hα follow the extended emission line region but the [NII]λ6584 maps has a different morphology, probably because of our spectral resolution these lines are so blended that it is difficult to recover the real flux of the different components.

The residual map of R image shows structures resembling shells in the outer regions. This would be a hint of past interaction.

Kinematical and photoionization modelling are in progress to determine the origin and physical conditions of the extended ionized region in Mrk3.

References

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