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

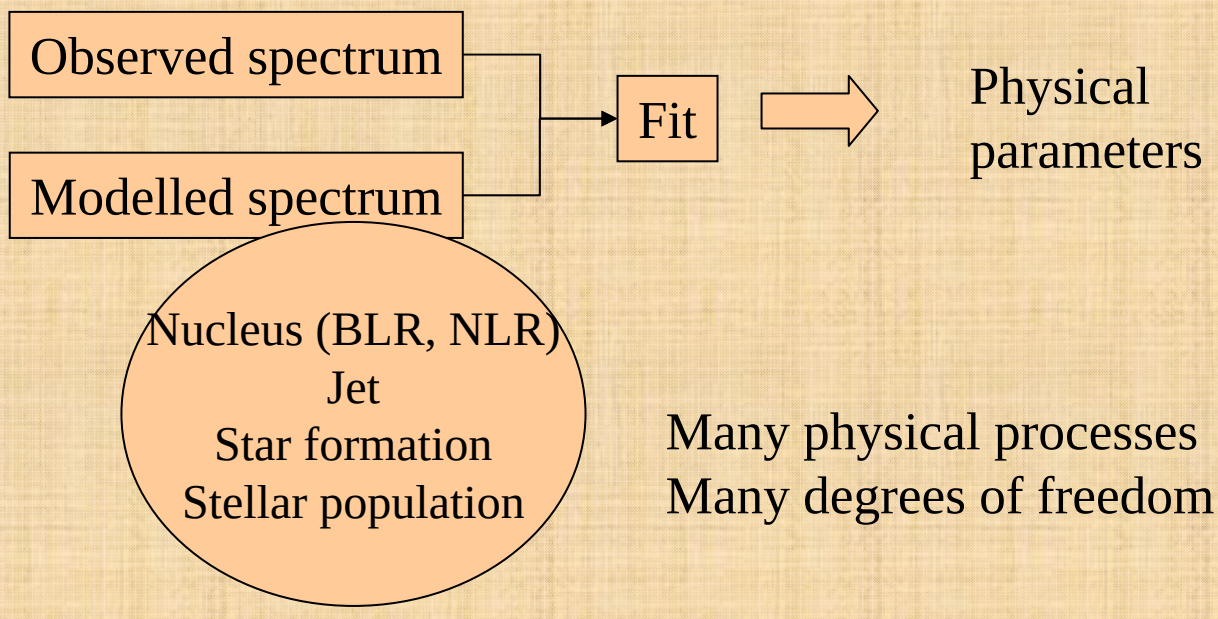
The interplay between the nucleus and the stellar population

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

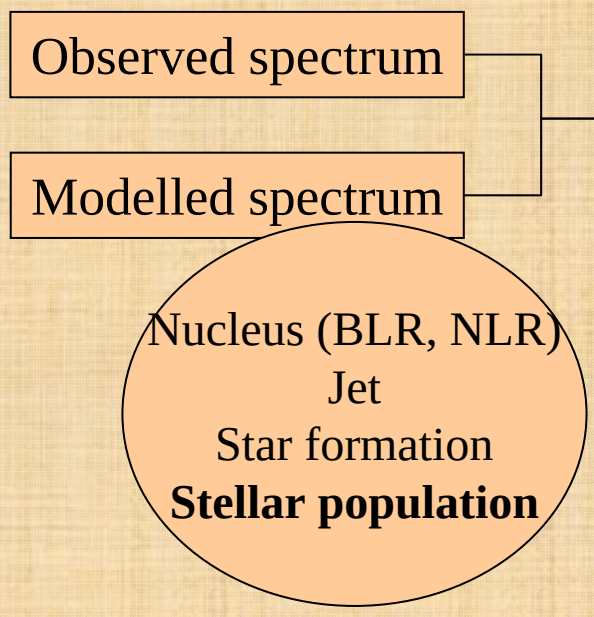
- Interpret observed spectra
- Integrated spatially and along the line of sight
- Composite spectra: Nucleus (NLR, BLR), jet, star forming region(s), stellar populations

==> Disentangle the stellar population from other components

Fitting spectra

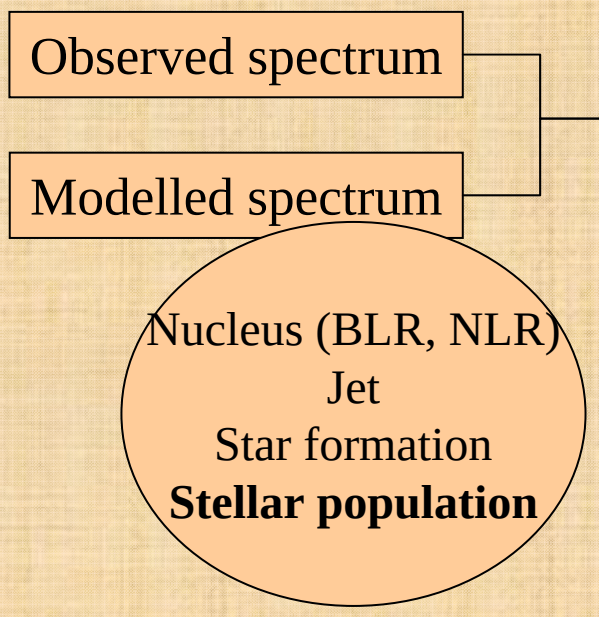


Fitting spectra



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

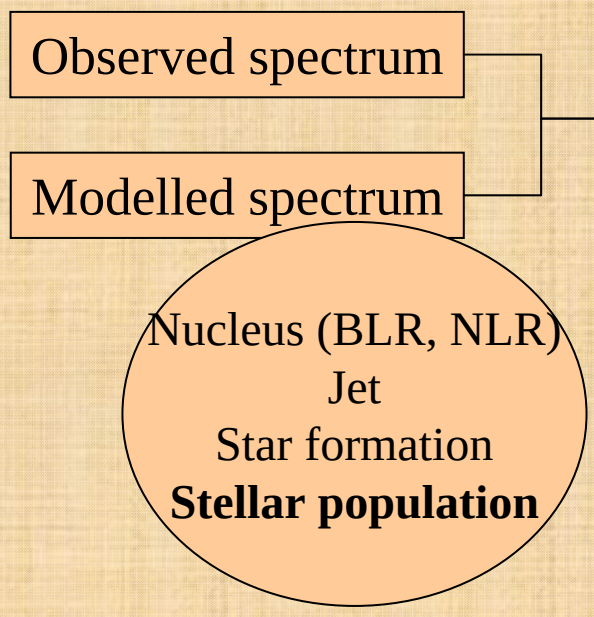
Fitting spectra



SED fitting:

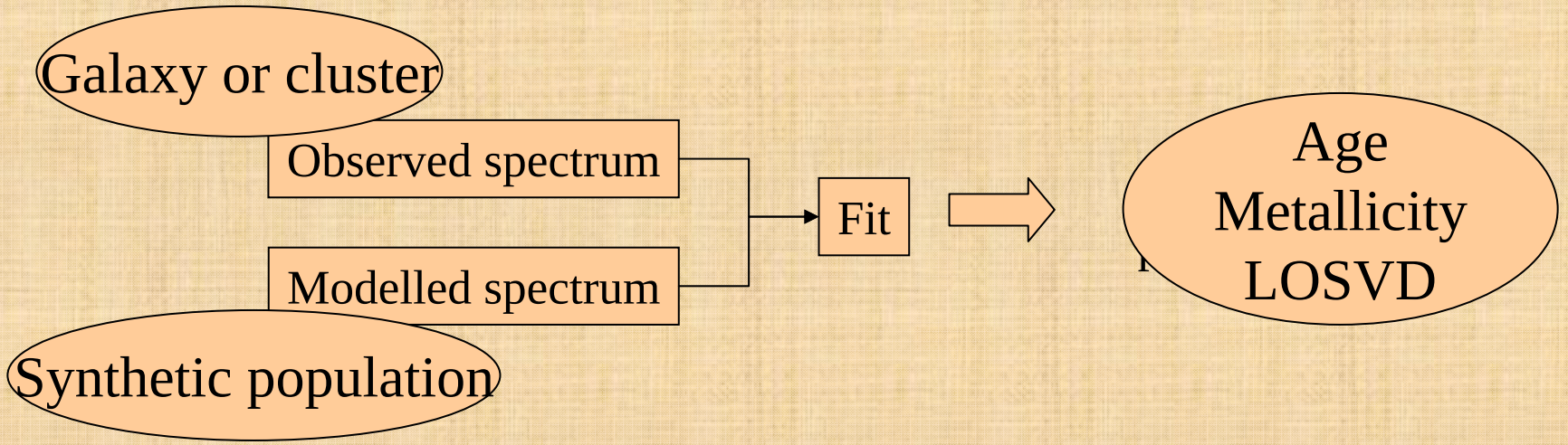
Not reliable … the shape of the continuum is sensitive to line-of-sight and internal extinction, flux calibration errors, ctn *nebular emission*

Fitting spectra



Spectrophotometric indices:
Not applicable.
Age indicators in the visible are the Balmer lines … filled with emission

Full spectrum fitting



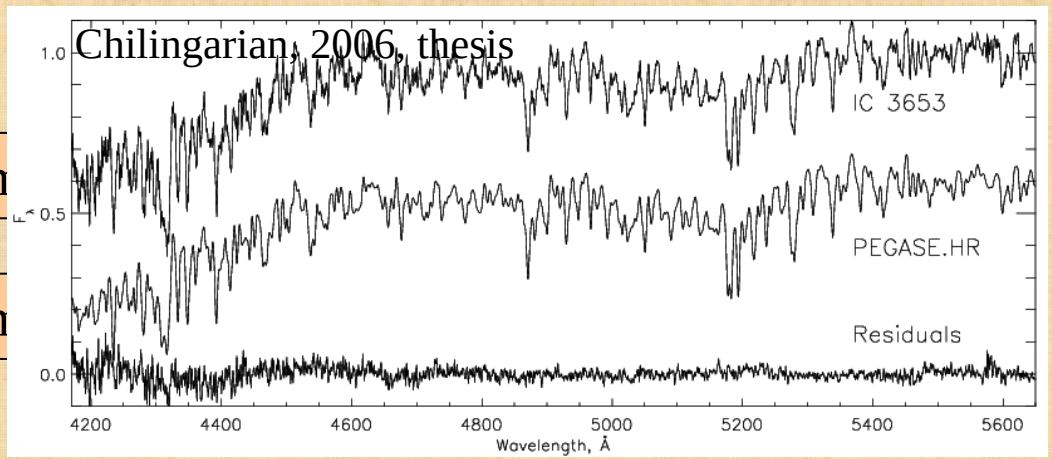
Full spectrum fitting

Galaxy or cluster

Observed spectrum

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

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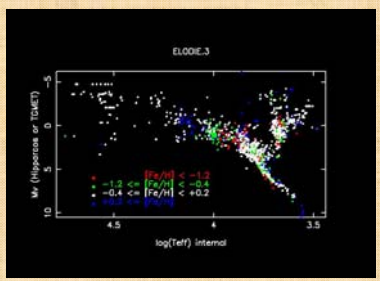

Library	year	*N stars*	*Res*	*W range*	*F calib*	*P cover*
Elodie	2001 +	**1388**	10000	390-680	good	good
Stelib	2003	249	2000	320-950	good	no
UVES-POP	2003	400	**80000**	**300-1000**	good	no
CFLIB	2004	1273	5000	346-946	no	good
Miles	2006	985	2000	352-750	good	good

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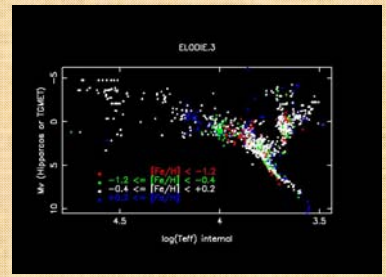

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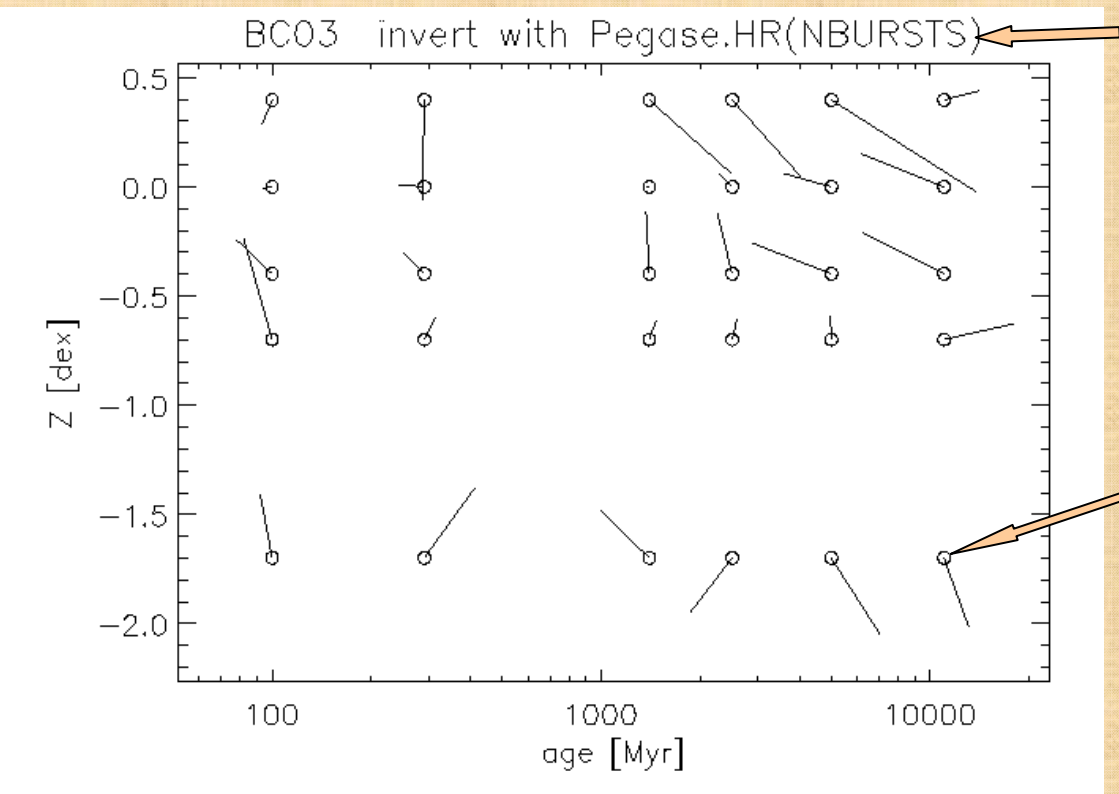
Comparison between models

SSPs

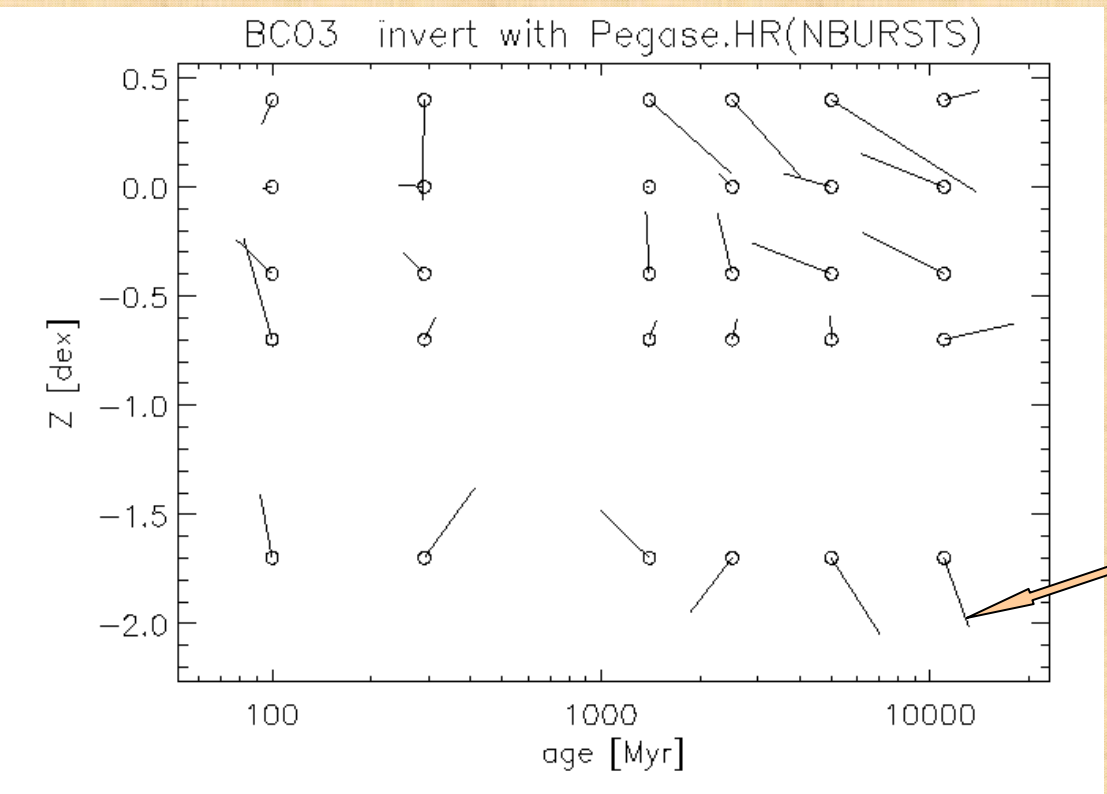


Chi2 parametric age, metallicity, LOSVD

Bruzual & Charlot ‘03

Comparison between models

SSPs

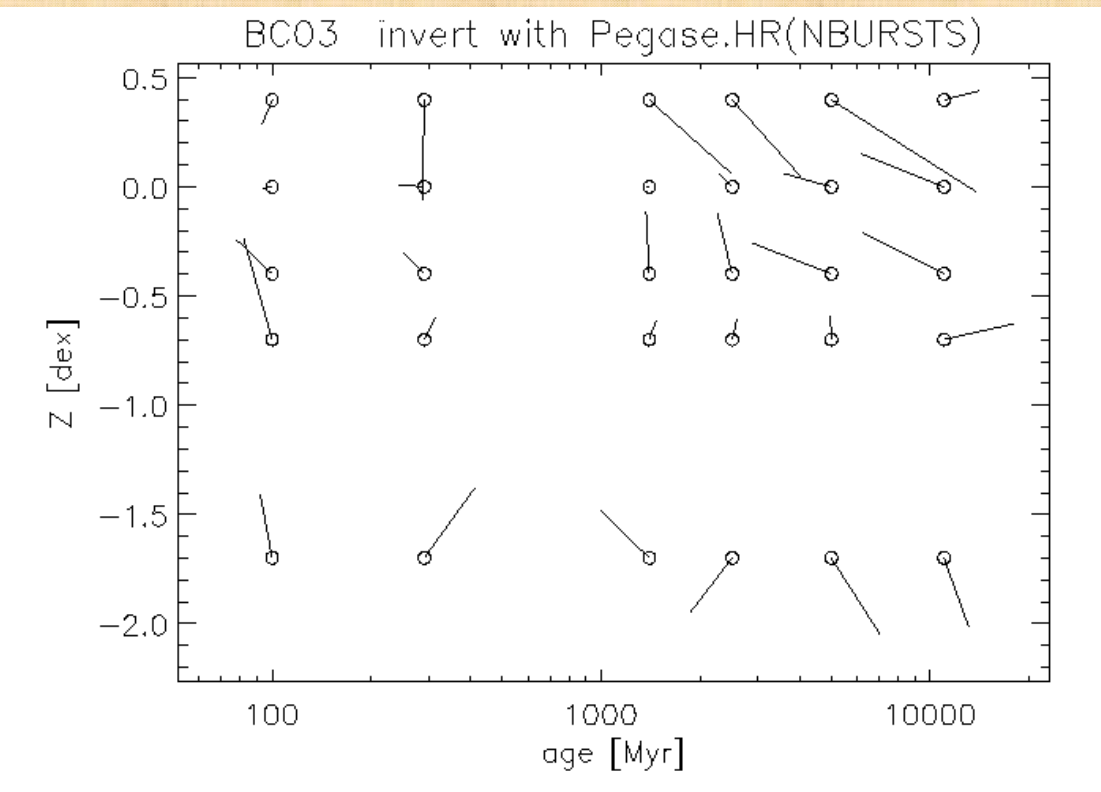


Inversion by Pegase.HR

Le Borgne + ,04

Comparison between models

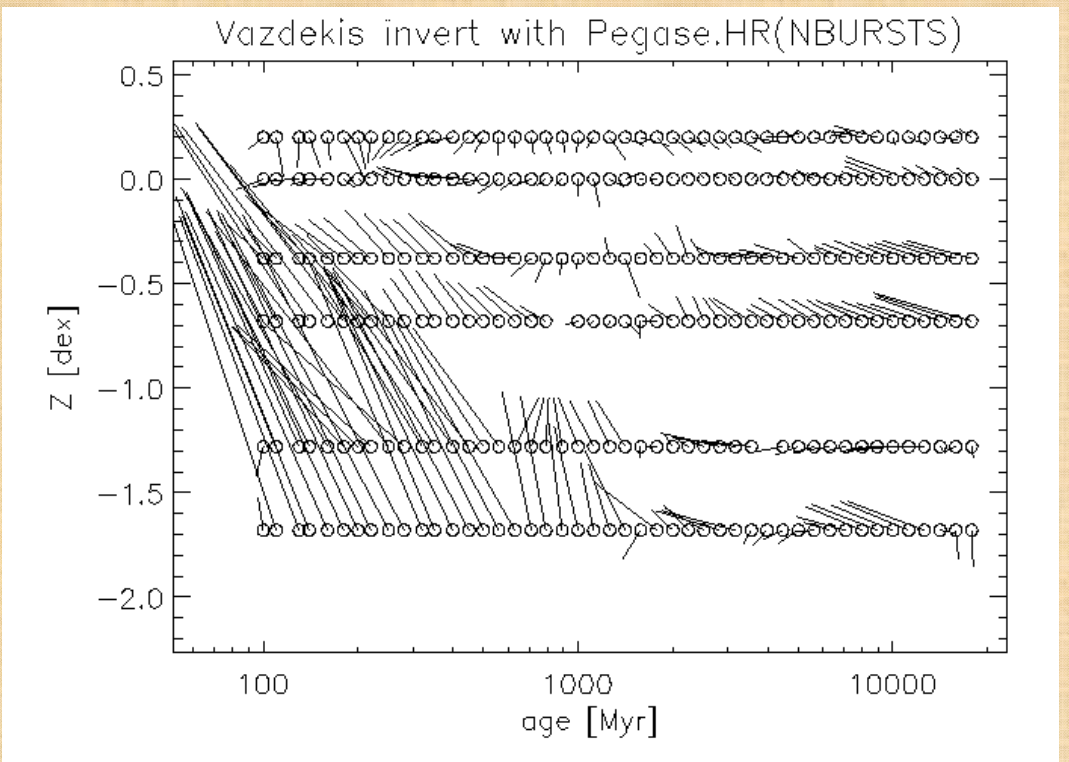
SSPs



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



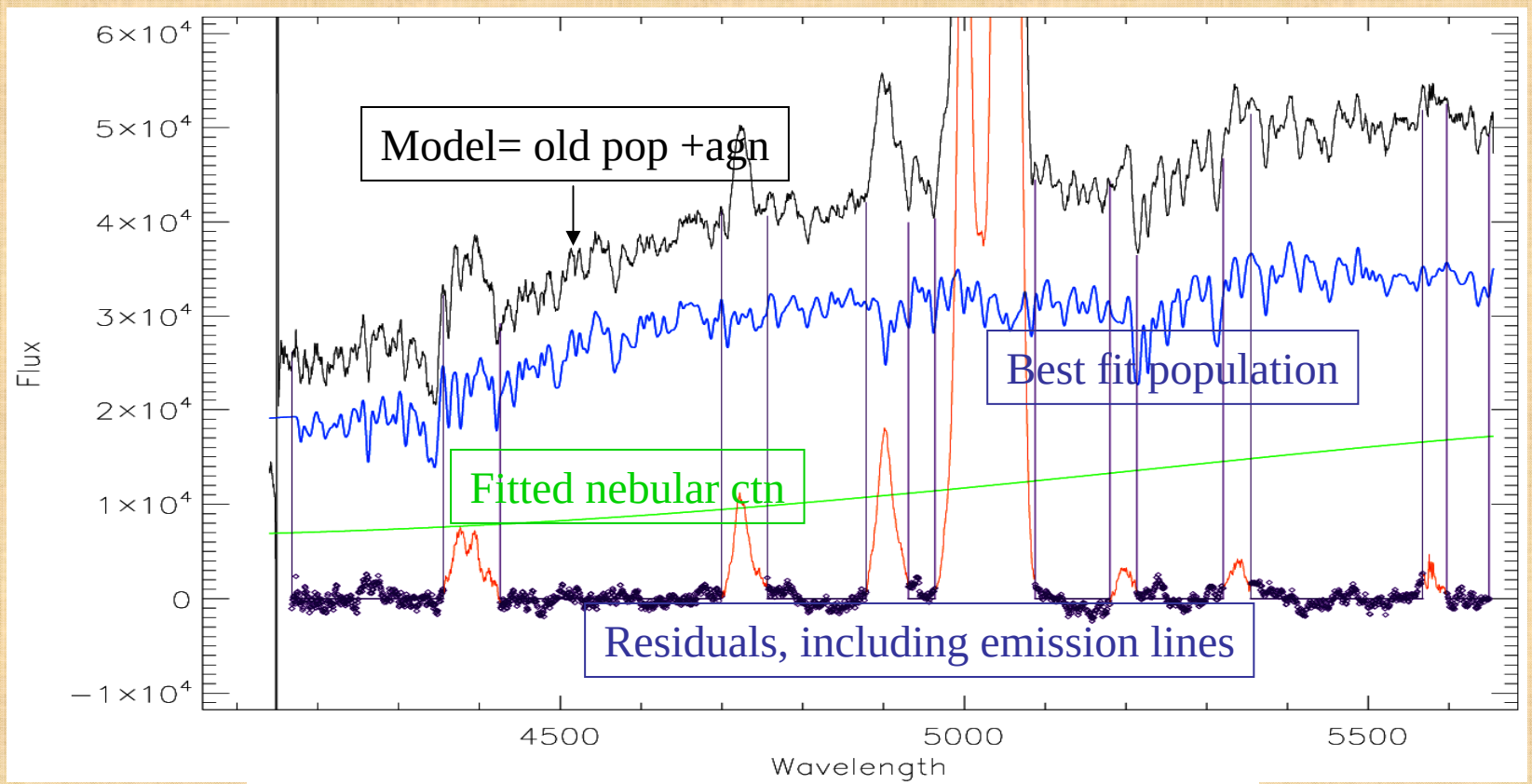
Reliability of full spectrum fitting

- 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

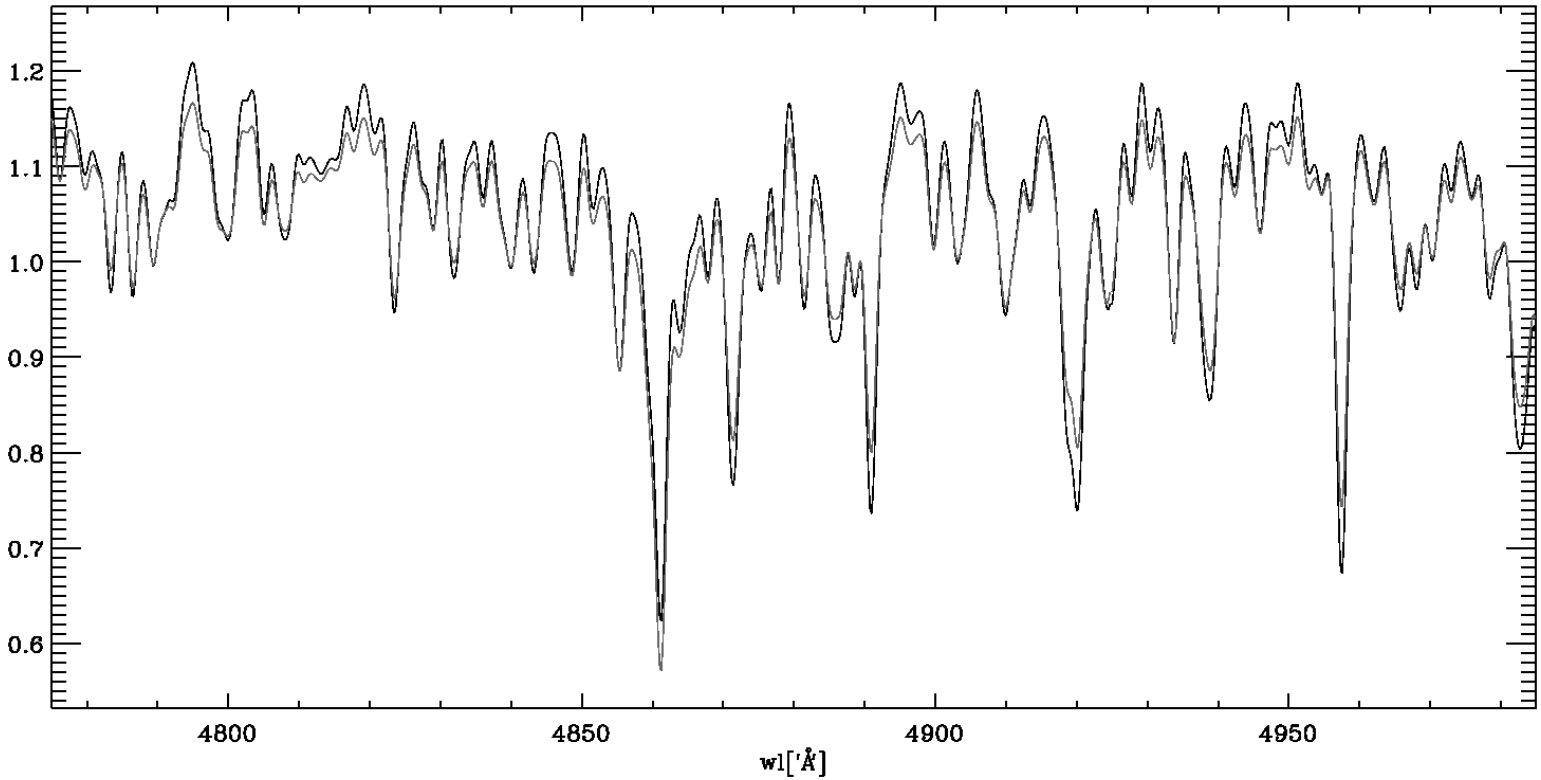
Summary

- 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

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

Summary



Summary