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# A LIBRARY OF SYNTHETIC GALAXY SPECTRA FOR GAIA

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**Abstract.** An extended library of synthetic spectra of galaxies is built for training and testing the classification system (SVM) of GAIA. The final aim is to derive astrophysical parameters for all the unresolved galaxies observed by the satellite with the low resolution prism spectrometer. Predictions of the evolutionary code PÉGASE give the basic templates by spectral types and their corresponding astrophysical parameters (star formation rates, initial mass function, metallicity, ages and others). The new library is a largely extended sample from basic templates, tested for classification. In the future, a peculiar attention will be focused on a selection of the main astrophysical parameters. Moreover we keep in mind ambitious objectives to make coherent the interpretation of low resolution data with high resolution spectra obtained with the RVS.

## 1 Introduction

Gaia will obtain observations of several million of unresolved galaxies over the whole sky, down to the 20th magnitude. This is an exceptional opportunity to access to statistical samples of galaxy data with a rare accuracy, every source being observed up to 70 times by Gaia. The main objectives are to use the low resolution spectroscopic observations to classify and determine the main astrophysical parameters of all the unresolved galaxies. The method rests on a set of galaxy templates by spectral types produced by the spectrophotometric evolutionary code PÉGASE (http://www2.iap.fr/pegase). The comparison of the model predictions with observed data is done with the SDSS colour-colour diagrams. The model templates are extended to the complete coverage of observations by varying the main physical parameters. The final part is to simulate Gaia observations and to train classification and parametrization algorithms.

### *1.1 The new extended library*

The new library (Tsalmantza et al. 2008) corresponds to 28885 synthetic spectra at redshift zero covering four Hubble type of galaxies respecting resolution and wavelength domains of the low resolution prism spectrometer. It is an improved version of the synthetic library (Tsalmantza et al. 2007). The first improvements are to add scenarios of starburst galaxies to cover the blue part of the SDSS colour-colour diagrams. The second improvement is to shorten the time-scales of star formation rates for elliptical galaxies to fit the reddest part of the diagrams. The comparison of model predictions with SDSS data in the g-r/r-i diagram is shown on Fig.1. The new library is also found in good agreement with LEDA (Paturel et al. 1997) photometric observations.

Tzalmantza et al. (2008) also presents a detailed comparison of synthetic spectra of the new library with flux calibrated spectra of the Kennicutt's atlas (Kennicutt, 1992) for similar types. Normalization, conversion to rest frame and spectra rebinning were done for such a comparison.

### *1.2 Classification and Parametrization*

The Support Vector Machines (SVMs) are trained and tested on an extremely large number of synthetic spectra derived from the new library for three G-band magnitude values G=15, G=18.5, G=20. Extinction by our

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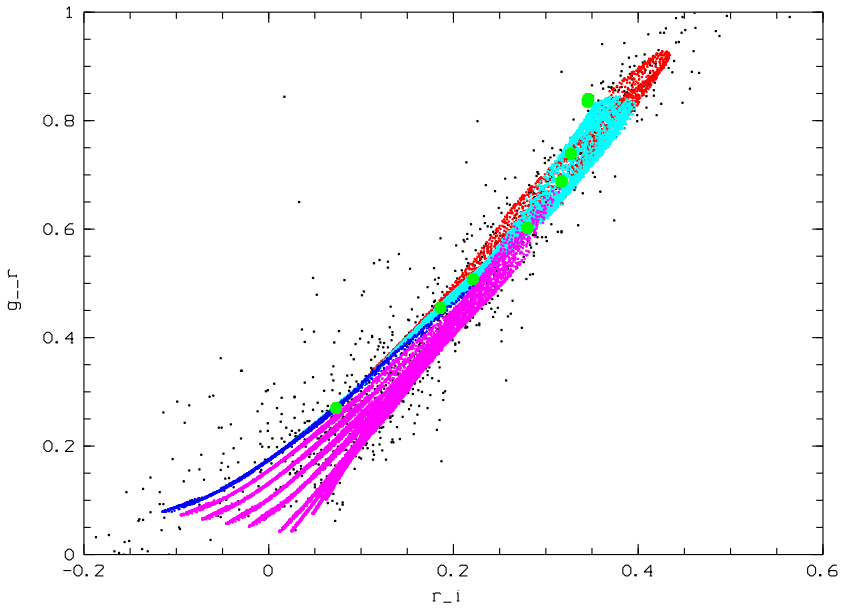


**Fig. 1.** Model predictions for the four galaxy types: irregular(blue), starburst(magenta), spirals(light blue) and early type galaxies (red). Observations (black dots) are from the SDSS data sample. Examples of the classical PÉGASE models for various types are also shown (green dots).

Galaxy, various noises (Poisson, CCD readout) are taken into account. Regression tests by galaxy types allow to test the classification of SVMs. Regression of redshifts are also performed by comparing predicted versus true z values for the test set. The first results of classification and parametrisation of the second library are very satisfying.

### *1.3 Conclusion*

The new library gives a satisfying comparison to observations of colours and spectra at low resolution. The training of SVMs with the extended library gives good results for galaxy types, redshift and Galaxy reddening. Improvements are required for the extraction of the astrophysical parameters. Synthetic models might suffer any degeneracy for the extremely extended training library. The best solution will be in the future to extract only a few number of the main physical parameters, representative of the morphology and evolution by type at all redshifts. Moreover a new exploration is in progress by building the high-resolution spectra library for the RVS instrument which will allow to coherently link the interpretation of resolved observations of nearby galaxies with the unresolved galaxy samples at higher redshifts.

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