TBD

if you only have a hammer all your problems become nails...

...but, actually, do you want only a hammer?

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Ivan Hubeny....

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David Valls-Gabaud...

...and the people for the VSF European Network...

Part I: Improving Synthesis Models

Previous works:

Synthetic Spectra of H Balmer and HeI absorption lines

- González Delgado & Leitherer (1999), ApJS, 125, 479

  Stellar library

- González Delgado, Leitherer & Heckman (1999), ApJS, 125, 489

  Evolutionary Models for Starburst and Post-Starburst Galaxies

NLTE (O stars) + LTE (Kurucz) (cooler stars)
TLUSTY+Synspec (codes by Hubeny and Lanz)

Stellar Library

High-spectral resolution= 0.3 A
Spectral windows: H_{12}-Hγ+Hβ

Evolutionary Models

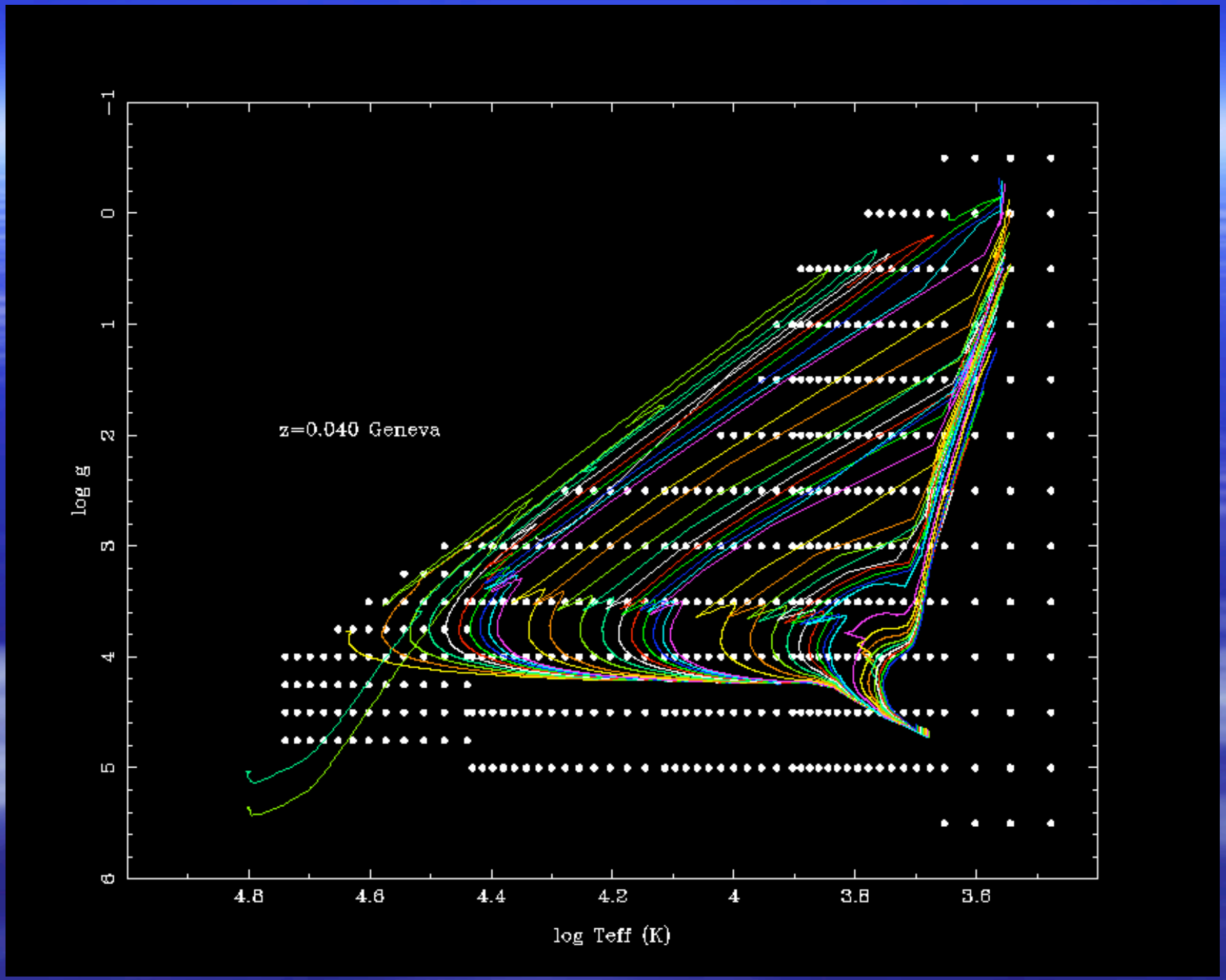
STARBURST99:
1-1000 Myr stellar population

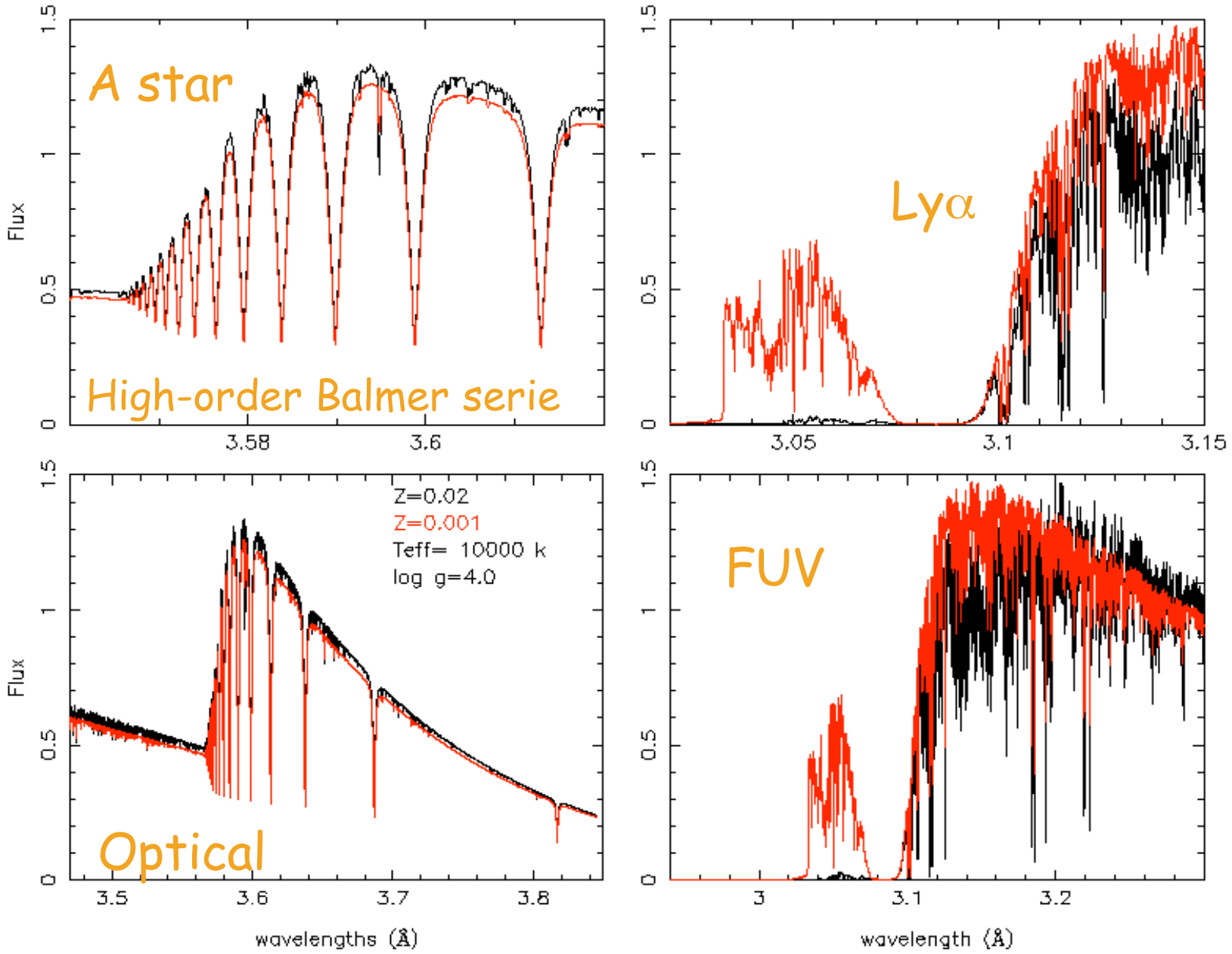
A New Stellar Library

(González-Delgado et al. 2004)

- Teff: 55000 - 4000 K
- Log g: 5.0 – 0.0
- Metallicity: 2Zsol, Zsol, Zsol/2, Zsol/4, Zsol/10
- Resolution: 10000-40000 (sampling=0.3 Å)
- Spectral coverage: 800-7000 Å (FUV-Optical)

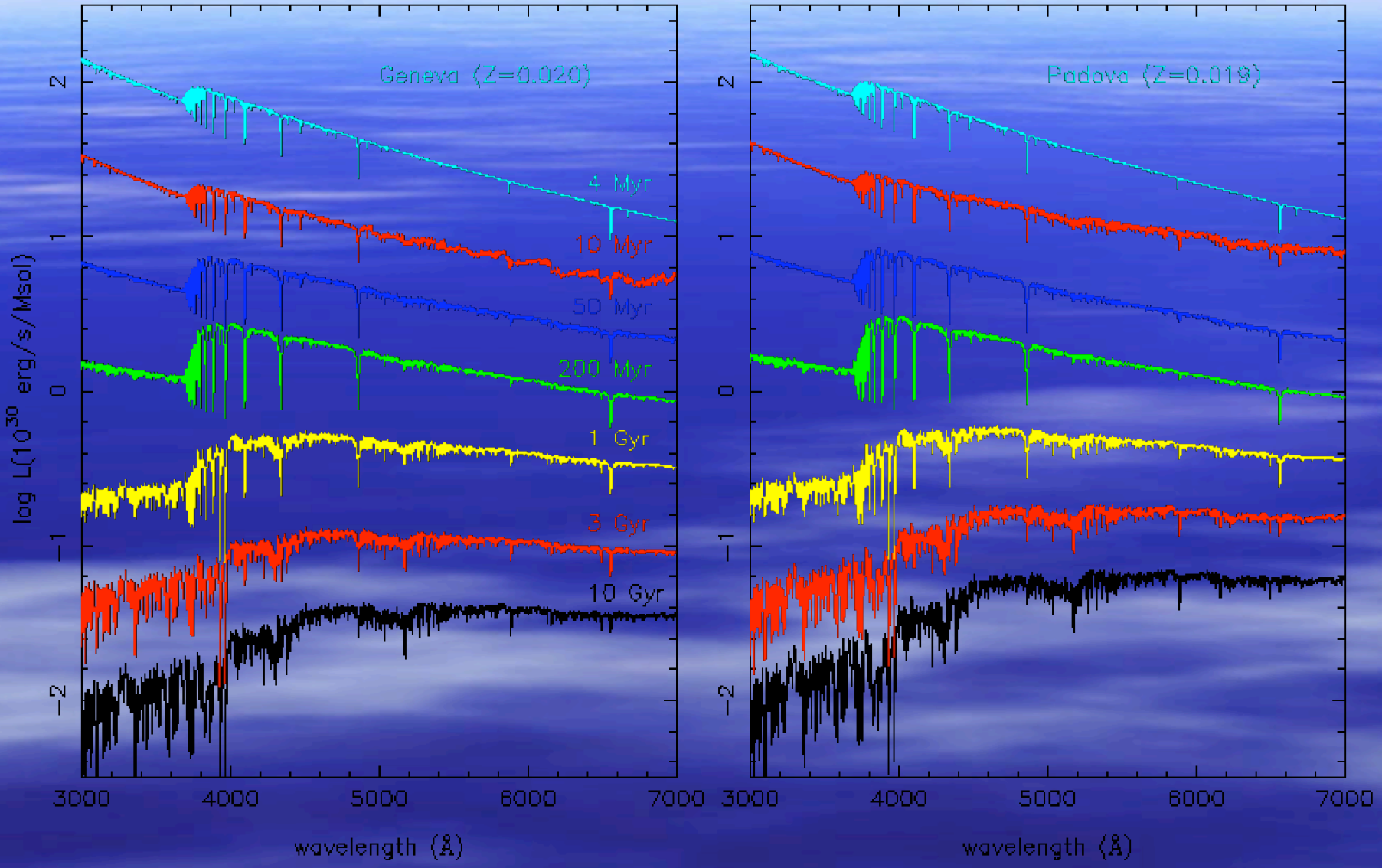
- NLTE+line-blanketing (O stars) (Lanz & Hubeny, 2003)
- LTE (Kurucz stellar atmospheres) (26000-4000 K)
  - SYNSPEC + ROTIN (Hubeny and collaborators): Teff > 7000 K
  - SPECTRUM (Gray): Teff < 7000 K
- NLTE (cool stars, Peter H: PHOENIX)

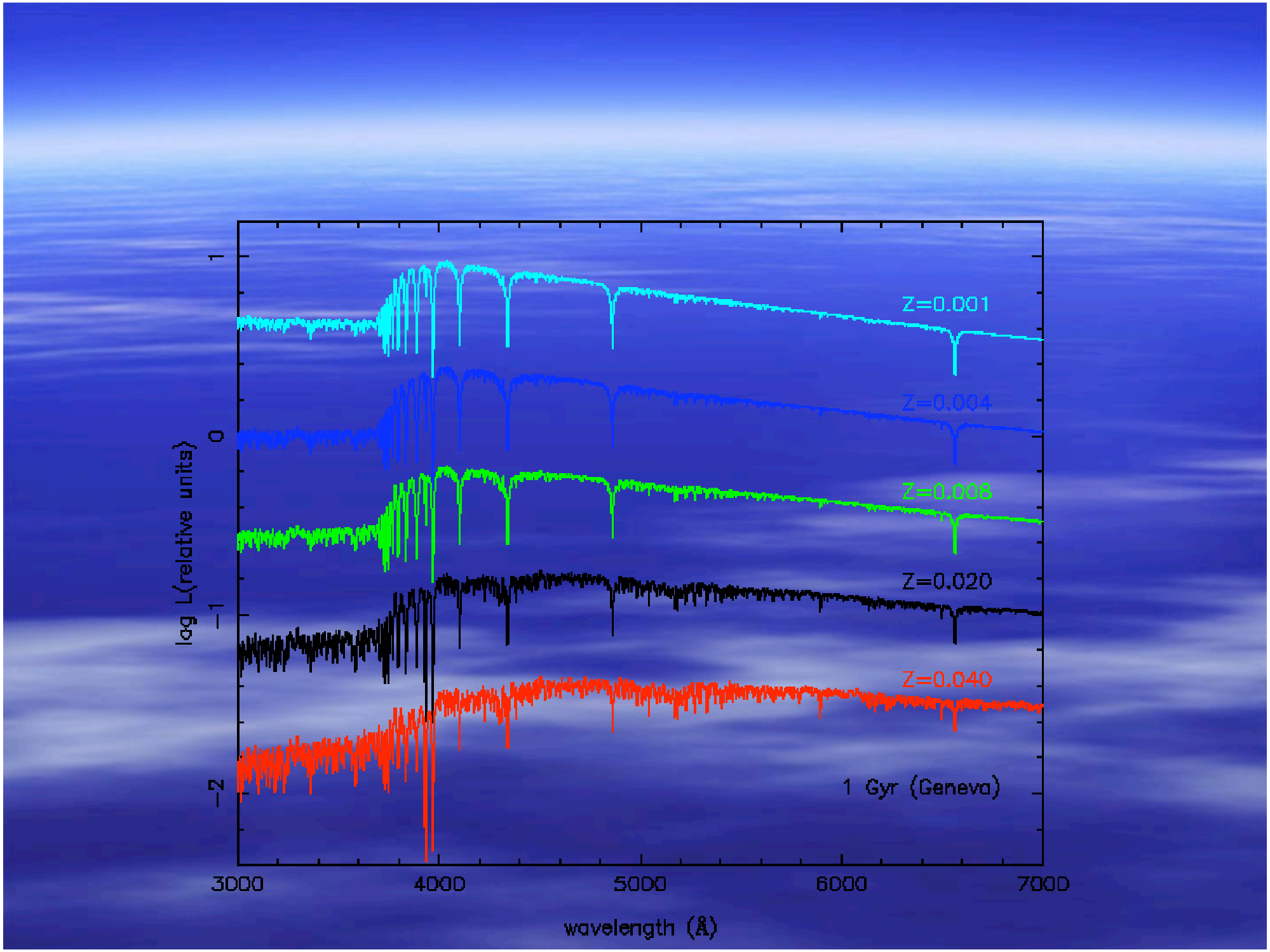

z=0.040 Geneva
log g
log Teff (K)
-1
0
1
2
3
4
5
6
4.8
4.6
4.4
4.2
4
3.8
3.6


A star
High-order Balmer serie
Lyα
Optical
FUV
Z=0.02
Z=0.001
Teff= 10000 k
log g=4.0
Flux
wavelengths (Å)
wavelength (Å)

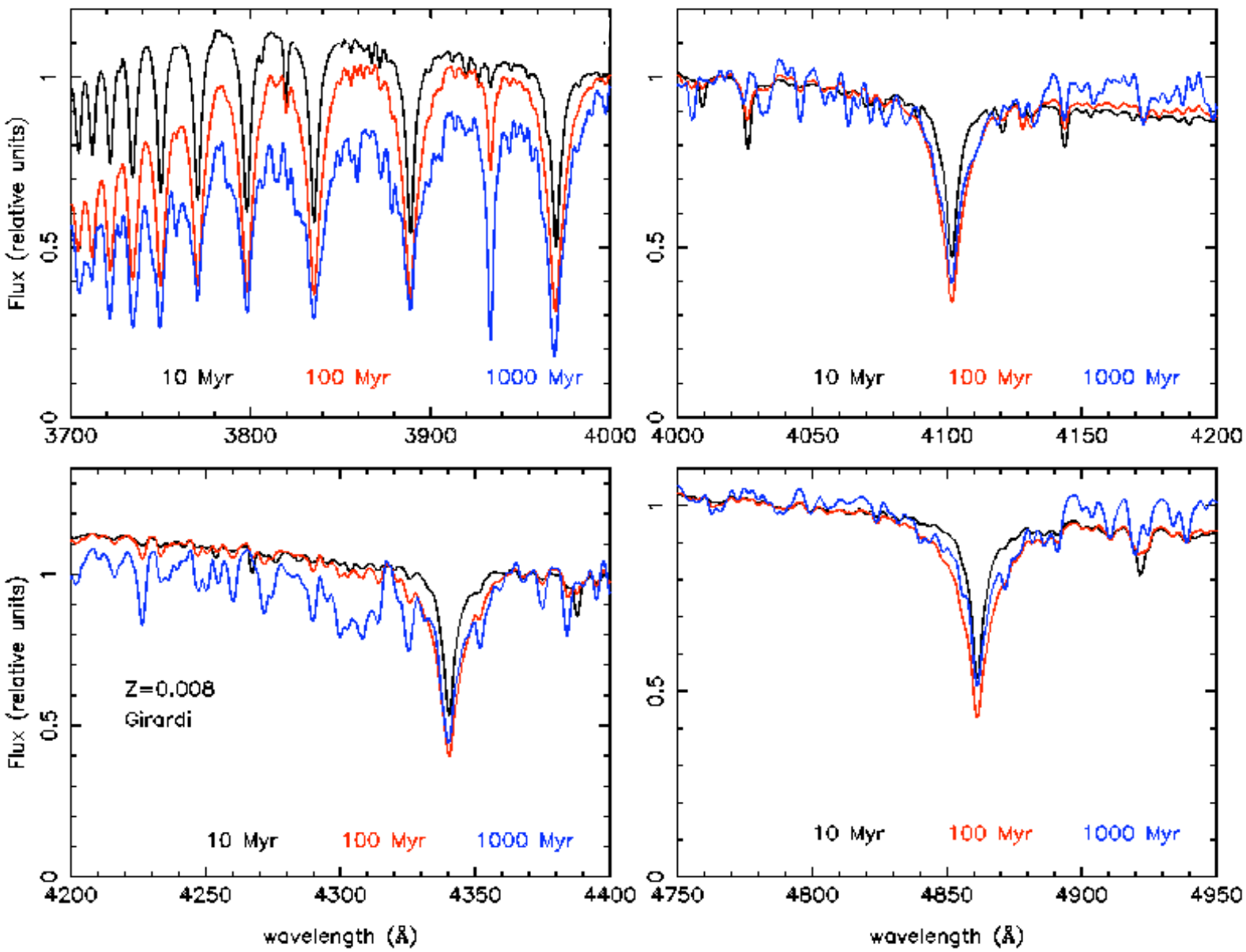
- Stellar library input to SED@
  - Isochrone free
    - At the moment: Geneva, Padova (1-17Gyr)
    - user defined isochrone **soon**
    - user defined star cluster (star by star computation without IMF assumptions) **soon**
  - IMF – Star Formation free
    - Note that such information is "implicit" in the isochrone or the "user defined star cluster" (...like the *factory*...)
  - Stellar atmosphere free:
    - At the moment: Kurucz low resolution, Lejeune low resolution, New high-resolution stellar library; using the "close atmosphere approach"
    - user defined atmosphere grid (including Linda Smith et al., CoStar) and choosing the overlaps and interpolations in atmosphere, and mix observtional and theoretical libraries **soon**

Spectral Evolution

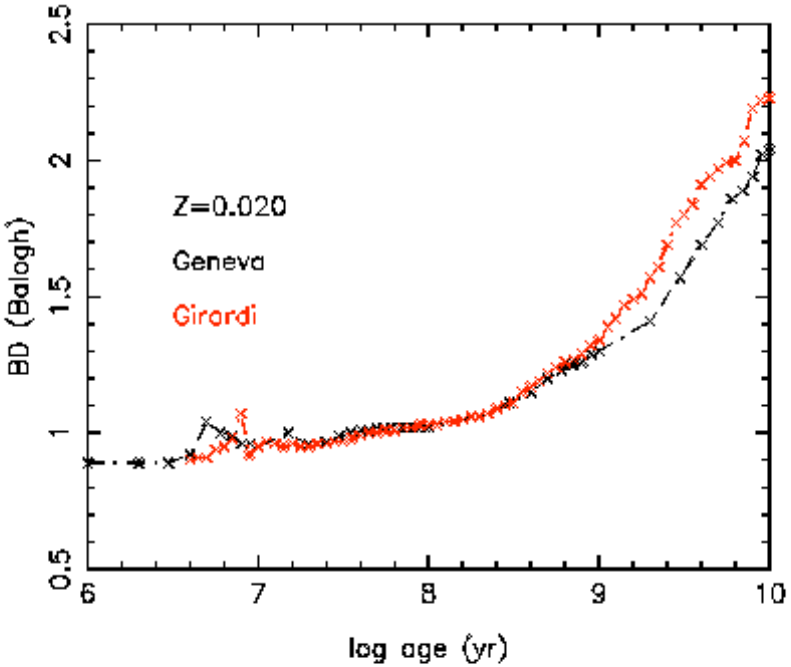


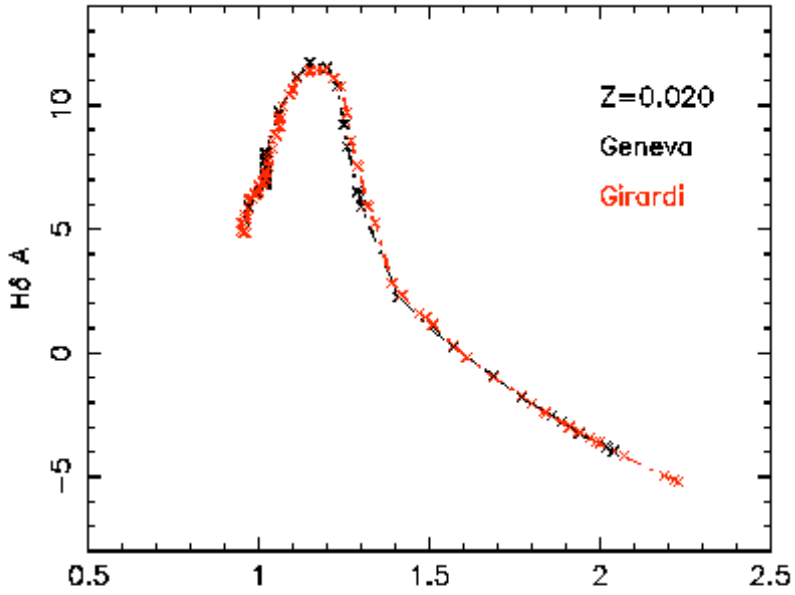

Z=0.001
Z=0.004
Z=0.008
Z=0.020
Z=0.040
1 Gyr (Geneva)
log L(relative units)
1
0
−1
−2
3000
4000
5000
6000
7000
wavelength (Å)

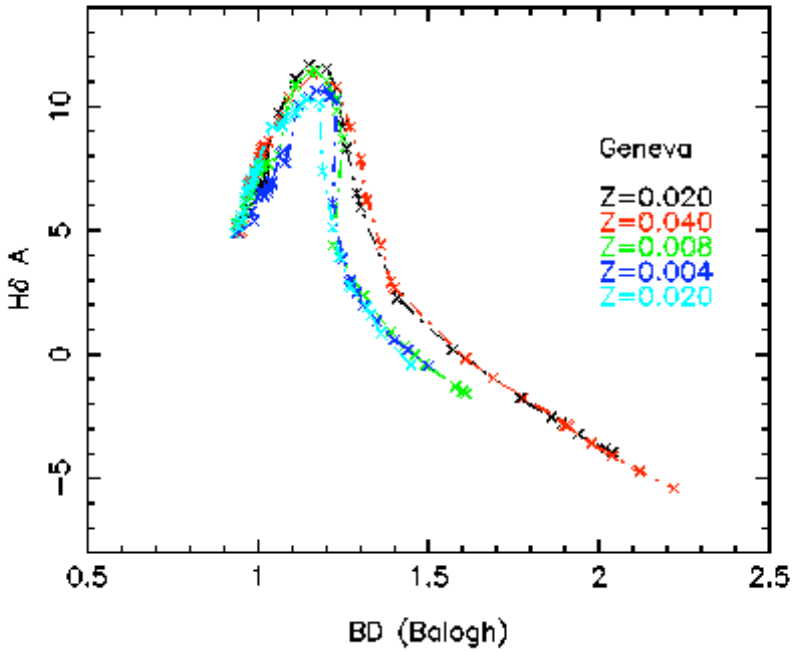
Line Profiles

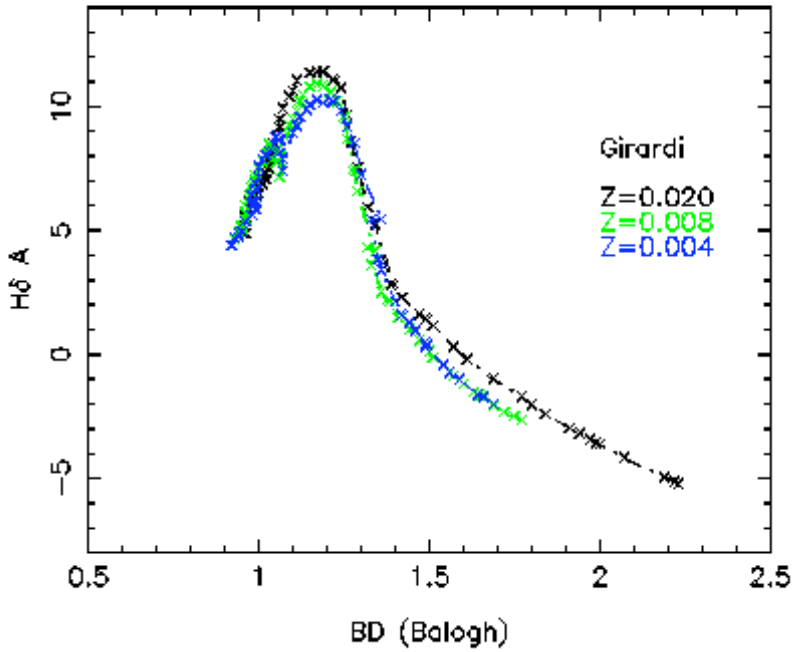


Balmer decrement

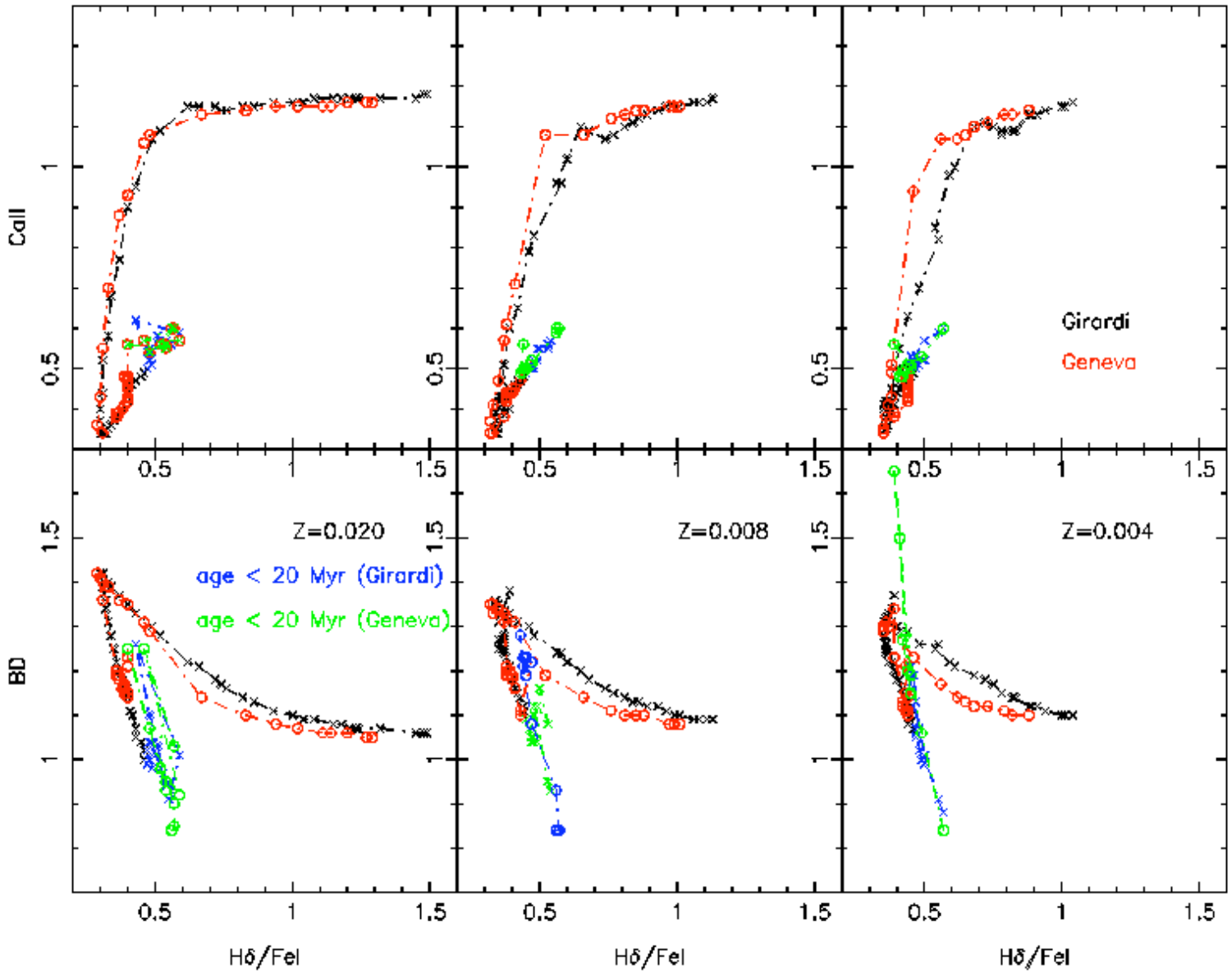




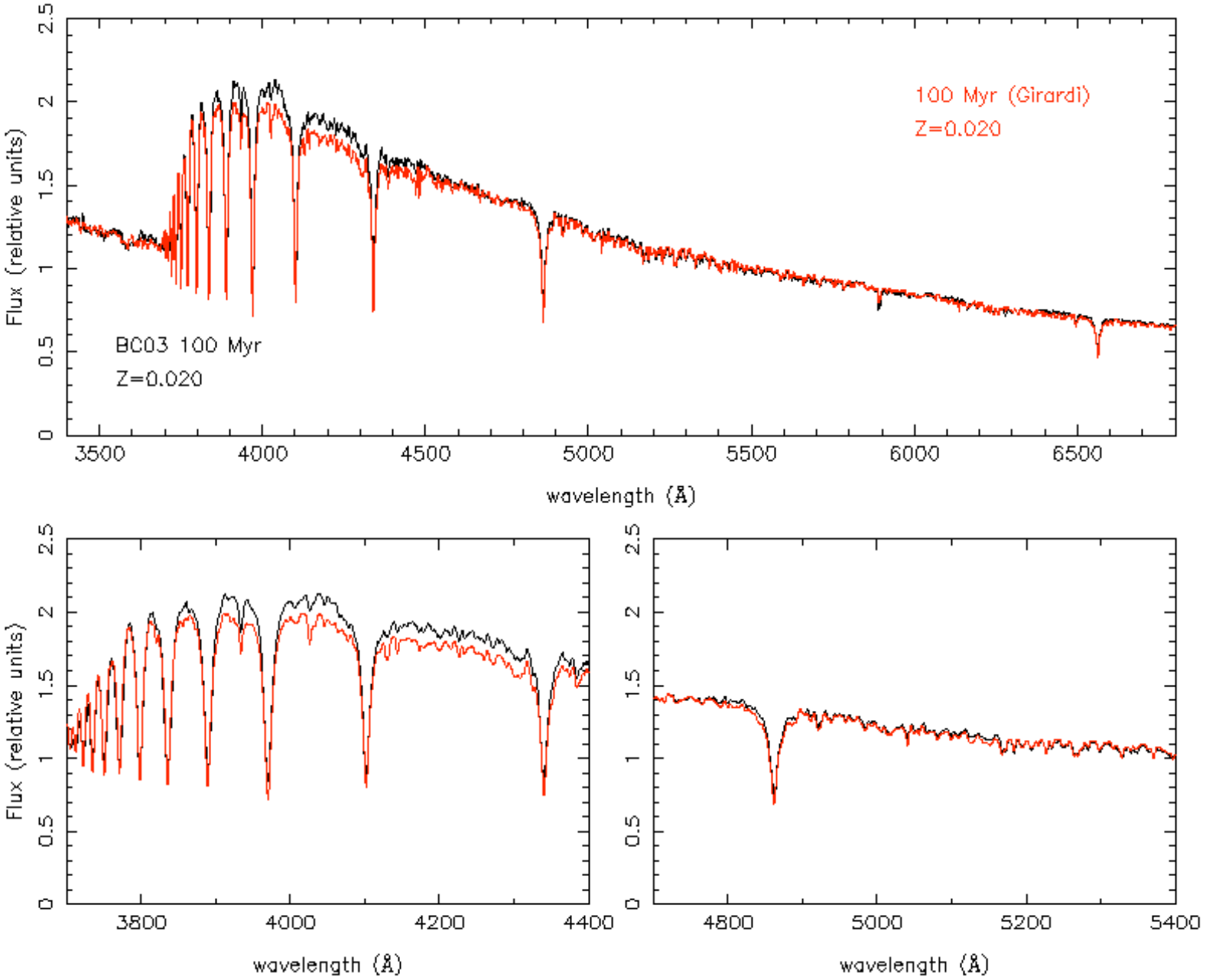


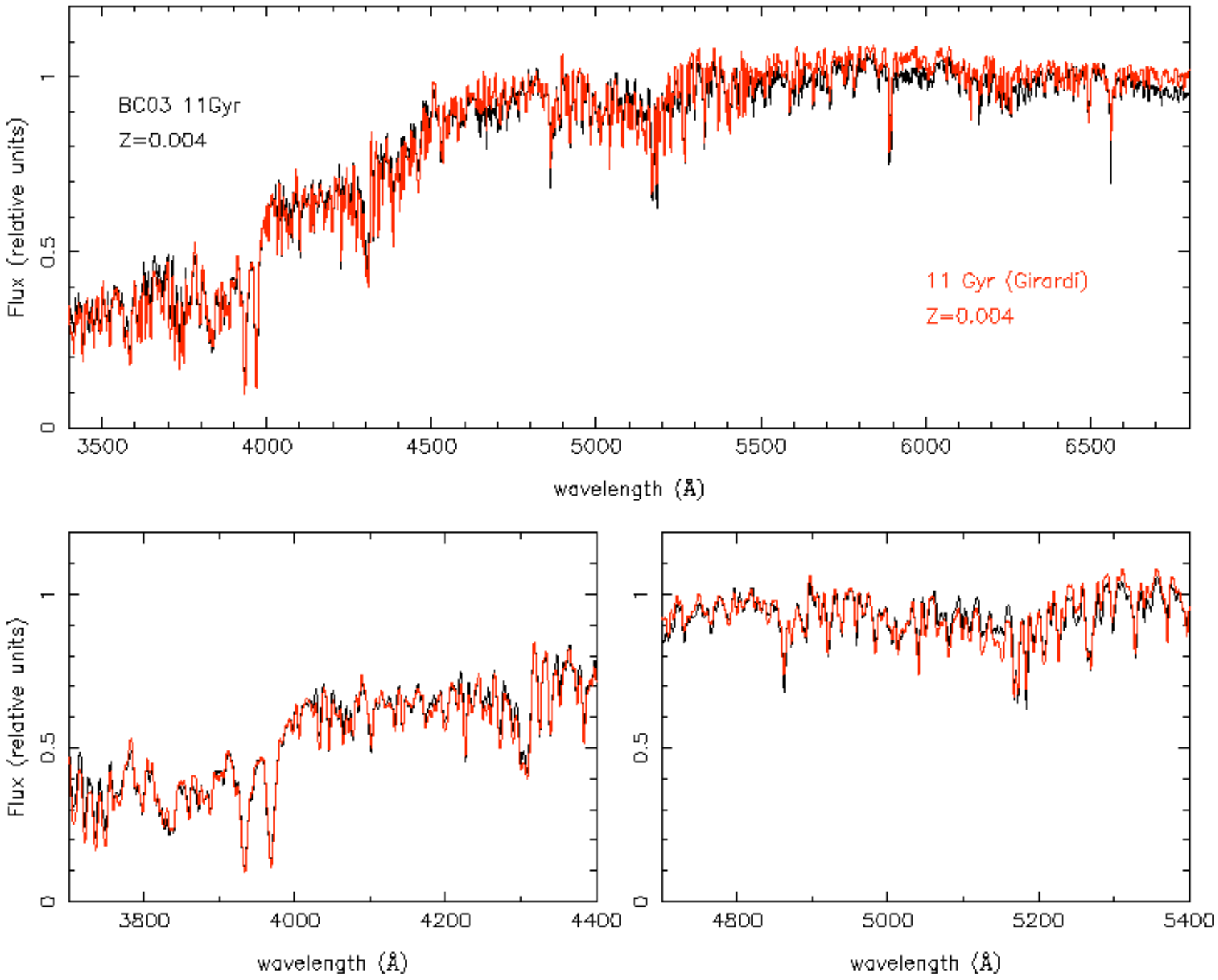


Spectral indexes: Rose system

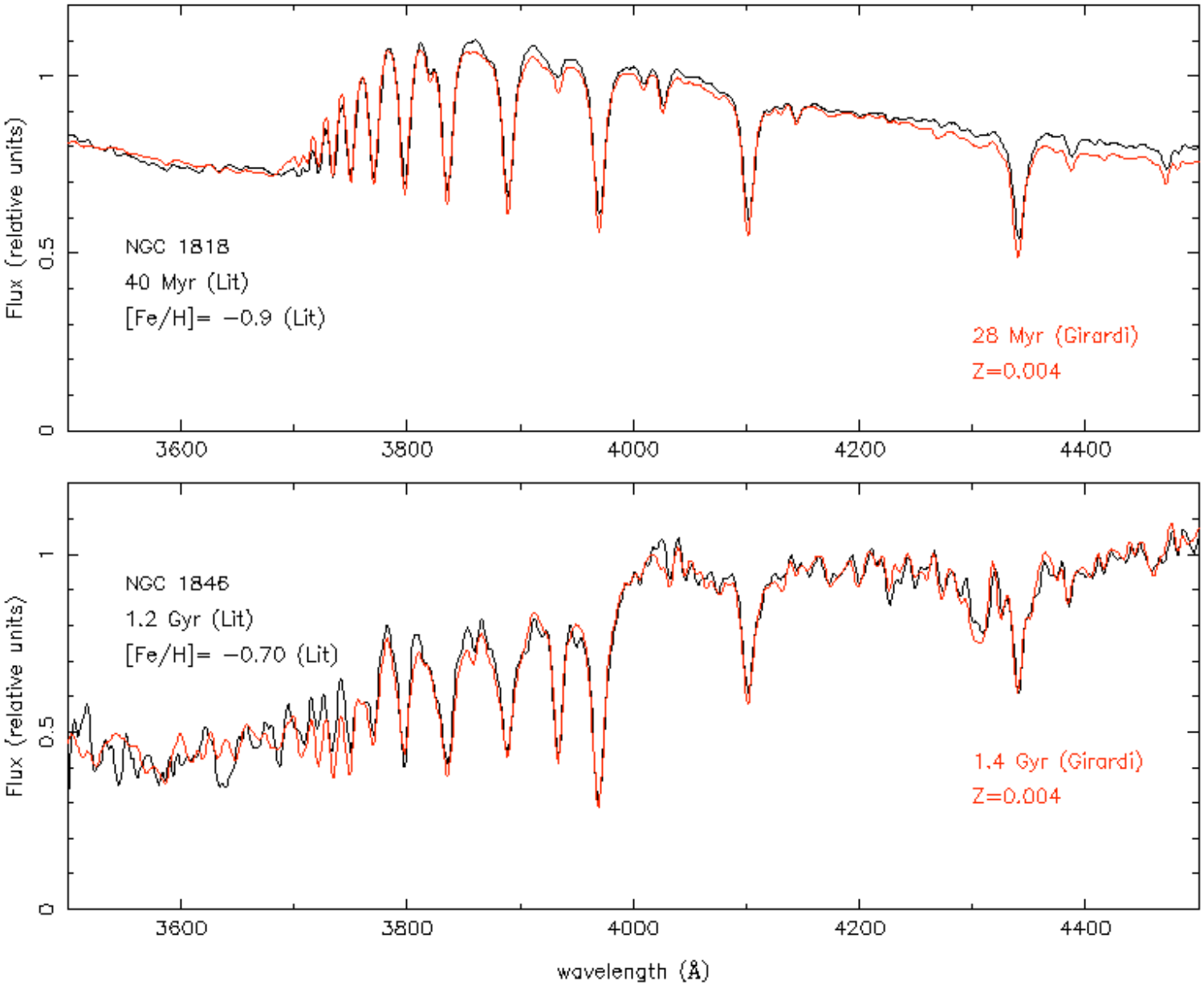


Comparison with BC03

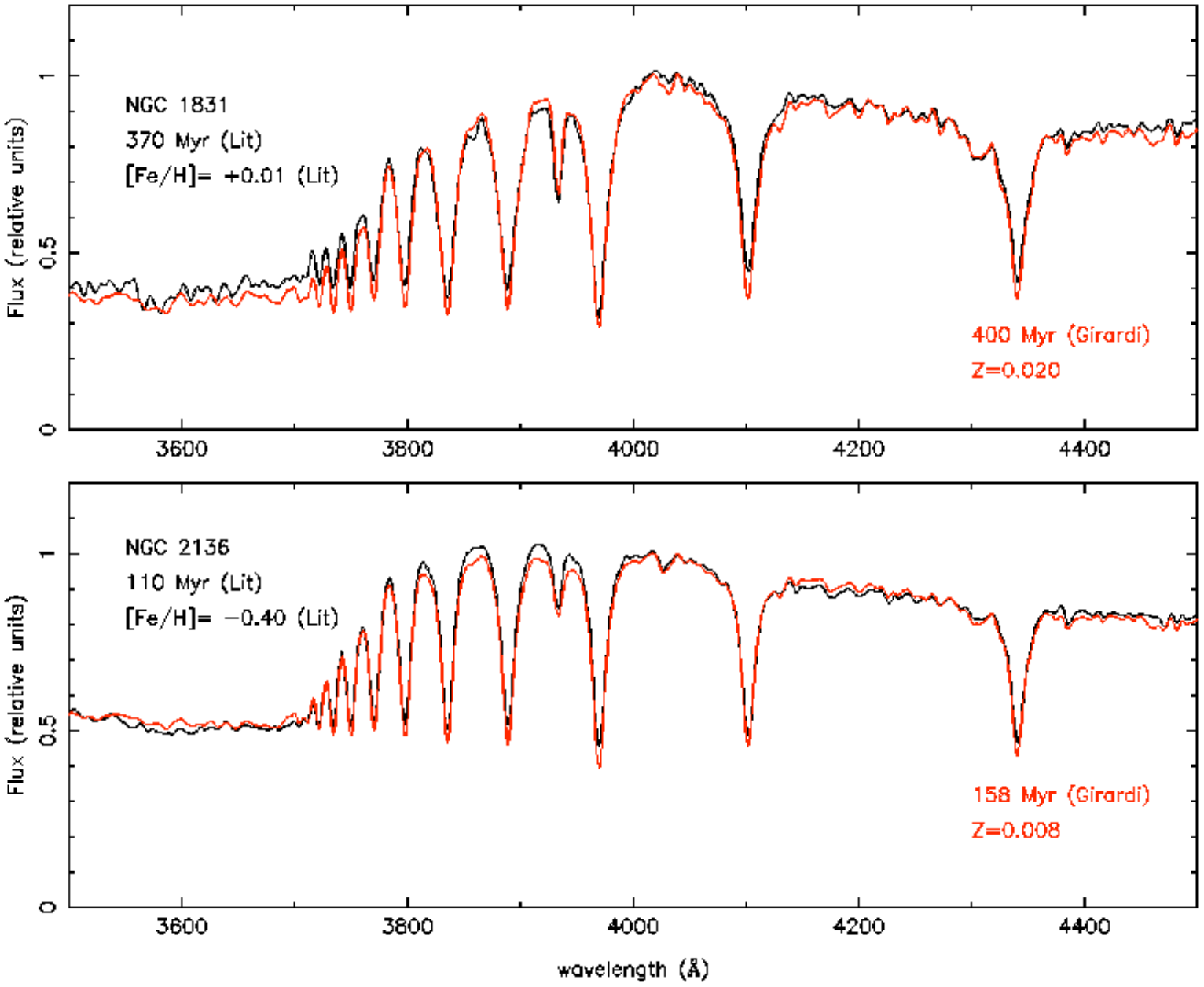



BC03 11Gyr
Z=0.004
11 Gyr (Girardi)
Z=0.004
Flux (relative units)
wavelength (Å)
0
0.5
1
3500
4000
4500
5000
5500
6000
6500
3800
4200
4400
4800
5200
5400

LMC clusters: Observations from Leonardi & Rose (2003)



LMC clusters



Conclusions I

- Large spectral covering at high-resolution (0.3 A) to predict weak lines.
- Large age covering (1Myr-10Gyr), being very well optimized for young age population.
- Large covering in metallicity (2Zsol....1/10Zsol).
- To predict SP for the Geneva and Padova tracks
  (Y^2 Yale and FRANEC Pisa isochrones).
- User defines his own spectral indexes/color/equivalent widths... system (effect of the spectral resolution).
- Stochastic effect of the IMF/SFH, index fluctuations (including Surface Brightness fluctuations).

Improving our understanding of synthesis models (Part II)

What do synthesis models do?

$$\int \frac{dN}{dm} L(m;t)\,dm = \int \frac{dN}{dL} L(t)\,dL$$

Integrate (average)

IMF + isochrone luminosity

Integrate (average)

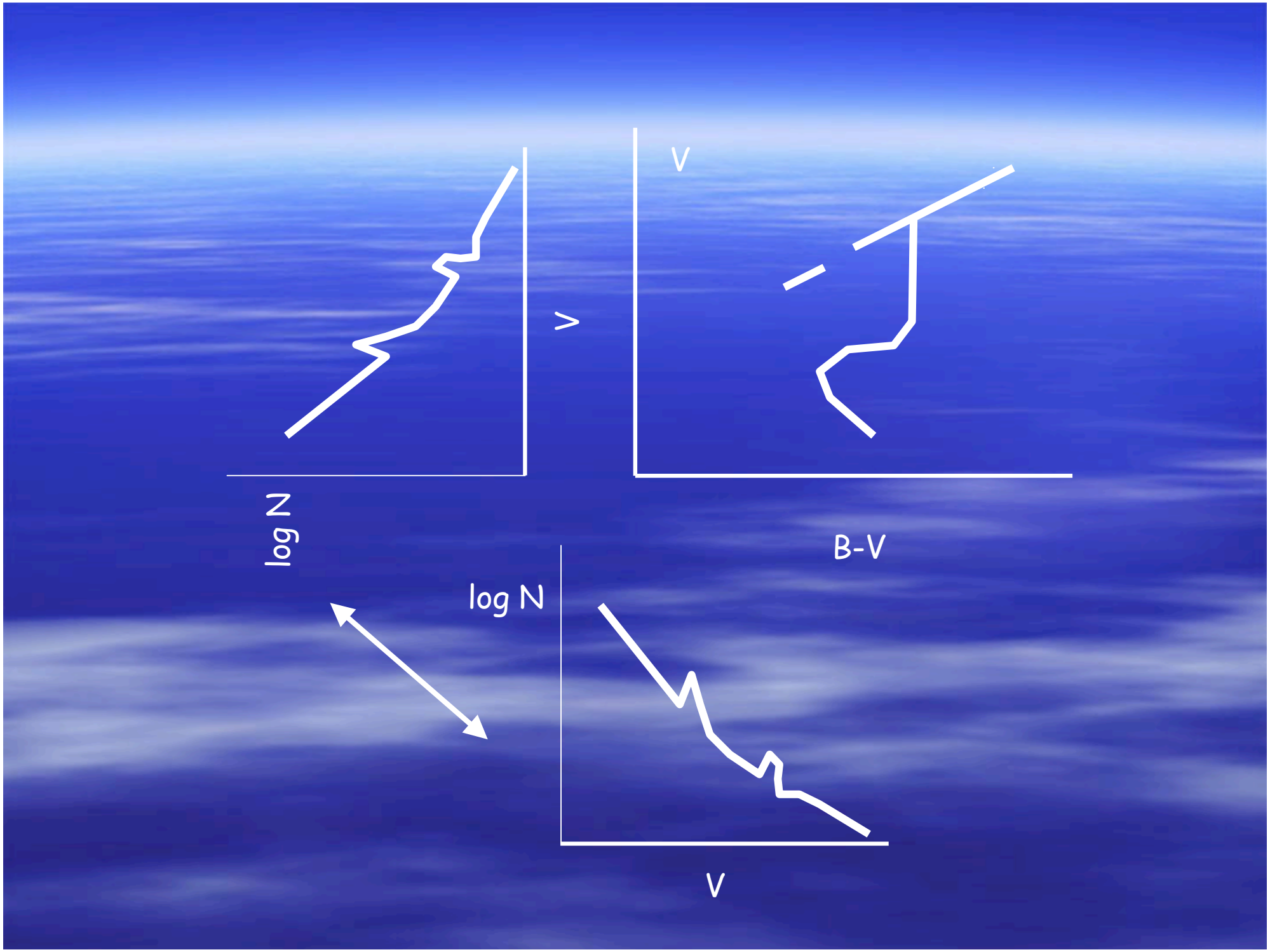
Luminosity function

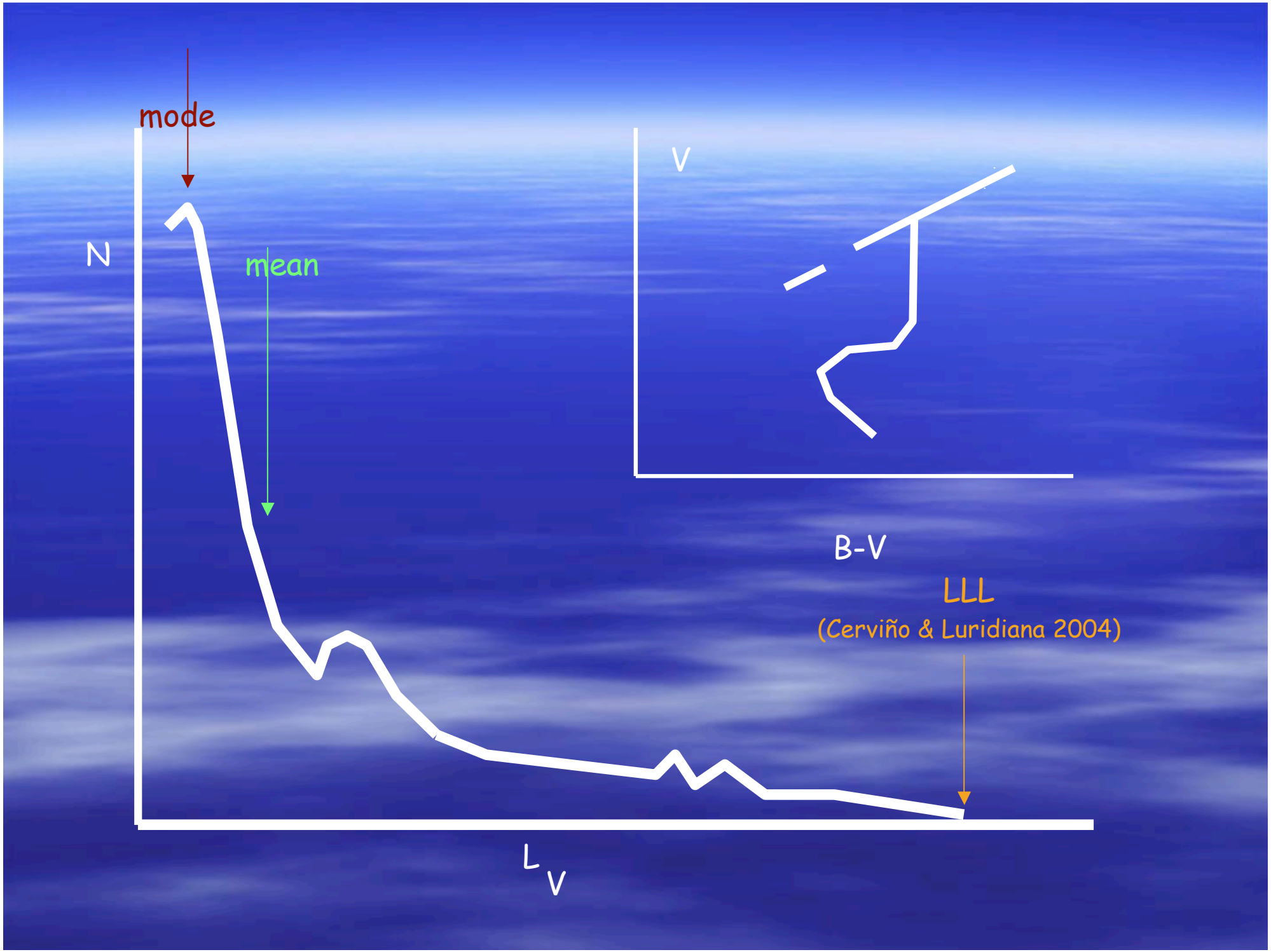
BUT

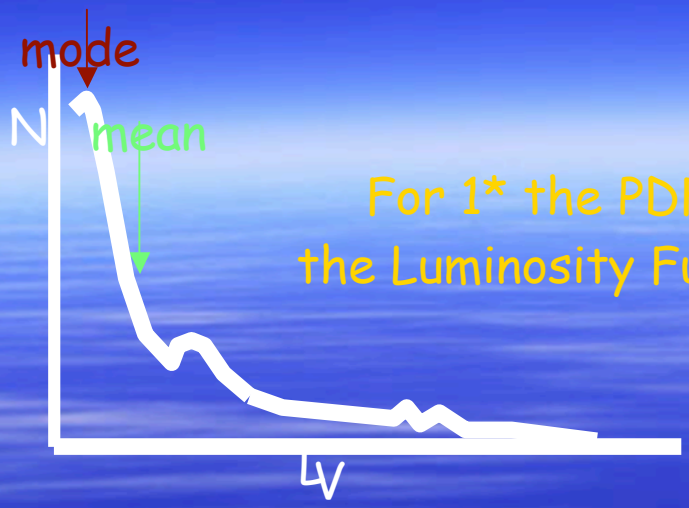
why average (obtain the first moment of the Luminosity function)?

why not obtain also the second moment (Cerviño et al, from 2000 to 2003)?

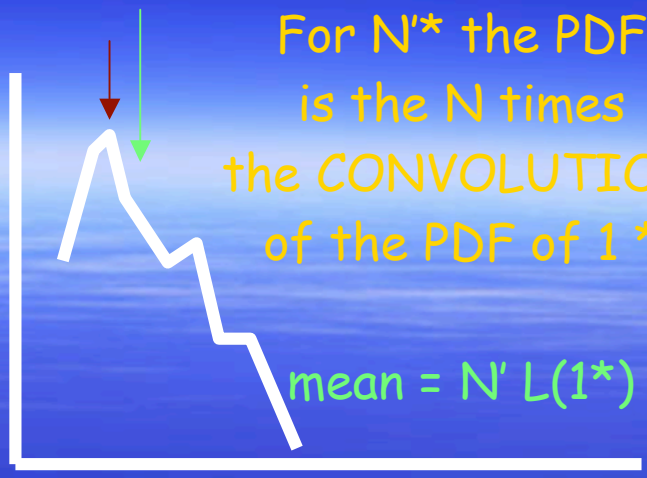
Why make integrals if we can work with the LF directly?


V
V
log N
B-V
log N
V


mode
N
mean
V
B-V
LLL
(Cerviño & Luridiana 2004)
L V

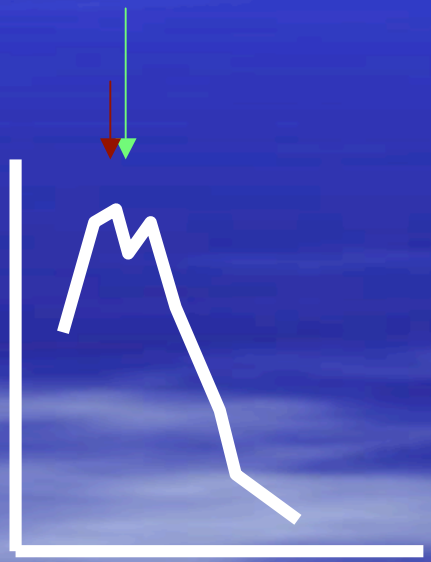


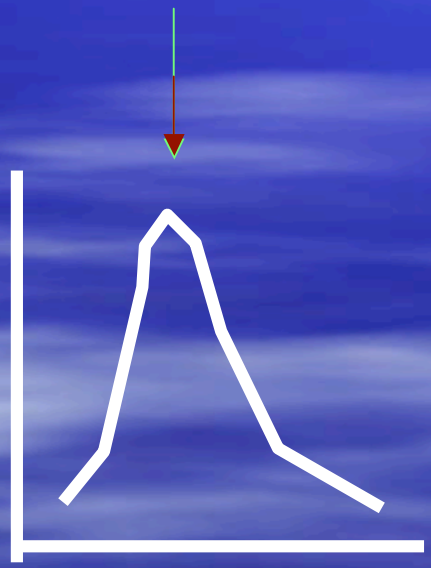
For 1* the PDF is
the Luminosity Function



For N'* the PDF
is the N times
the CONVOLUTION
of the PDF of 1 *

mean = N' L(1*)





Note that the variance also increases with N -> the relative dispersion decreases with N^0.5 (that is the Neff used in Mercedes talk)

Conclusions

- If you know make convolotions (FFT for example), you can obtain the exact PDF due to sampling (and use it more confidenciabely than psi-square, that assume gausians)
- Any SFH is a convolution of SSP models
- For a single object (with a single observation) you can quantify better the acuracy of the model (ussing not only the mean, but also the most probable value, the mode)
- For extended observations (like radial or 2D profiles) it is posible to use also the mode. It may explain the low luminosity end curvature sometimes observed in the profiles and also “sudden” color gradients at some radius.
- The same game can be done with chemical evolution...
- Convolution game is easier and faster than Monte Carlo simulations