Stellar populations in active and star-forming galaxies

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Stellar populations in active and star-forming galaxies

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The fate of galaxies

- Collapse gas, dissipate energy, form stars, produce metal, recycle …

- AGN, black-hole, accretion, energy feed-back

- Mass of the BH proportional to the stellar mass
  - Sub-parsec scale knows about kpc scales
  - Nuclei affect overall evolution

==> Study the relations between the stellar population and the nuclear region
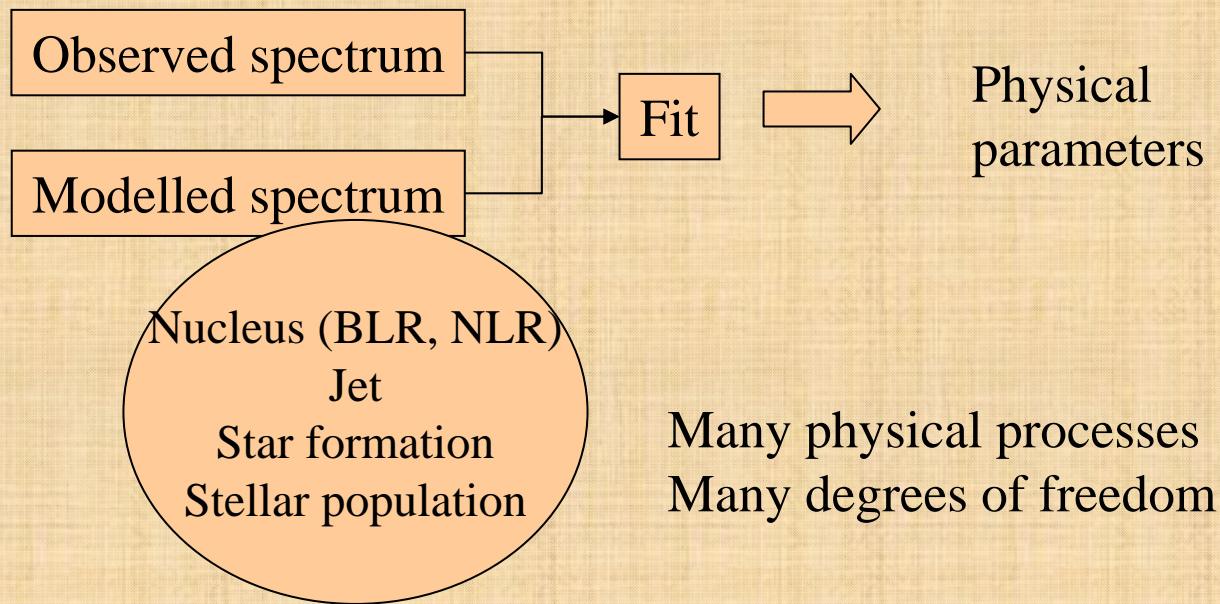
The interplay between the nucleus and the stellar population

- Study the AGN --> wish to *subtract* the stellar population
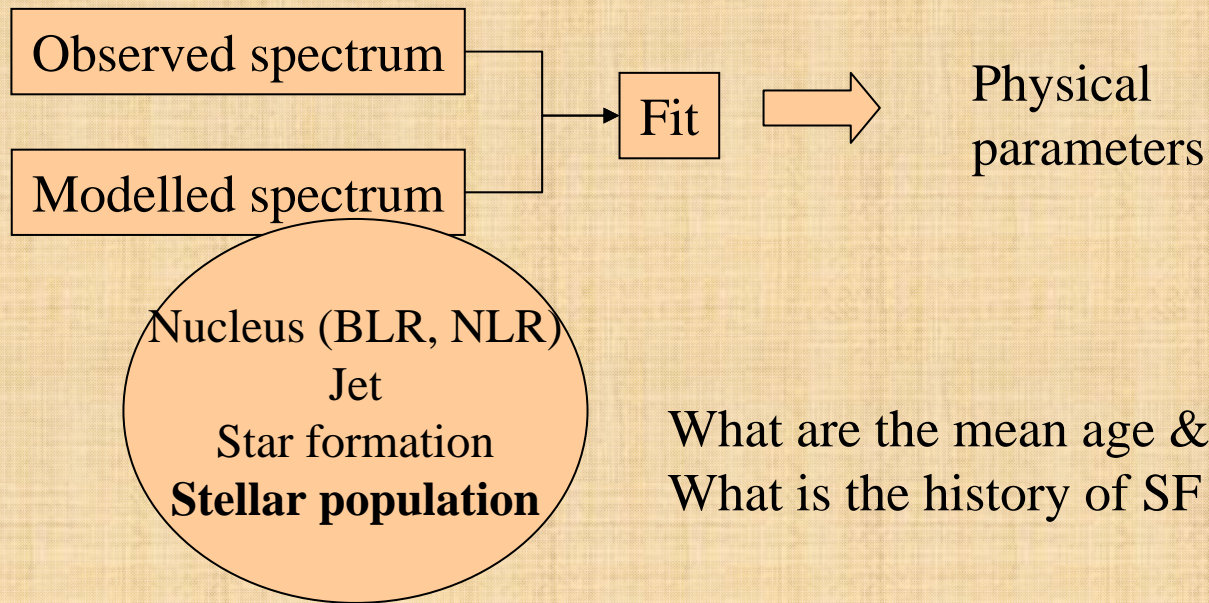- Search weak activity (small AGN)
- Study the stellar population

- Interpret observed spectra
- Integrated spatially and along the line of sight
- Composite spectra: Nucleus (NLR, BLR), jet, star forming region(s), stellar populations

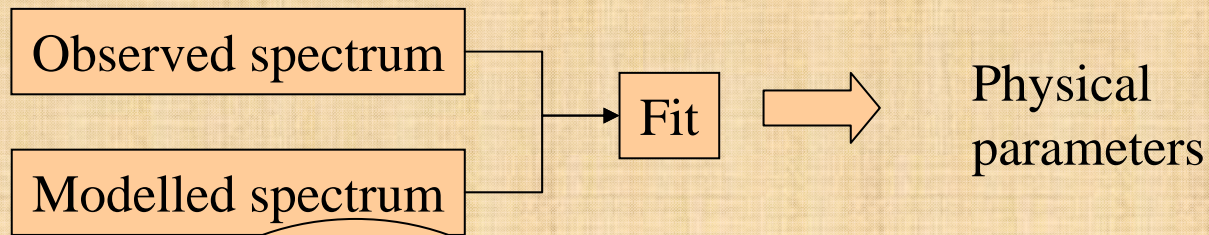==> Disentangle the stellar population from other components

Fitting spectra

Observed spectrum

Modelled spectrum

Fit ⟹ Physical parameters

Nucleus (BLR, NLR)
Jet
Star formation
Stellar population

Many physical processes
Many degrees of freedom

Fitting spectra

Observed spectrum

Modelled spectrum

Fit

Physical parameters

Nucleus (BLR, NLR)
Jet
Star formation
Stellar population

What are the mean age & metallicity?
What is the history of SF & metal?

Fitting spectra

Observed spectrum

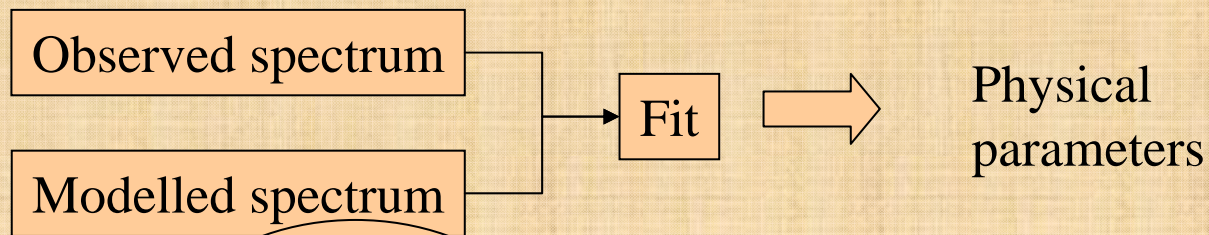Modelled spectrum

Fit

⟹

Physical parameters

Nucleus (BLR, NLR)
Jet
Star formation
Stellar population

SED fitting:
Not reliable … the shape of the continuum is sensitive to line-of-sight and internal extinction, flux calibration errors, ctn *nebular emission*
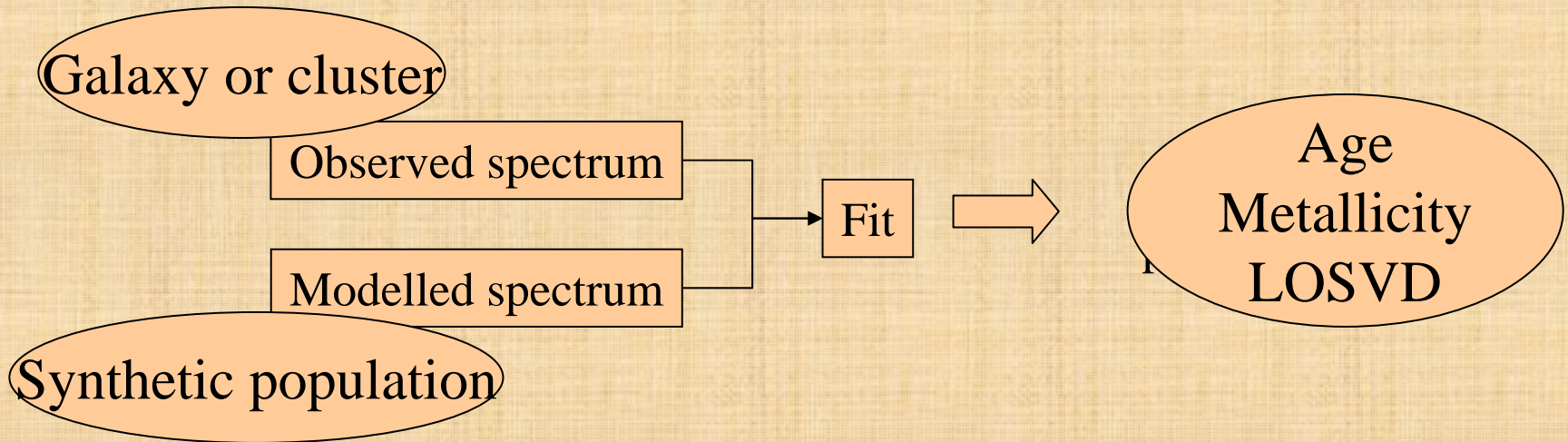
Fitting spectra

Observed spectrum ⟶ Fit ⟹ Physical parameters

Modelled spectrum

Nucleus (BLR, NLR)
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Star formation
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Spectrophotometric indices:
Not applicable.
Age indicators in the visible are the Balmer lines … filled with emission
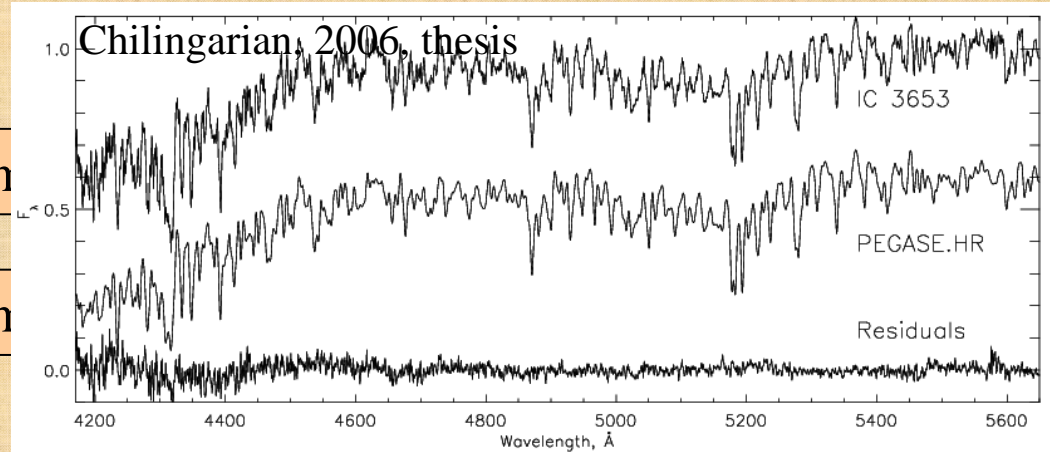
Full spectrum fitting

Galaxy or cluster

Observed spectrum

Fit

Modelled spectrum

Synthetic population

Age
Metallicity
LOSVD

Full spectrum fitting

Galaxy or cluster

Observed spectrum

Chilingarian, 2006, thesis

Modelled spectrum

Synthetic population

Optimal usage of the signal.
High spectral resolution: determine in the same time LOSVD & population parameters.
Insensitive to the shape of the continuum

Prugniel et al. 2003, 2007

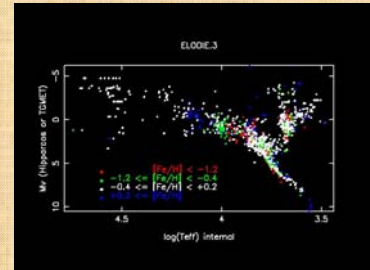# What can we tell of the stellar underlying an AGN?

- Assess the reliability of full spectrum fitting in simple cases (star clusters, pure stellar populations)

- Assess the reliability on AGN composite spectra

Reliability of full spectrum fitting

- Stellar libraries

- Population models
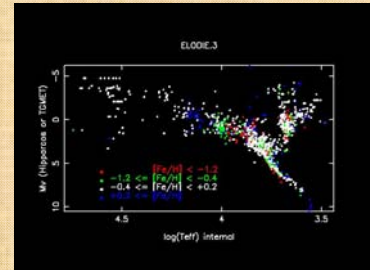
- Fit of star clusters

Reliability of full spectrum fitting

- Stellar libraries
- Population models
- Fit of star clusters

Library	year	N stars	Res	W range	F calib	P cover
Elodie	2001 +	**1388**	10000	390-680	good	good
Stelib	2003	249	2000	320-950	good	no
UVES-POP	2003	400	**80000**	**300-1000**	good	no
CFLIB	2004	1273	5000	346-946	no	good
Miles	2006	985	2000	352-750	good	good

Reliability of full spectrum fitting

- Stellar libraries
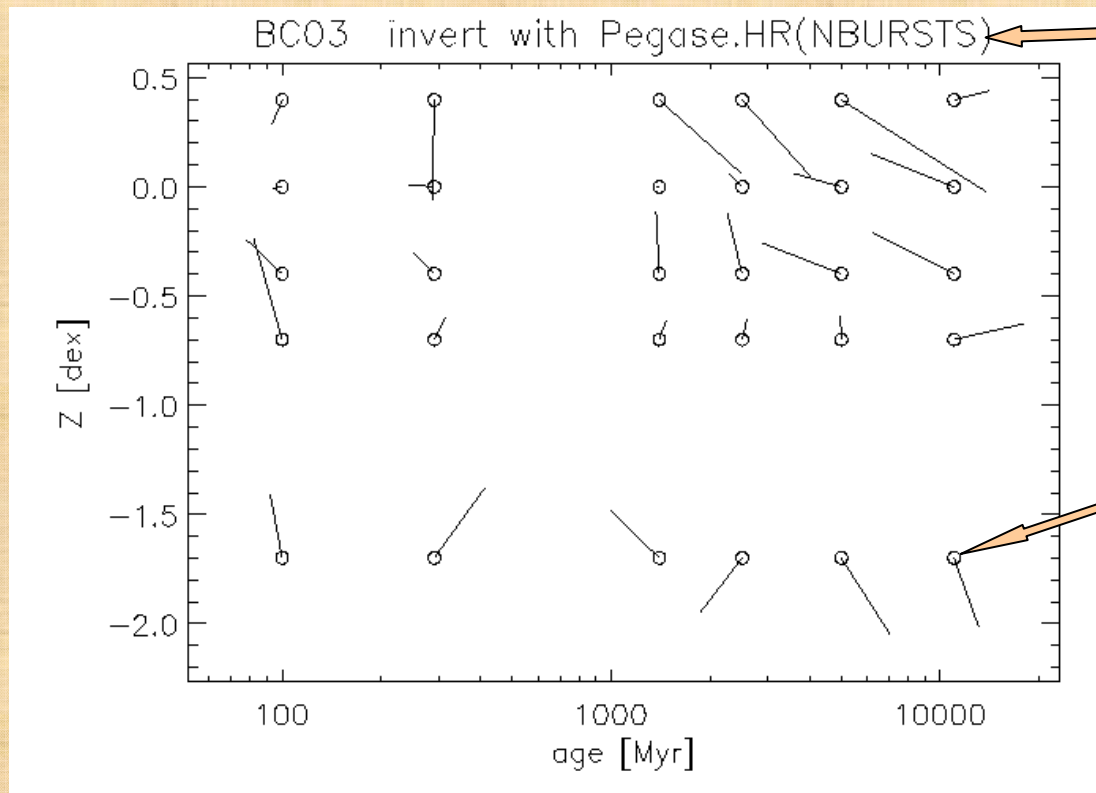- Population models
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Reliability of full spectrum fitting

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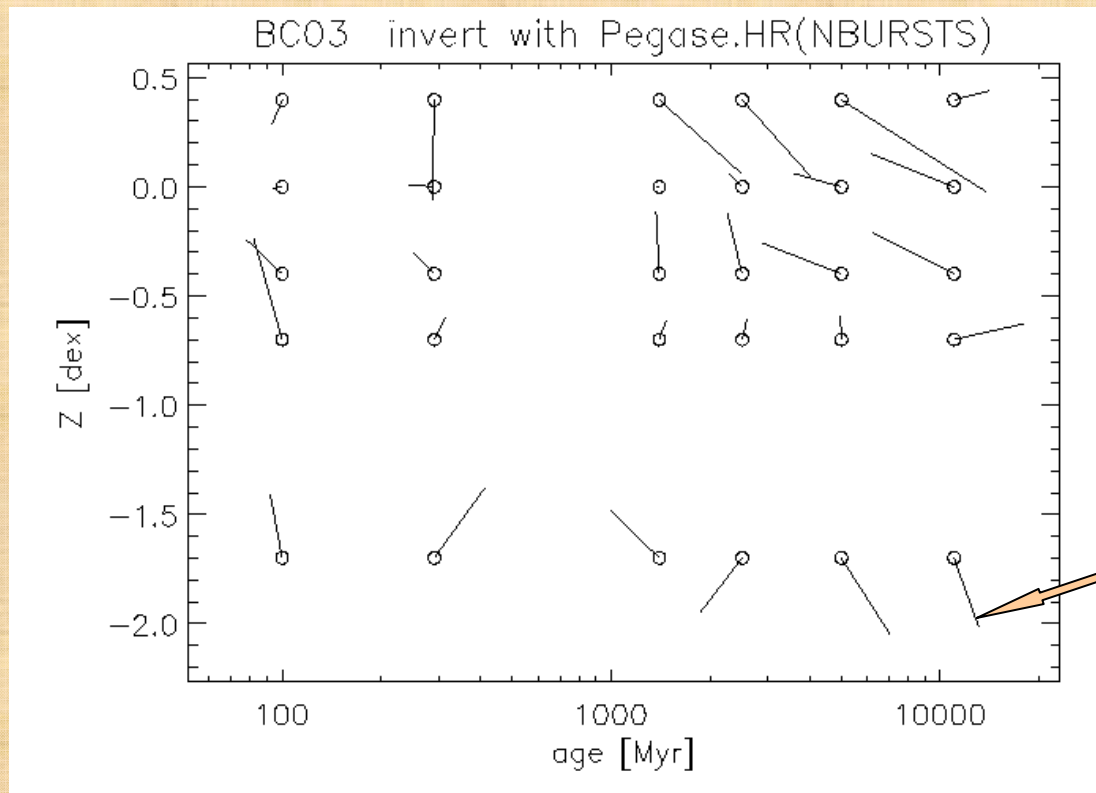- Fit of star clusters

Comparison between models

SSPs

Chi2 parametric age, metallicity, LOSVD

Bruzual & Charlot '03
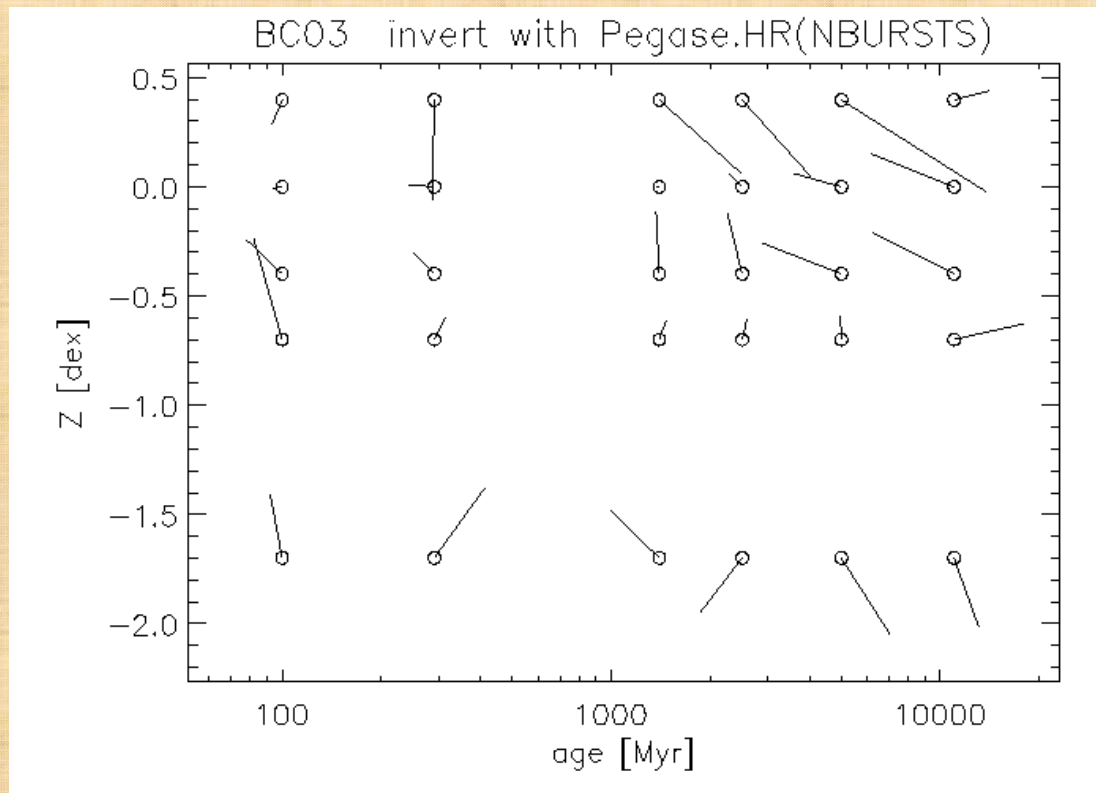
Comparison between models

SSPs

Inversion by
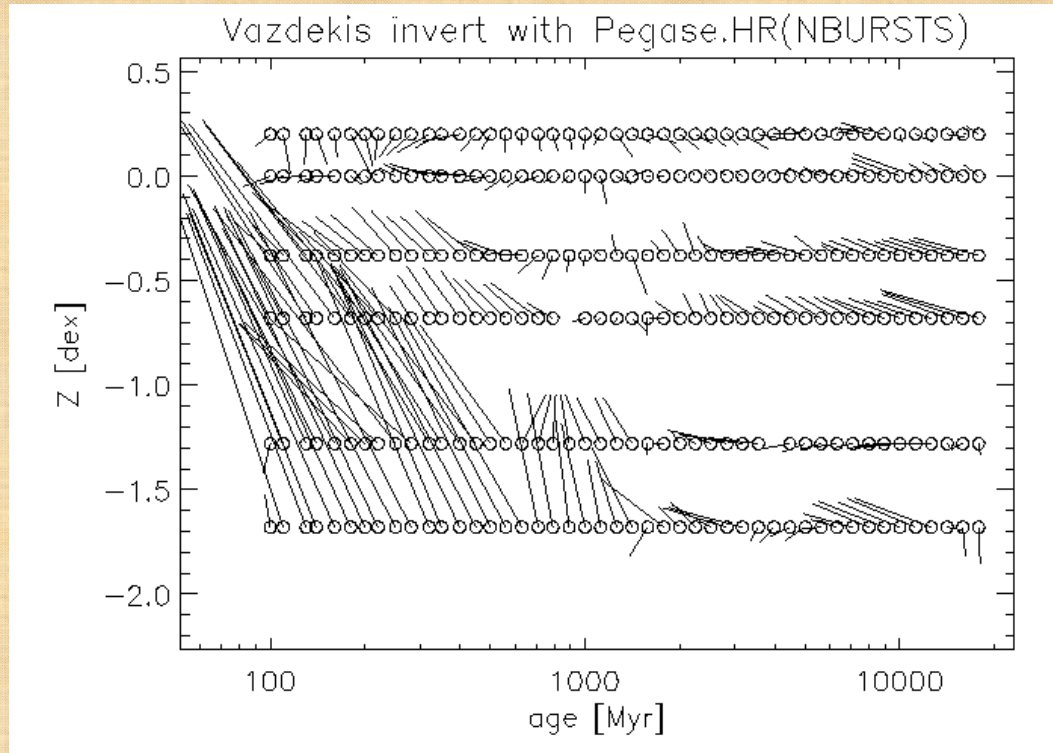Pegase.HR

Le Borgne + ,04

Comparison between models

SSPs

Convergence toward solar metallicity

Comparison between models

Inversion of Vazdekis-Miles (Sanchez-Blazquez, 2006) models with a grid of Pegase.HR models with NBURSTS, Koleva et al. 2007
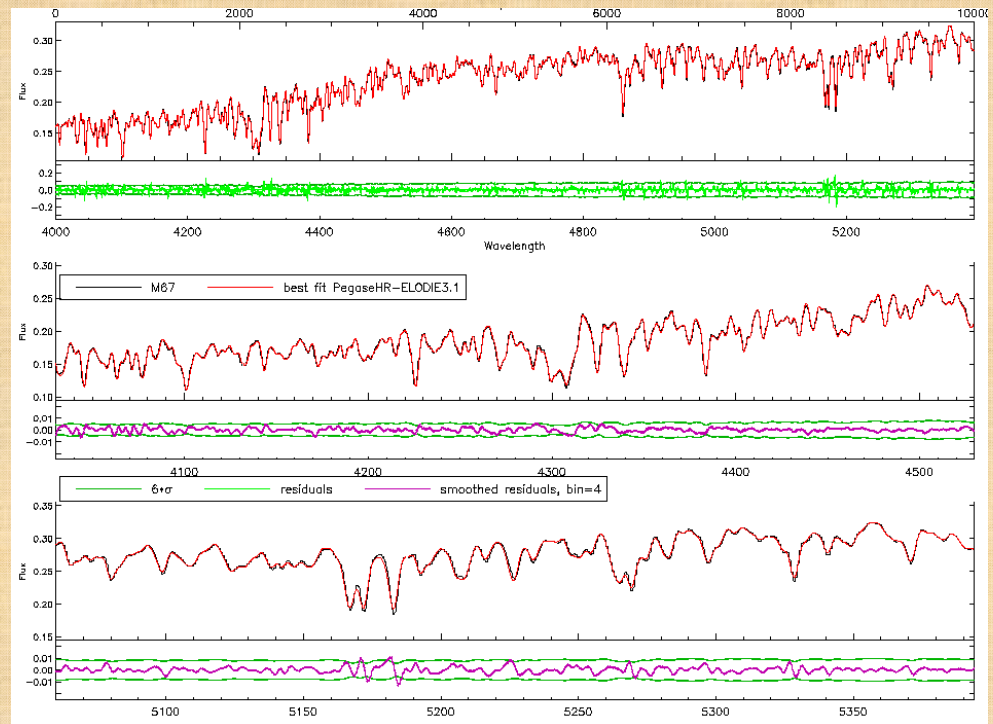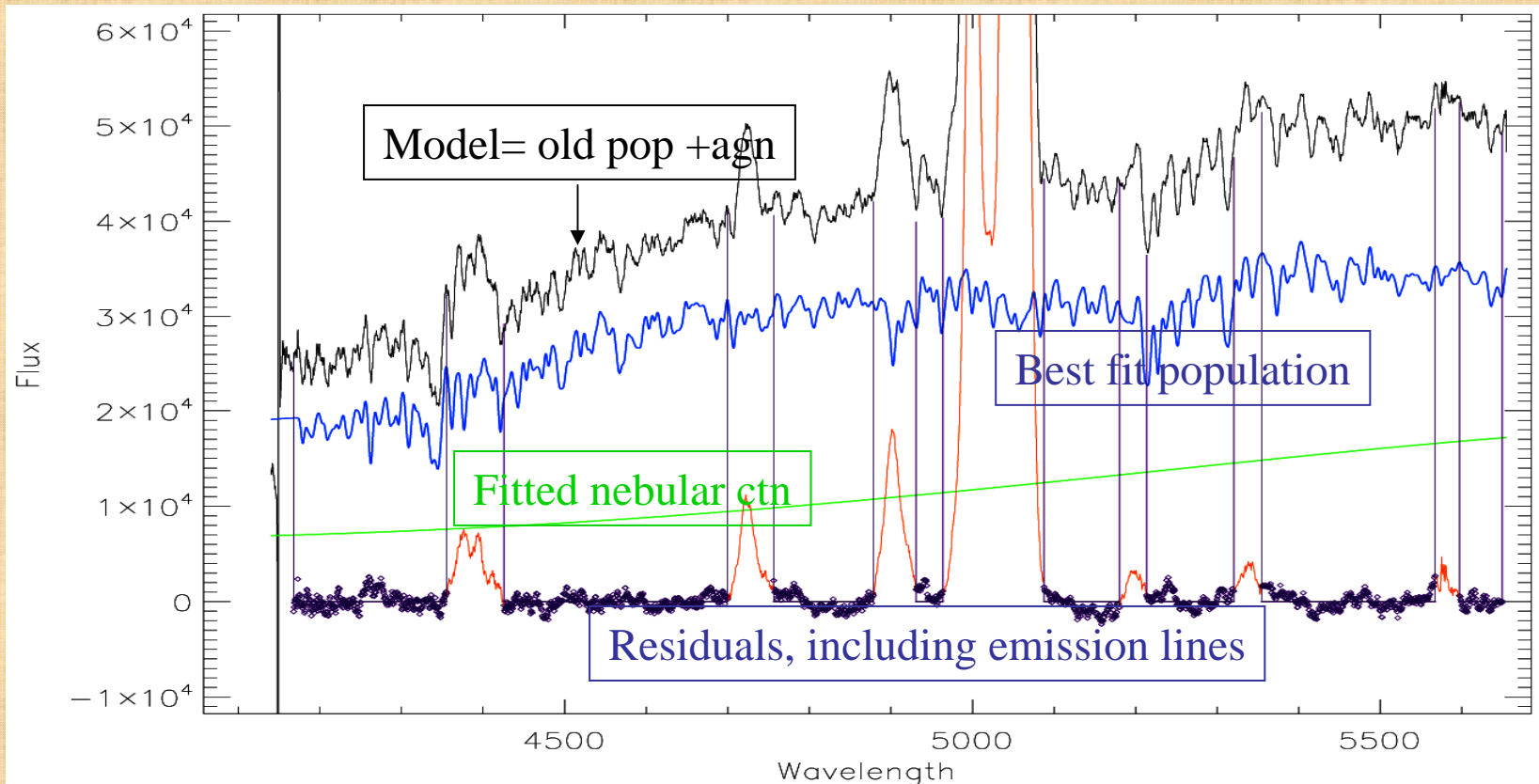
Reliability of full spectrum fitting

- Stellar libraries
- Population models
- Fit of star clusters

Precision of the modelling of real spectra is better than 1%

Inversion of M67 and of Globular Clusters
(Schiavon et al. 2005) , see Koleva et al. 2007

Stellar population + AGN: simulations

Prugniel, Chilingarian & Popovic 2005, Vth Serbian..

Stellar population + AGN: simulations

Simulation	Velocity dispersion (km/s)	Age (Gy)	Metallicity (dex)	Fraction of AGC ctn at 550 nm	Fraction of AGN (PEGASE.HR inversion)
Stellar 1	109±2	5.7±0.2	-0.14±0.02	n/a	n/a
Stellar 2	110±2	4.5±0.3	-0.05±0.02	n/a	n/a
Stellar 3	106±2	7.1±0.3	-0.07±0.02	13 %	1 %
AGN 0%	107±2	7.4±0.6	0.04±0.02	15 %	1 %
AGN 25%	107±2	6.1±0.3	-0.04±0.02	31 %	20 %
AGN 50%	110±2	6.1±0.3	-0.22±0.04	44 %	33 %

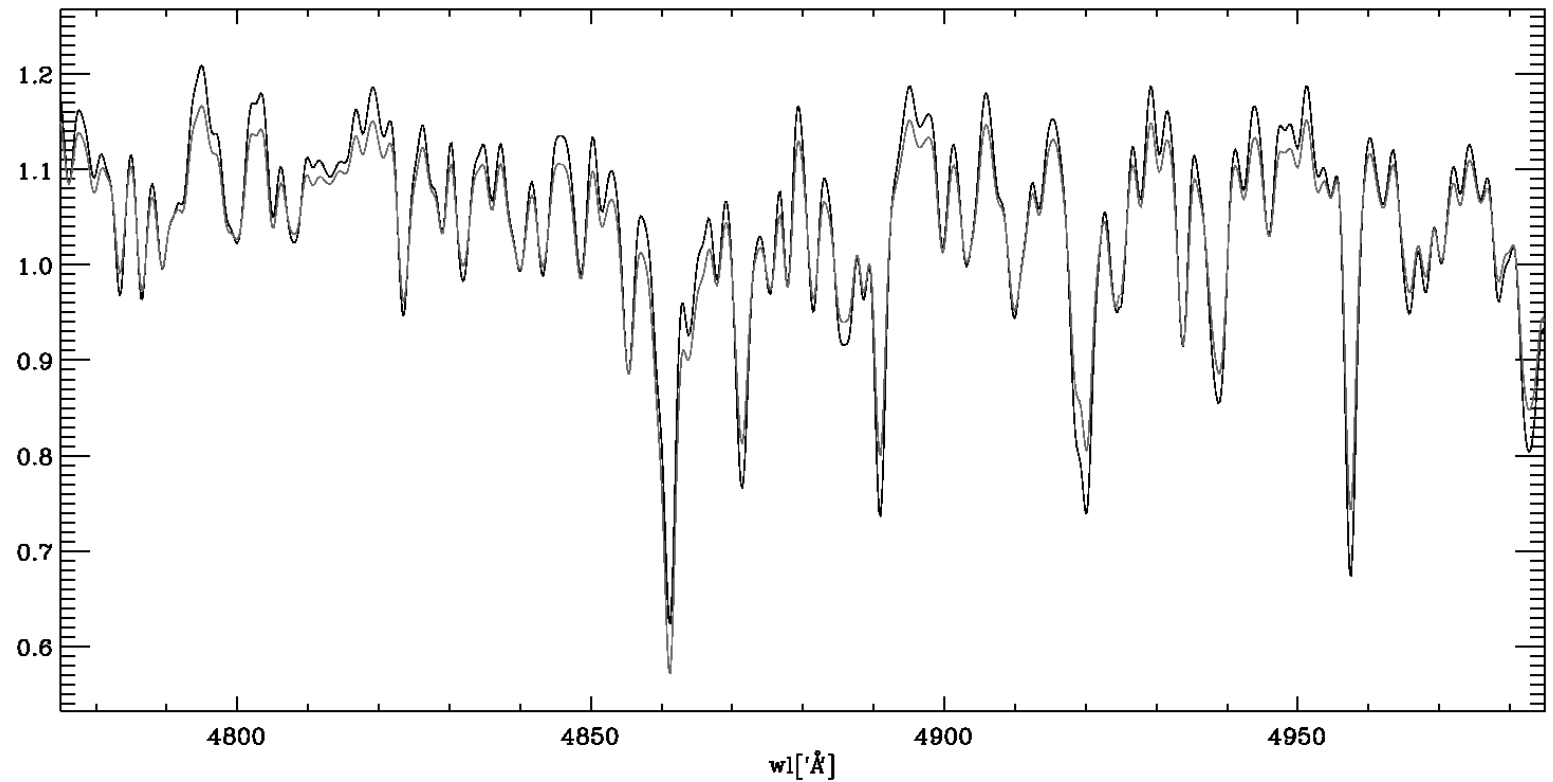|	
Stellar 1	Pure stellar population, fitted on the whole spectral range
Stellar 2	Stellar population with the wavelength ranges of line emission masked
Stellar 3	Stellar emission fitted with additive continuum on the whole spectral range

Flux

Summary

- To study the interplay between the nucleus and the stellar population, we need to analyse composite spectra

- With new methods, it becomes possible to reliably constrain the stellar population underlying the AGN

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- To study the interplay between the nucleus and the stellar population, we need to analyse composite spectra

- With new methods, it becomes possible to reliably constrain the stellar population underlying the AGN

- Thanks to recent progress on models and observations, spectral analysis relies more and more on *Spectral line Shape*

Summary

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