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The history and dynamics of the stellar population in the central kpc of active galaxies

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Abstract. We propose a method for extracting kinematics, age and metallicity of the stellar population in the inner kpc of active galactic nuclei, based on pixel fitting of high-resolution (R > 1500) spectra with synthetic stellar populations. Our analysis method can efficiently constrain the kinematics of the stellar population beneath the AGN and restore the age and metallicity. But the constraint on the AGN contribution to the continuum remains poor.

Key words. Galaxies: stellar populations – AGN

1. Introduction

The fueling of an AGN depends on availability of gas and on the dynamical mechanisms that drive the gas from the inner kpc to the center. The signatures of these mechanisms may be searched in the kinematics of the stars. Also, in the core of the galaxies the gas form stars and the study of the population may give hints of the history over the past few Gy (Moultaka 2005; Boisson et al. 2000).

We have started a collaboration in order to study the central kpc of active galaxies using 3D spectroscopy. Recent new techniques to model a stellar populations and constrain the kinematics and distribution in the population box (Le Borgne et al. 2004; Prugniel et al. 2005; Chilingarian et al. 2005) can be used to study the stars underlying AGN, and to subtract the stellar spectrum in order to provide a clean AGN emission.

We made simulations in order to assess the possibilities and the limits of this approach.

2. Simulations

We used a spectrum characteristics of a disk population (ie. close to Solar-type abundance) that we combined with a variable AGN contribution, and we applied inversion procedures to fit the stellar population. In this way, we can determine how the AGN contribution may affect or bias the measurements of the kinematics, age or metallicity.

The stellar population spectrum was extracted from a 3D observation of a low mass elliptical galaxy, NGC 770, obtained with the MPFS spectrograph at the Russian 6 m telescope. This observation was analysed in detail and preliminary results presented in (Prugniel et al. 2005). The reciprocal FWHM resolution is 2500, S/N is about 70, the spectral range used: 420 - 560 nm. The AGN spec-

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Table 1. Results of the simulations. $S\%_{5500}$ – recovered fraction of the AGN contribution to the continuum at 5500 Å, $M\%_{5500}$ – the same as previous, but PEGASE.HR SSP was used instead of real population of NGC 770. Experiments: Stellar 1 – spectrum of NGC 770 fitted without additive continuum, Stellar 2 – the same as Stellar 1, but regions of AGN's emission lines are masked, Stellar 3 – the same as St1, but with additive terms included in the fit, AGN xx% – fitting AGN model with a given contribution to the continuum

Experiment	σ (km/s)	Age(Gy)	Z(dex)	$S\%_{5500}$	$M\%_{5500}$
Stellar 1	109 ± 2	5.7 ± 0.2	−0.14 ± 0.02	n/a	n/a
Stellar 2	110 ± 2	4.5 ± 0.3	−0.05 ± 0.02	n/a	n/a
Stellar 3	106 ± 2	7.1 ± 0.3	−0.07 ± 0.02	13%	1%
AGN 0%	107 ± 2	7.4 ± 0.6	0.04 ± 0.02	15%	1%
AGN 25%	107 ± 2	6.1 ± 0.3	−0.04 ± 0.02	31%	20%
AGN 50%	110 ± 2	6.1 ± 0.3	−0.22 ± 0.04	44%	33%

trum comes from HST-FOS observation of the nucleus of NGC 1068, smoothed in order to increase the S/N of the continuum to about 65.

The results of the inversion for three levels of AGN contribution, measured by the flux ratio of the continuum at 5500 Å: No AGN, 25% and 50% of total, are presented in Table 1. The model consists in a single burst generated with PEGASE.HR with free age and metallicity, a multiplicative polynomial continuum accounting for errors in flux calibration and internal extinction and an additive polynomial continuum accounting for AGN. The wavelength regions of the AGN emission are rejected from the fit (see Fig. 1). The fit has a good quality, with residuals compatible with the noise.

The inversion procedure restores correctly the stellar kinematics in all cases. Surprisingly, though the Balmer lines which are the main age/metallicity discriminators in this spectral range are masked from the fit, age and metallicity is also restored with success.

The method fails to restore the fraction of AGN emission. We first note that the analysis of the pure stellar population with an AGN model (additive continuum) indicates a 15% spurious AGN. We tested that this is an effect of the template miss-match (non-solar abundance ratios) by replacing the real stellar population with a PEGASE.HR synthetic population. However, even with synthetic population, the AGN continuum is poorly constrained by our method for important AGN.

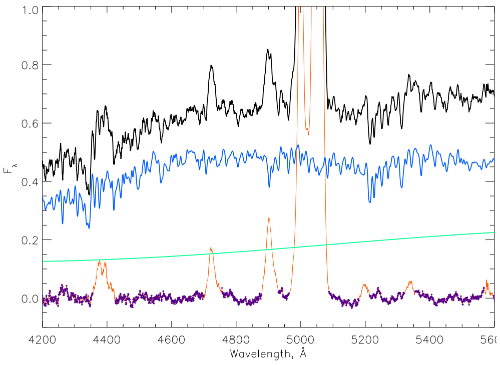

Fig. 1. Simulated spectrum (with 25% AGN) is fitted by stellar population and AGN continuum (polynomial). The AGN emission lines are excluded from the fit.

3. Conclusions

Our analysis method based on pixel fitting with PEGASE.HR templates can efficiently constraint the kinematics of the stellar population beneath the AGN. It succeeds also to restore the age and metallicity. But cannot constraint the relative contribution of the continuum emission of the AGN.

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