# A library of synthetic galaxy spectra for GAIA

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SF2A, AS GAIA, Juillet 2008

## Objectives

- Identification and classification of unresolved galaxies
- Determination of Astrophysical Parameters spectral type, Star formation rate, age, metallicity, masses, nebular emission, extinction + redshifts
- Training and Testing for Automatic classification by Support Vector Machines SF2A, AS GAIA, Juillet 2008

## Methods and Tools

- 1. To select observations of several galaxy samples (SLOAN/SDSS, RC3 (z=0), VIMOS/VVDS)
- 2. To fit the observed color-color distribution of galaxies with a library of Synthetic models:

i) Basic scenarios of Pegase2 <u>http://www2.iap.fr/pegase</u>, simulating the evolution of 8 types for the Hubble Sequence + starbursts at redshifts 0<z<0.2

ii) To extend scenarios for a complete coverage of observations Main physics parameters (M/L, Mass, Z, age, others ) are known for all spectra

 To build the GAIA library of ~40 000 spectra used to educate and test the analyser SVM for Classification and Parametrisation of galaxies observed by Gaia

Scheme of SFR scenarios for the Hubble sequence: SFR ugas mass Mgas of the galaxy embedded within the reservoir + exchanges as infall and galacticwinds Winds **Gas Inflow LVLbaryon:** initial gas SF2A, AS GAIA, Juillet 2008 Mgalaxy cloud(reservoir)

Main SFR time scales by galaxy types: Ellipticals and Spirals Elliptical (winds) Spiral



Mgalaxy (full), Mstar (t) (dotted), Mgas(dashed)

Note: ULIRGs are modelled as ultra massive ellipticals with a young starburst and/or active nuclei . They are less than 10% of the global population, see Rocca-Volmerange. Seymour. de Lapparent. 2007. AA. 475. 801

## Star formation parameters\*



#### Fits of spectral (colors) synthesis:

PEGASE: Fioc & Rocca-Volmerange, 1997, Fioc, thesis, 1998



 Spectral synthesis of the elliptical M87,
Rocca-Volmerange,
MNRAS,236,47)

> The majority of local ellipticals are gaspoor (after suffering galacticwinds) and then dust-poor and of low star formation activity.



Figure 2. A comparison of the *IUE* and visible observed spectra of M87 (Bertola *et al.* 1980) with our UV-hot model at age 13 Gyr. Flux units for observational data are  $10^{-14}$  erg s<sup>-1</sup>Å<sup>-1</sup> cm<sup>-2</sup>.



Figure 3. A comparison of the *IUE* and visible observed spectra of NGC4649 (Bertola *et al.* 1982) with our UV-hot model at age 13 Gyr. Flux units for observational data are  $10^{-14}$  erg s<sup>-1</sup>Å<sup>-1</sup> cm<sup>-2</sup>.

Fits of the RC3 catalogue with PEGASE And Coleman&Wu, Yuko Kakasu, 2008

Morphological types are from de Vaucouleurs 1991



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PEGASE2.0 galxy color track at 0 < z <= 0.5(z = 0.0, 0.3, 0.5 are marked by circles with increasing size)



Yuko Kakasu, 2008



## An example of covering the blue part of the color-color diagram(Tsalmantza et al, in preparation)





#### **Classification and parametrization of the simulated Gaia spectra**



#### **Regression of Astrophysical Parameters**



## For galaxy spectra of known reddening



Training: 14440 galaxy spectra Testing: 129985 galaxy spectra

AP	<real-predicted>/<real></real></real-predicted>	sd(rea-predicted)/ <real></real>
Z	-2.64e-05	0.003
Av	0.002	0.100

#### Classification of galaxy types for galaxy spectra of known redshift and reddening

Testing set 4885

Error: 0.61%

Туре	E	S	Im	SB
E	484	25	0	0
S	5	1820	0	0
Im	0	0	255	0
SB	0	0	0	2296

Testing set 24000

Error: 2.87%

Туре	E	S	Im	SB
Е	2033	274	0	0
S	215	8434	95	0
Im	0	91	1153	1
SB	3	1	9	11691

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#### **Regression of Astrophysical Parameters for galaxy spectra of known reddening and redshift**



Training: 4885 galaxy spectra Testing: 24000 galaxy spectra

AP	<real-predicted>/<real></real></real-predicted>	sd(rea-predicted)/ <real></real>
M/L	0.0004	0.039
Present SFR	-0.0077	0.305

### Future works

- To solve degeneracies by multi-lambda solutions
- To improve the U band predictions



To improve spectral resolution power R=200 → 10000
with new stellar libraries

from Kurucz+Lejeune, 1996 (Basel)

- → Munari, 2005
- ➔ The stellar library ELODIE and Pegase-HR (DamienLe Borgne et al , 2002) for z> 0 wavelength domain
- To disentangle dynamics-metallicity
- Nebular emission (continuum+lines) are computed for templates, but have to be included in starbursts