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EVOLUTION OF OUR GALAXY AND OTHERS WITH THE HIGH-RESOLUTION VERSION OF THE CODE PÉGASE

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Abstract. With the high performances of the Radial Velocity Spectrograph(RVS) on board of the ESA/Gaia mission, Gaia will detect nuclei and the contrasted zones of a large number of galaxies. With the resolution $R \sim 11500$ and the wavelength domain of the RVS (847nm – 874 nm) the main evolutionary parameter is the metallicity traced by the Ca triplet, Fe and Paschen lines. We propose to use the Munari et al., (2005) library with the galaxy evolution code PÉGASE, to constrain the star formation histories and to solve the degeneracy age-metallicity. High-resolution synthetic spectra might be used for educating the Support Vector Machine (SVM) allowing the automatic classification of observed targets.

Keywords: unresolved galaxies, Galaxy, galaxy nuclei, high resolution, metallicity, Calcium triplet

1 Introduction

For several years, an extended library of synthetic spectra of galaxies (Tsalmantza et al., 2009 and references therein) was built for training and testing the classification system (SVM) at the low resolution ($R \sim 200$) of Gaia prisms (BP/RP instruments). The significant fits of this library with the SDSS observations are shown in Fig. 1 for a series of classical types (elliptical, spiral, irregular) and Quenched Star-Forming Galaxies. The evolution code PÉGASE used for this library, in its available version PÉGASE.2 (`www.iap.fr/pegase`, Fioc & Rocca-Volmerange 1997), is based on the spectral stellar library BaSeL 2.2 suitable for the low resolution instruments of Gaia.

Then a first version of the code at high resolution: PÉGASE-HR (Le Borgne et al, 2004) was built with the observational stellar library ELODIE (Prugniel & Soubiran, 2004) including metallicity effect. The spectral resolution is $R = 10000$ and the optical range $\lambda = 400$–680 nm. The ELODIE library takes advantage of a fairly complete coverage of the Hertzprung-Russell (HR) diagram on the range [Fe/H]=–2 to +0.4. PÉGASE-HR is a tool for exploring signatures of metallicity, age, and kinematics. Unhappily it does not cover the wavelength range of the RVS/Gaia.

We intend to improve the resolution of the synthetic library of galaxies computed with the code PÉGASE, on the wavelength domain of the RVS to interpret observations and to test the coherency at low and high resolutions.

2 The high resolution stellar library

The high resolution stellar library (Munari et al, 2005) is based on Kurucz's codes, extended on the wavelength range from 2500–10500 Åat the resolution of 1 Å/pix. The global library maps the whole HR diagram, but is limitated to stars with $T_{eff} > 3500K$. We extract a selection of parameters (T_{eff}, gravity, [M/H] and others). The entire library of synthetic spectra is accessible via the web, gently complemented for a given α/Fe range by R. Sordo and A. Vallenari (private communication). The contribution of cold stars to this library is in development.

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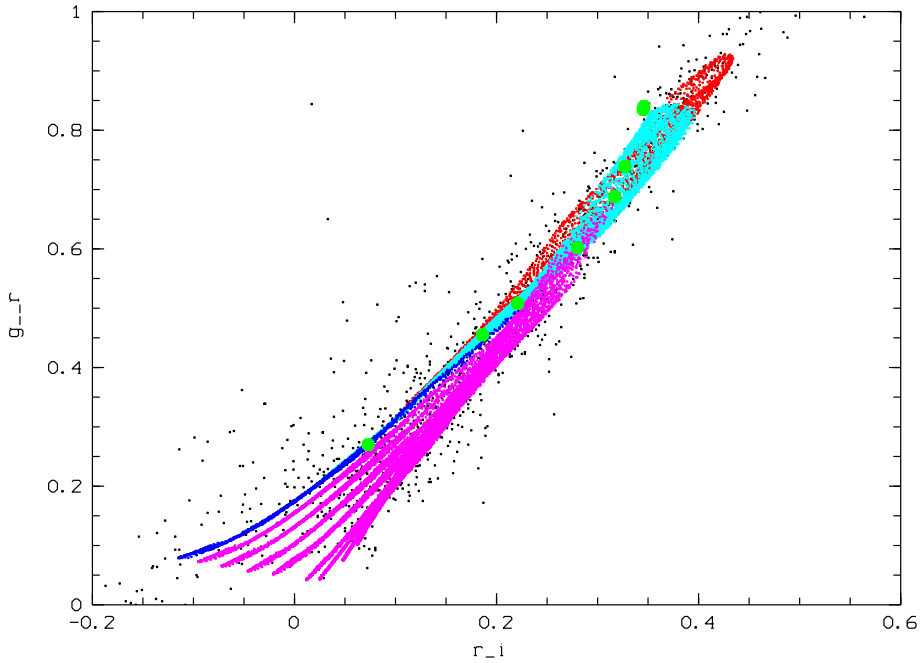

Fig. 1. The synthetic library of galaxies by types for Gaia compared to observations of the SDSS $g-r/r-i$ diagram.

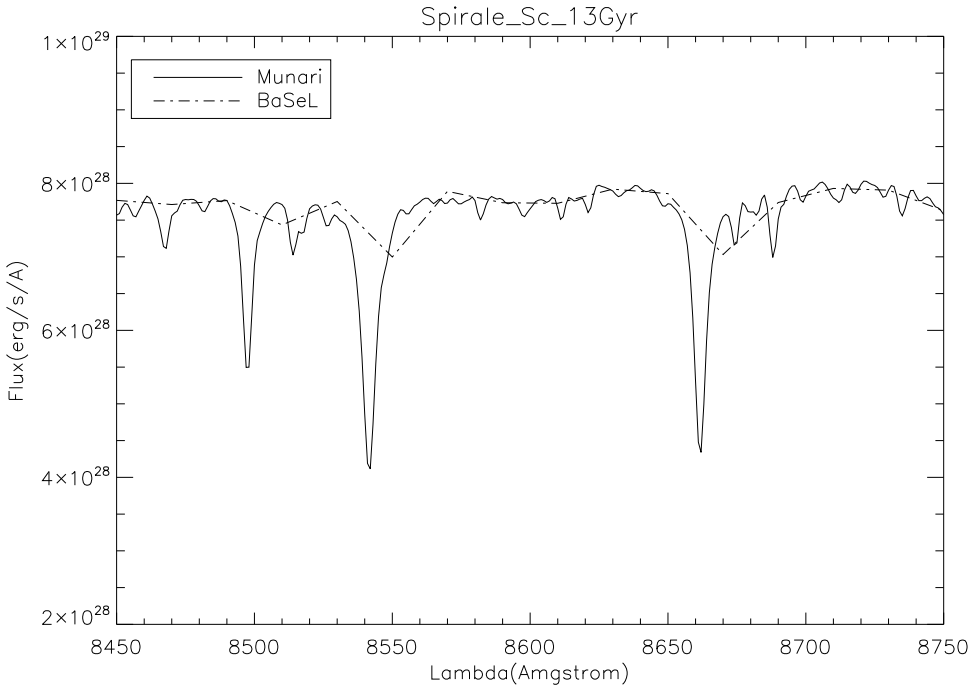

Fig. 2. Sc spiral SEDs at 13 Ga predicted by the code PÉGASE at low and high resolution through the RVS window.

3 Present status of the code PÉGASE-HR2

The new version of PEGASE-HR2, based on the theoretical library described in the previous section computes high- resolution single stellar populations (SSPs) from 10^7 to 2.10^{10} a. Evolution scenarios of galaxies are computed by a combination of SSPs giving predictions of Spectral Energy Distributions (SEDs) by types at all ages. The wavelength domain covers the RVS domain, allowing to follow the evolution of the Calcium triplet, Fe and Paschen H lines. The star formation laws are those adopted for the Gaia synthetic library at low resolution (Tsalmantza et al, 2009). They are fitting at best SEDs of the z=0 templates by galaxy types.

After checking the coherency of flux calibration between the code PÉGASE and the library by Munari et al, (2005), we compute SEDs for various galaxy types.

Fig. 2 compares the two SEDs at low and high resolutions for a typical spiral Sc galaxy of 13 Ga old. The lack of cold stars is hard to evaluate but its effect on the equivalent widths of absorption lines will be improved in the near future by a complement of cold star spectra. Predictions are extended to evolved populations from globular clusters, starbursts, spirals Sd to Sa and elliptical galaxies.

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