Near-Field Cosmology with Dwarf Elliptical Galaxies
Proceedings IAU Colloquium No. 198, 2005
H. Jerjen and B. Binggeli, eds.

doi:10.1017/S1743921305003571

3D Spectroscopic studies of dE galaxies

Igor Chilingarian[1,2], Philippe Prugniel[2,3], Olga Sil'chenko[3] and Victor Afanasiev[4]

[1]Sternberg Astronomical Institute of MSU, Russia
[2]CRAL Observatoire de Lyon, France
[3]GEPI Observatoire de Paris-Meudon, France
[4]Special Astrophysical Observatory of RAS, Russia

Abstract. We present first studies of dE galaxies by means of 3D spectroscopy, and address questions concerning data processing and analysis techniques used to extract internal kinematics and stellar population properties from integrated light spectra.

Keywords. methods: data analysis, galaxies: dwarf, kinematics and dynamics, stellar content

1. Introduction

Diffuse elliptical galaxies is a dominant population in the nearby Universe, but their origin and evolution remain controversial. Two main scenarios are (a) early collapse with a feedback of star formation, and (b) environmental effects: ram pressure stripping of disc galaxies in clusters and groups, gravitational harassment. To choose the scenario we propose to search for kinematical counterparts of the morphological fine structures found in some dEs (Jerjen *et al.* 2000) and subpopulations in the stellar content.

In 2004 we started the project of observing dEs with the MPFS integral field unit (IFU) spectrograph at the Russian 6-m telescope. 3D spectroscopy is a rapidly developing direction in a modern astrophysical experiment. Based on the ideas of Courtes described in the sixties, integral field spectroscopy has 17 years of successful scientific exploitation since first realization ("Tiger" at CFHT). This technique allows to obtain spatially resolved distribution of kinematics (radial velocity and velocity dispersion fields) and stellar population parameters (for example maps of line-strength indices).

Here we address technical questions concerning data reduction and analysis. Scientific aspects, presentation of the results for three dEs (IC3468, IC3653, and NGC770) are given by Prugniel *et al.* (this volume).

2. Data Processing and Analysis

IFU data require some new methods dealing with them besides specific process of data reduction. One of those techniques is so-called adaptive binning approach. Basically the idea is to achieve equal S/N ratio over the field of view by binning the data spatially: as lower signal is as larger bins should be. We use the implementation of Voronoi 2D binning procedure (Cappellari & Copin 2003). Specifying different target S/N ratio we obtain various tessellations to extract of different physical parameters of galaxies.

For the spectrum in each bin we apply direct template fitting procedure: the template spectrum (or the superposition of several ones) is fitted into the observational data using the parameterized LOSVD. We use high-resolution synthetic spectra computed with the new PEGASE.HR evolutionary synthesis code (Le Borgne *et al.* 2004). For a moment, these models exist only for solar abundance ratios of α/Fe and Mg/Fe. This puts some limitations on the upper limit of mass of galaxies being modeled, and allows to study

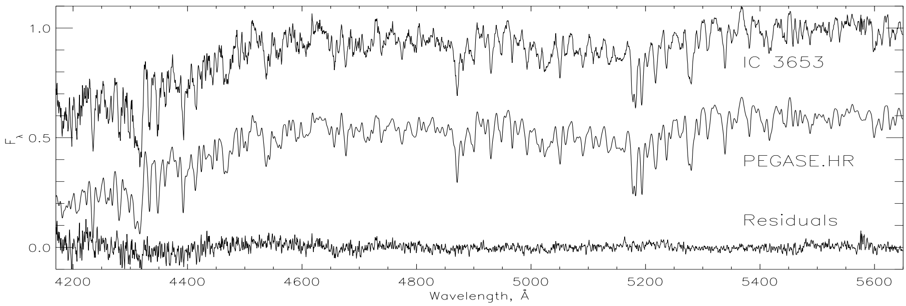

Figure 1. Example of the fit for a central part of IC 3653, a dE galaxy from Virgo cluster.

stellar populations only in low-mass objects like dEs. Hereafter we discuss simple models of star formation histories, containing one or two starbursts, each of those is described by age, metallicity, and mass contribution (in case of two bursts).

We make nonlinear fit by varying: radial velocity, velocity dispersion, Gauss-Hermite coefficients, parameters of multiplicative continuum, and parameters of the starburst(s) (see Fig. 1). The penalized pixel fitting method (Cappellari & Emsellem 2004) is used.

To gain high precision for kinematical parameters we have to take into account variations of the spectrograph's line-spread function over the wavelength range and field of view. We are comparing high S/N spectra of the Sun (twilight sky) and late-type stars by in several wavelength segments for each IFU element with high resolution Echelle spectra of the corresponding objects obtained with ELODIE spectrograph at the OHP.

We use Monte-Carlo simulations for various S/N ratios based on the synthetic spectra to check our approach and estimate errors on the parameters. Simultaneous fit of kinematics and stellar population allows to avoid problems of degeneracies between age-metallicity and metallicity-velocity dispersion, which principally might lead to strong artefacts, for example, in the velocity dispersion distribution if metallicity is fixed.

3. Conclusions

Only non-linear simultaneous fit of kinematical parameters and stellar population constraints using synthetic spectra of galaxies provides reliable results. All other methods (cross-correlation with or fitting a combination of stellar spectra obtained during the same observing run, fitting separately kinematics and stellar population, etc.) suffer from complex degeneracies between different parameters ($\sigma - Z$, $Z - age$, $v - h3$) causing significant artefacts in the final results. Combining 3D spectroscopy with a proposed technique allows to obtain spatially resolved distribution of properties of stellar populations in dwarf galaxies, that is extremely important for understanding their origin and evolution.

Acknowledgements

We would like to thank IAU providing financial support, 6-m telescope TAC, INTAS foundation (project N04-83-3618), EGIDE and CNRS.

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