Abstract

We have mapped the stellar and gaseous kinematics, and the emission-line flux distributions and ratios from the inner ~700 pc nucleus of the Seyfert galaxy Mrk 79, using two-dimensional (2D) near-IR J- and K-band spectra obtained with the Gemini NIFS at a spatial resolution of ~100 pc and velocity resolution of ~40 km/s. We detected 69 emission lines from [FeII], H$_\alpha$, H$_\beta$, [PII], H$_\gamma$, [SIX] and [CaVIII], most of them presenting extended emission, for which we constructed two-dimensional maps for their flux distributions and kinematics.

Introduction

Since 2006, we are studying details of the central region of active galaxies using integral field spectroscopy with Gemini Telescopes. The main goal of this project is to map inflows and outflows around nearby active galactic nuclei (AGN) and try to constrain the mass flow rates. In particular, in the near-IR, we have found that the molecular (H$_2$) and ionized gases present distinct flux distributions and kinematics, with the former restricted to the plane of the galaxy and presenting, in some cases, streaming motions towards the nucleus, while the latter presents emission from outflowing material at high latitudes above the plane and usually is associated to the radio emission (Riffel et al. 2006, 2008, 2009, Riffel, Storchi-Bergmann & Nagar 2010, Riffel & Storchi-Bergmann 2011, Storchi-Bergmann et al. 2009, 2010).

In this work, we present results for the Seyfert Galaxy Mrk 79, observed with NIFS at the J and K bands. This object was selected for this study because it presents extended radio and [OIII] emission (e.g. Ulvestad & Wilson 1984, Nagar et al. 1999, Schmitt et al. 2003) allowing us to explore the relation between the radio jet and the Narrow Line Region (NLR) kinematics, as well as its effect in the excitation of the near-IR lines.

Results

Top-left: V-band optical image of Mrk 79 obtained with the 4-m telescope of the Lick Observatory by Hunt et al. (1999). Top-right: [OIII]6007 image obtained with the HST (Schmitt et al. 2003). Bottom-left: 3.6 cm radio continuum image obtained with the VLA by Schmitt et al. (2001). The green box overlaid to this panel represents the NIFS field of view. Bottom-right: Paβ flux map obtained from our NIFS database.

Sample of spectra of Mrk79, extracted within an aperture of 0.25''x0.25'' centered at the nucleus, at the position of the [OIII] emission peak (marked as OS in the Paβ flux map above) and at the radio hotspot (labeled as RS in Paβ flux map).

Main Conclusions

- We detected 69 emission lines from [FeII], H$_\alpha$, H$_\beta$, [PII], H$_\gamma$, [SIX] and [CaVIII], most of them presenting extended emission.
- The coronal line emission is marginally resolved by our observations, being more extended to the north-south direction, the same orientation of the radio jet.
- The [Fe II] and [P II] emission are well correlated with the radio emission, while the H$_\beta$ recombination lines are more related to the [OIII] emission.
- We detected two spiral arms with extension of approximately 680 pc in the H$_\alpha$ flux distribution. These structures could be the feeding channel of the central AGN.
- The excitation of the H$_\alpha$ and [FeII] lines is due to heating of the gas by X-rays from the central AGN. A small contribution of shocks due to the interaction of the radio jet with the ISM may also contribute to the [FeII] emission, as evidenced by enhancements in the [FeII] flux and in locations co-spatial with radio structures.
- The H$_\beta$ kinematics can be represented by two components, one due to a rotating disk and other for inflowing material along the spiral arms.

Emission-line flux distributions obtained from the fitting of the emission-line profiles. The green contours overlaid to Paβ are for the [OIII] image, while the cyan contours are from the radio image. The [S IX] coronal emission is marginally resolved by our observations, being more extended to the north. The H$_\beta$ recombination lines show extended emission up to the borders of the NIFS field to the north and to the south, being well correlated with the [OIII] emission.

The [FeII] emission shows a good correlation with the radio image. The H$_\alpha$ flux map clearly shows two spiral arms extending up to 1.5'' from the nucleus, which seems to originate from the tips of a nuclear bar oriented approximately in the East-West direction, as evidenced by the highest flux levels.

Velocity dispersion maps. The cyan contours overlaid to the [FeII] map are from the 3.6 cm radio-continuum image of Schmitt et al. (2003). The H$_\gamma$ presents smaller sigma values than those for the ionized gas, with the smallest values observed along the spiral arms seen in the flux map. The highest [FeII] $\alpha$ values seems to surround the radio structure, suggesting an interaction between the radio jet and the [FeII] emitting gas.

Velocity channel maps along the H$_\alpha$ emission line profile, showing that the blueshifts are dominated by emission from the southern spiral arm, while the northern spiral arm is observed mainly in redshifts.

References