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Spectrophotometric study of nearby Seyfert nuclei

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Abstract. We present new results about the spectrophotometric study of the nuclear regions in nearby ($z < 0.03$) Seyfert galaxies. The observations were carried out using the Multi Pupil Fiber Spectrograph (MPFS), the integral field unit mounted at the 6-m telescope of the Special Astrophysical Observatory (Russia). The main purpose of this work is to test the Unified Model in nearby AGNs through the investigation of the the gaseous/stellar environment close the active nucleus. In particular, we show emission line ratio maps, included excitation maps ($[OIII]/H\alpha$), which allowed us to trace the regions with different degrees of ionization, to identify ionization cones and/or circum-nuclear star forming regions, and to study in detail their physical properties.

Key words. galaxies: active – galaxies: individual (IRAS 04502-0317,Mrk3, Mrk 6)

1. Introduction

According to the Unified Model (Antonucci 1993) type 1 and type 2 Seyfert galaxies differ only in our viewing angle: in Seyfert 1 the central engine and the broad emission-line region are viewed directly, while in Seyfert 2 they are obscured by a surrounding dusty torus, whose geometry is able to restrict the emergent radiation from the nucleus to a bipolar cone. These so-called ionization cones are direct evidence that radiation escapes anisotropically from the nuclear region (see e.g. Pogge (1989); Mulchaey (1994). Unfortunately not much is known about the shape of these ionization cones in type 1 and intermediate type Seyfert galaxies, and more in general about their origin, that is if they are powered by photoionization, or hydrodynamic shocks, or a mix of these mechanisms. Many Seyfert nuclei are also characterized by enhanced nuclear and circumnuclear star formation (starbursts), but it is not yet demonstrated if a real connection exists between starburst and AGN phase, and if in this respect there is any difference between the circumnuclear environment of Seyfert 1 and Seyfert 2 galaxies. All these key issues can be addressed through observations with integral field spectroscopy and analysis of 3D data.

2. Observations

We have performed spectrophotometric observations of a sample of low redshift Seyfert galaxies ($z < 0.03$) with the Multi Pupil Fiber Spectrograph (MPFS; Afanasiev et al. (2001)) mounted at the 6-m telescope of the Special Astrophysical Observatory (SAO-RAS, Russia). A 600 mm-1 grating was generally used to cover two overlapping spectral

ranges: 3700 – 6300 Å and 4800 – 7400 Å, with a resolution of ∼ 7 Å and a dispersion of 2.6 Åpx^{-1}. The field-of-view (FoV) of the MPFS was 15"x16" with a sampling of 1"x1" per spatial element. Here, we present preliminary results about three Seyfert galaxies: IRAS 04502-0317, Mrk 6 and Mrk 3.

2.1. IRAS 04502-0317

Assuming $H_0 = 75\ km\ s^{-1}\ Mpc^{-1}$ the total FoV was about 4.8 x 4.5 kpc. After the analysis of the spectra we reconstructed the maps of the brightest emission lines. Before to compare them, we corrected the maps for atmospheric refraction effects. The correction for internal reddening was applied by using the $H\alpha/H\beta$ ratio and the Cardelli et al. (1989) extinction law. The $[OIII]\lambda5007$ and $H\alpha$ emissions cover an area of about 15" x 10" elongated in SW direction. The excitation map $[OIII]/H\alpha$ has an extended structure with a main peak at the nucleus and a second peak 5" far from the center in the SW direction. The $[OI]\lambda6300$ emission is mainly located in the nucleus and in the SW region, with a $[OI]/H\alpha$ ratio map similar to the $[OIII]/H\alpha$ map. The kinematical analysis of the ionized gas reveal a quite regular velocity field of a disk galaxy with an asymmetry of the rotation curve with respect to the center of the continuum map. The image of the FWHM of the [OIII] shows higher values in an extended region aligned to the kinematical and photometric minor axis.

subsectionMrk 6 The reconstructed [O III] image of the galaxy in the FoV of MPFS shows a bright nuclear component and an emission toward North. This emission is part of the ENLR, already shown in [O III] images by Kukula et al. (1996). Our spectra of this region confirm the AGN origin of the gas ionization. The nuclear spectrum, extracted over 3"x3", shows a complex profile of the hydrogen emission lines. The broad $H\alpha$ component is not reproduced by a single Gaussian profile, therefore we attempted a multi-Gaussian decomposition. Given the not so high spectral resolution, two possible solutions fit the total profile with similar residuals. The first fit requires three broad components, a blue ($-800\ km\ s-1$) and a red ($+4000\ km\ s^{-1}$) component with FWHM ∼ $4700\ km\ s^{-1}$ and a blue ($-1700\ km\ s^{-1}$) component with FWHM ∼ $10600\ km\ s^{-1}$. The second fit involves two broad emission lines, one with FWHM ∼ $9000\ km\ s^{-1}$ and the other blue-shifted ($-1000\ km\ s^{-1}$) with FWHM ∼ $3600\ km\ s^{-1}$.

2.2. Mrk 3

In NED this object is classified as S0 galaxy with Seyfert 2 nucleus. From narrow band HST imaging Capetti et al. (1995) revealed a biconical configuration of the ionized gas in the inner 2 and an ensemble of clouds with a S-shape structure. Our reconstructed maps of [OIII] and $H\beta$, obtained with a single gaussian model line fit show a similar S-shape ionized gas region and ionization map $[OIII]/H\beta$ but with an extension of 2 Kpc. Recently Ruiz et al. (2001) using HST spectroscopy observed a complex gas motion in NLR that they explained with gas in a double cone distribution strongly interacting with the environment. Our velocity field shows a strong deviation from a simple circular motion with a clear central kinematical decoupling.

References

Afanasiev, V. L., Dodonov, S. N., & Moiseev, A. V. 2001, in Proc. Int. Conf. Stellar Dynamics

Antonucci, R. 1993, ARA&A 31, 473

Capetti, A., Macchetto, F., & Axon, D. J., et al. 1995, ApJ, 448, 600

Cardelli, J. A., Clayton, G. C., & Mathis, J. S. 1989, ApJ, 345, 245

Kukula, M. J., Holloway, A. J., Pedlar, A., et al. 1996, MNRAS, 280, 1283

Mulchaey, J. S., Koratkar, A., Ward, M. J., et al. 1994, ApJ, 436, 586

Pogge, R. W. 1989, ApJ, 345, 730

Ruiz, J. R., Crenshaw, D. M., Kraemer, S. B., et al. 2001, AJ, 122, 2961