Relative merits of different types of observations to constrain galaxy physical parameters

Camilla Pacifici - *Yonsei University Observatory*
Stephane Charlot, Susan Kassin, Sukyoung Yi

KIAS Workshop - Cosmology and Structure Formation
1st November 2012, Seoul

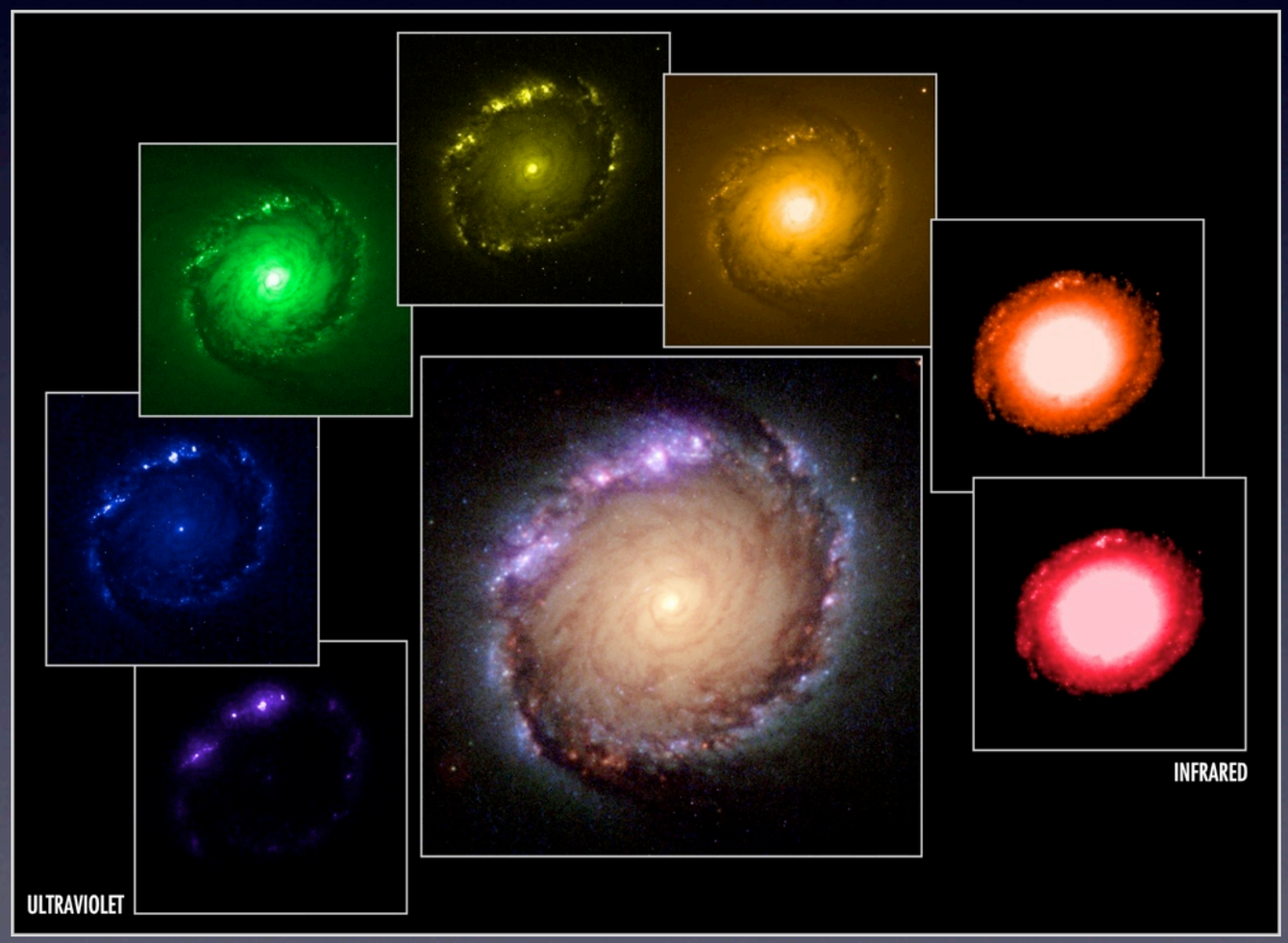
Outline

- Motivation
- Modeling approach
- Assess relative merits of different types of observations to constrain physical parameters
- Current and future applications
    - assessing the star formation histories of DEEP2 galaxies

Motivation

Galaxies...

- how do they form?
- how do they evolve?
- what are they made of?



characterize physical properties of galaxies from their light

MODELS

priors

pseudo data

known physical parameters

real data

unknown physical parameters

sed-interpretation techniques

accuracy and uncertainty in estimates of physical parameters

estimates of physical parameters

Models

required to relate observables to physical parameters

build library of galaxy spectra which can best reproduce a wide range of observables

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star formation and chemical enrichment histories

+

emission by the stars

+

emission by the gas

+

effect of the dust

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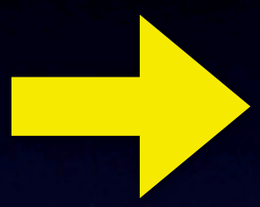
required to relate observables to physical parameters



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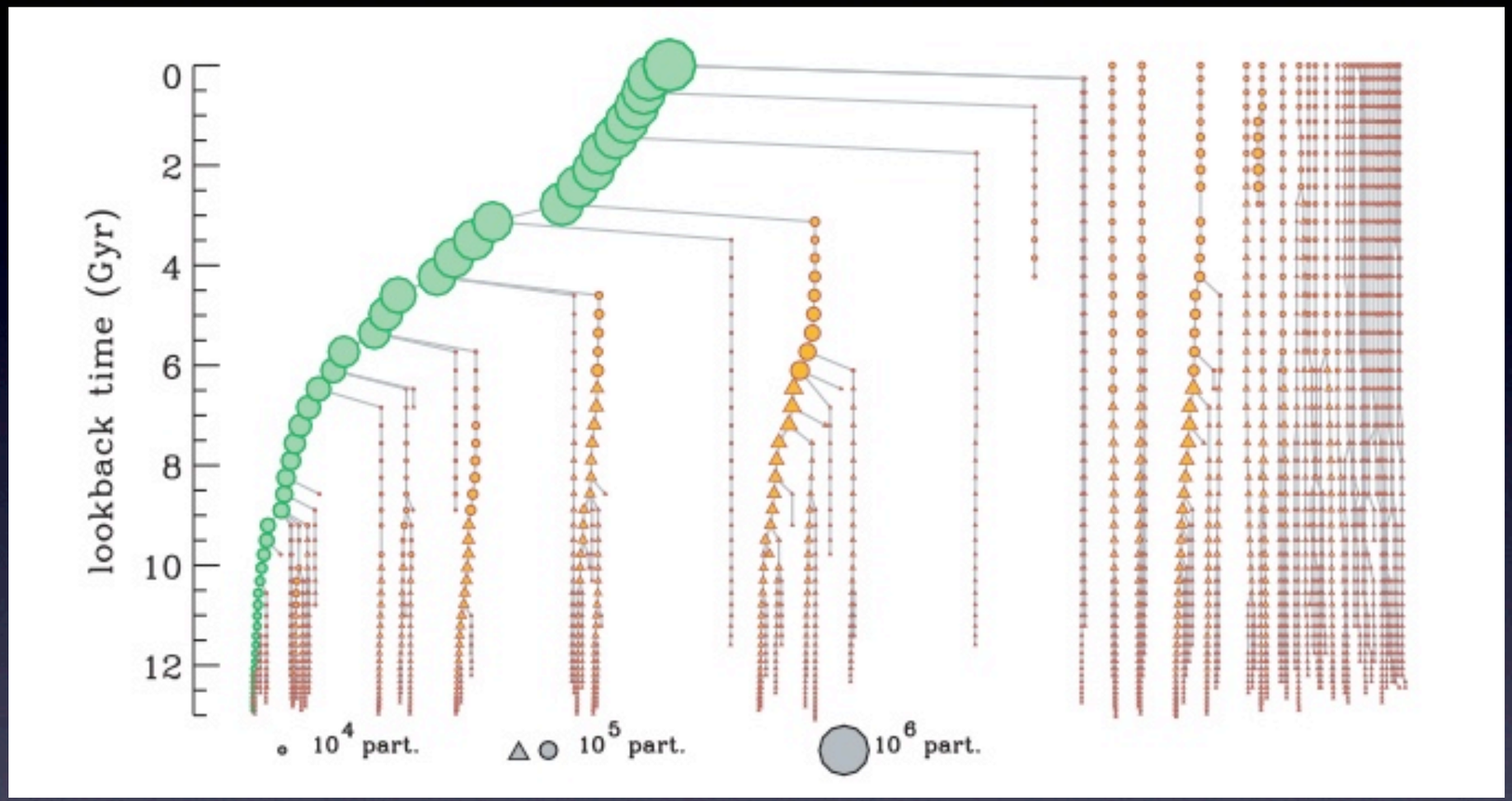
Library of SF and chemical enrichment histories



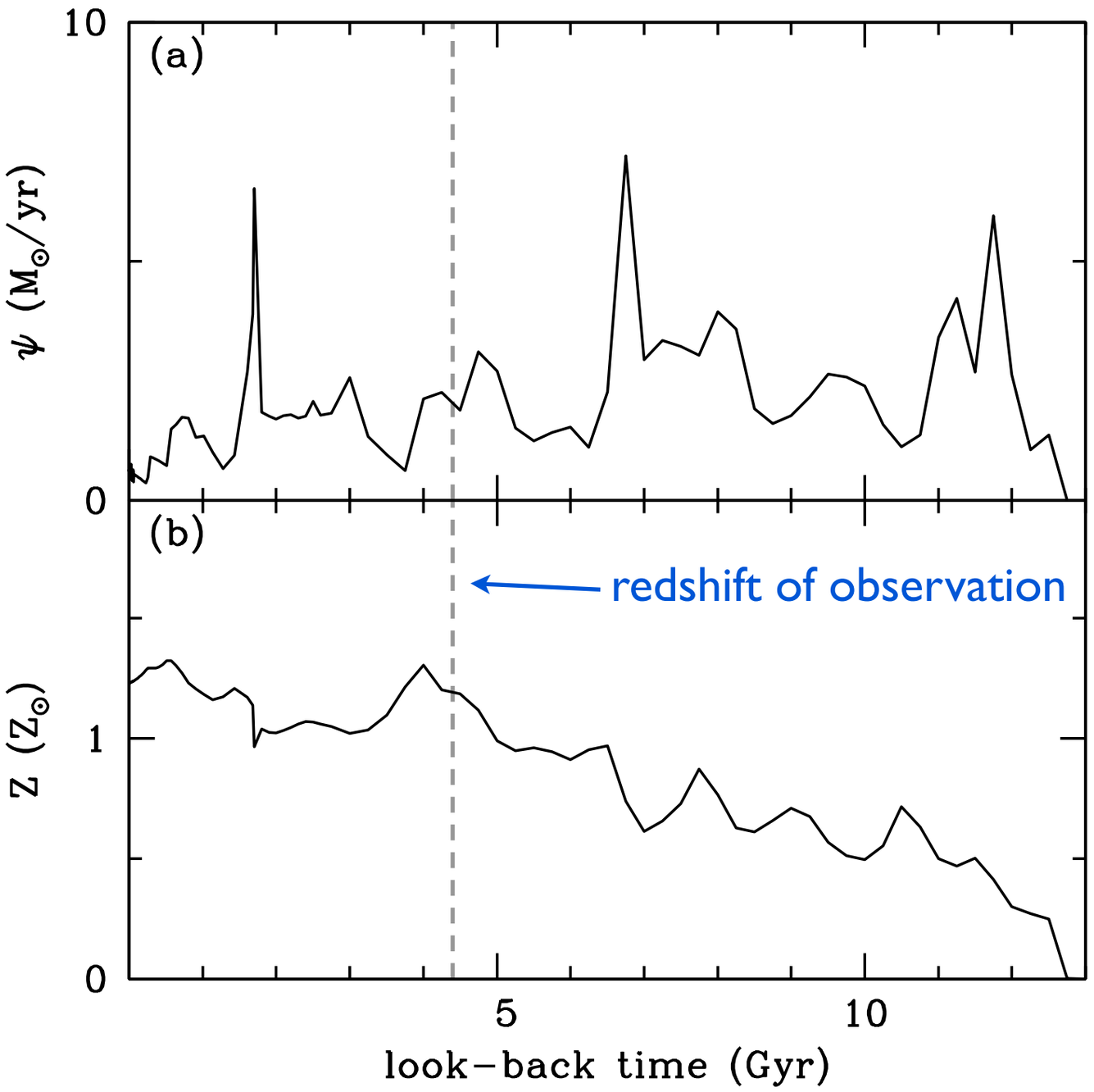
Springel et al. (2005)
Croton et al. (2006)
De Lucia & Blaizot (2007)

merger tree of dark matter halos

semi-analytic post-processing of the Millennium Simulation

- minor and major mergers
- trigger of star formation
- AGN and SN feedback

Library of SF and chemical enrichment histories



semi-analytic post-processing of the Millennium Simulation

Springel et al. (2005)
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draw 5,000,000 model galaxies in wide ranges of physical parameters and evolutionary stages

Models

required to relate observables to physical parameters

→ build library of galaxy spectra which can best reproduce a wide range of observables

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Pacifici et al. (2012), MNRAS

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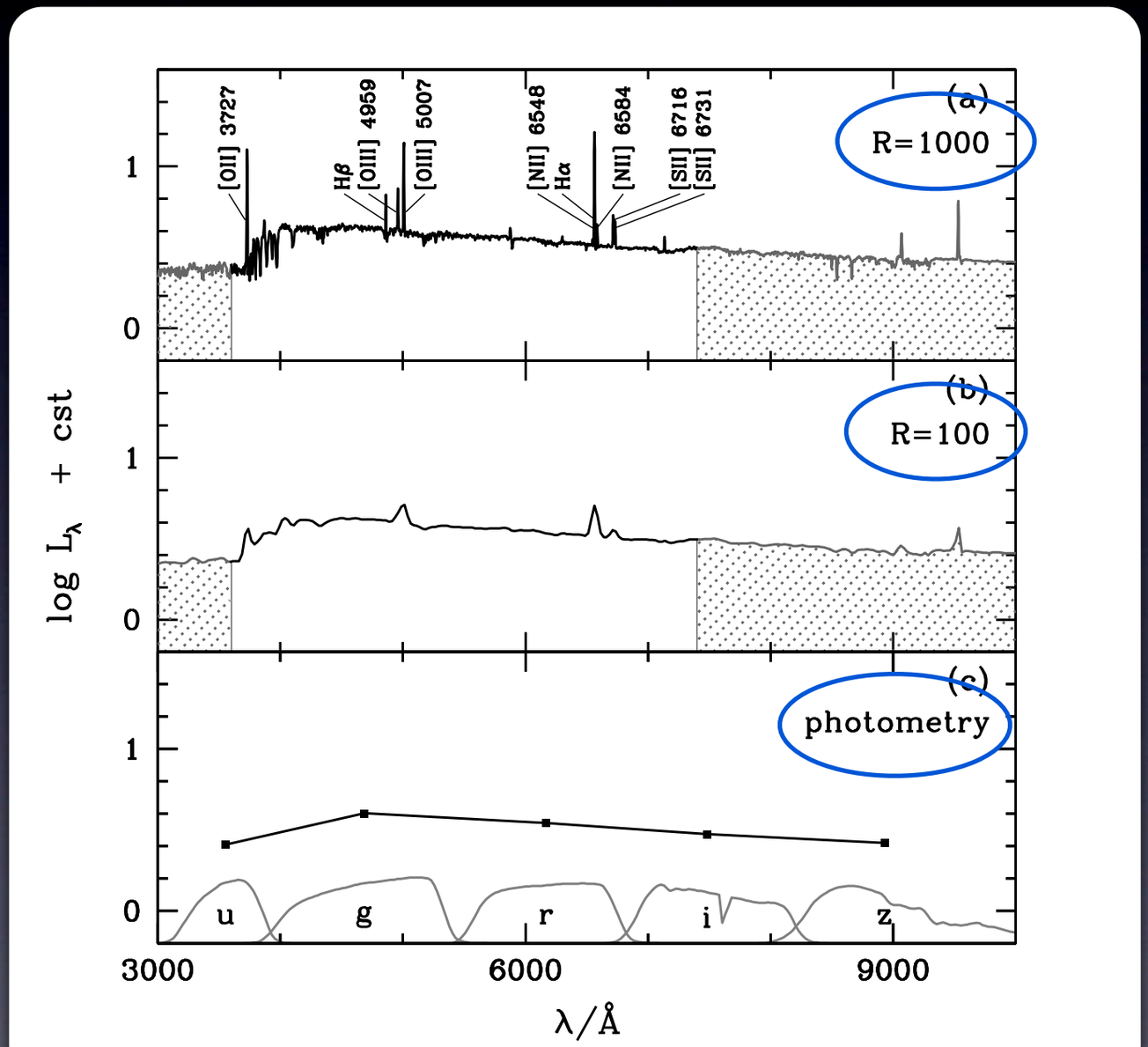
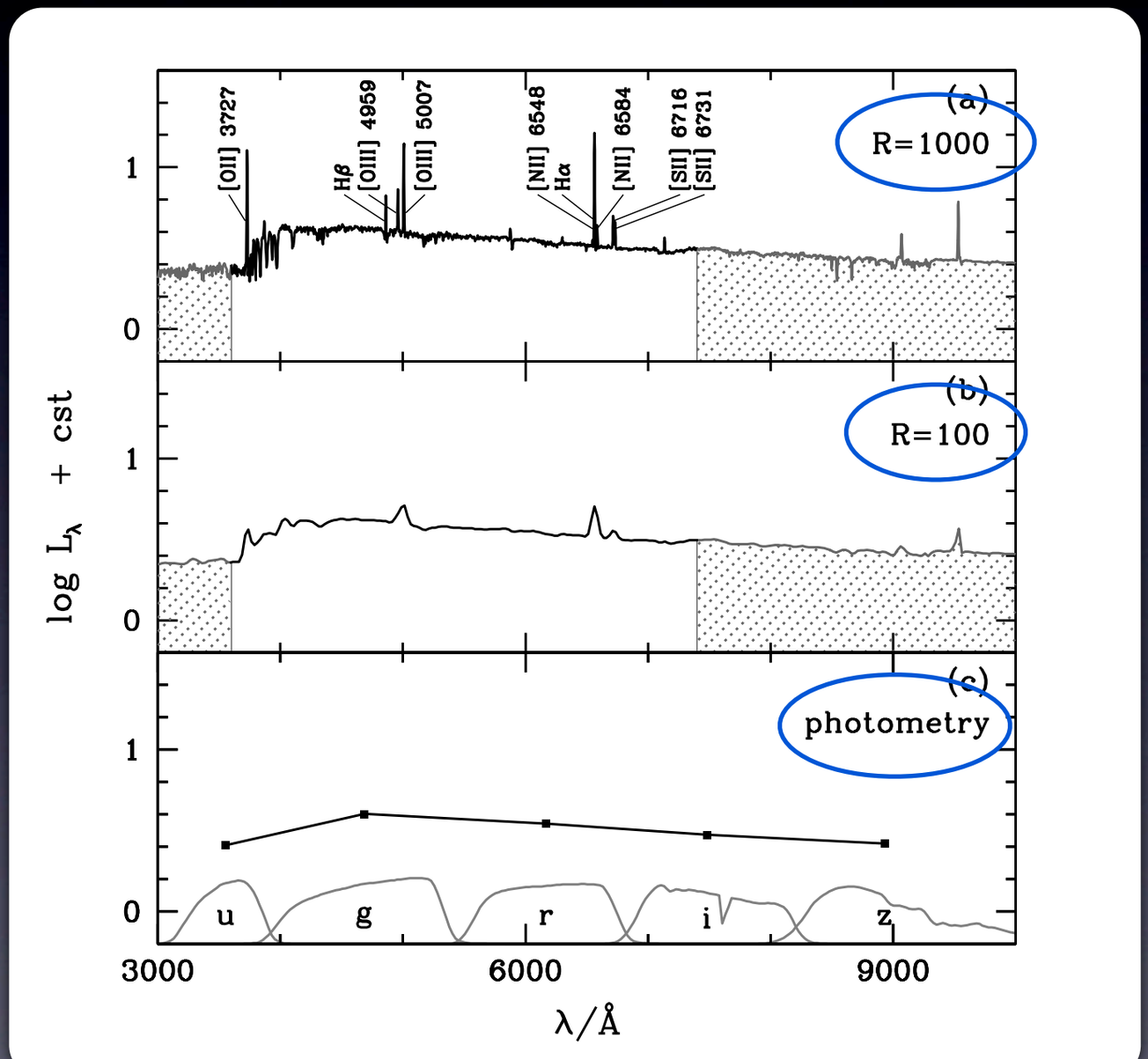
Building pseudo-observations



use these models to generate SEDs of 5 millions galaxies in the library

estimate physical parameters of observed galaxies by comparison with every model in library (Bayesian)

Building pseudo-observations

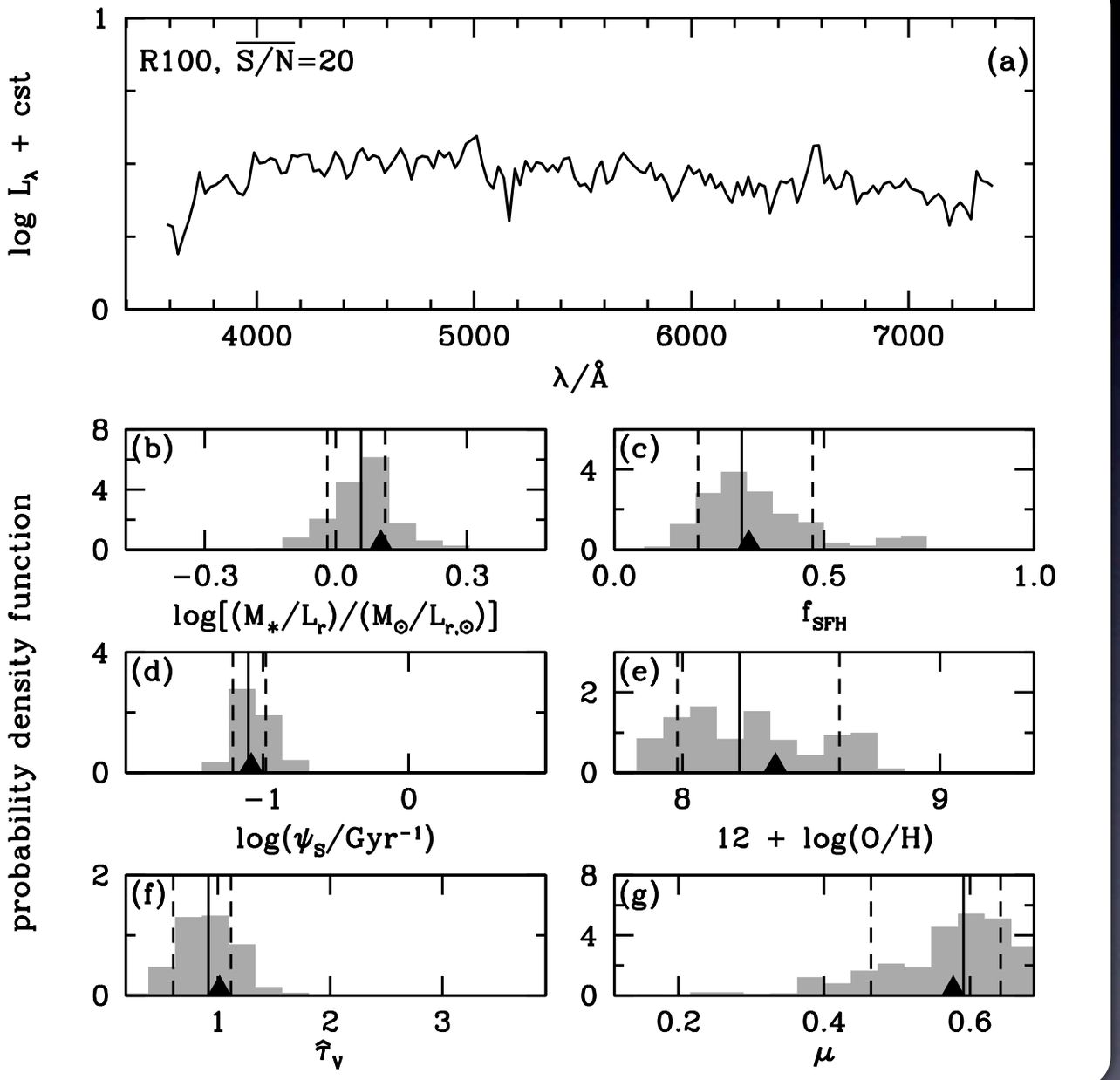


Pacifici et al. (2012), MNRAS

main feature: stellar continuum and nebular emission fitted simultaneously

estimate physical parameters of observed galaxies by comparison with every model in library (Bayesian)

Example of parameter retrieval



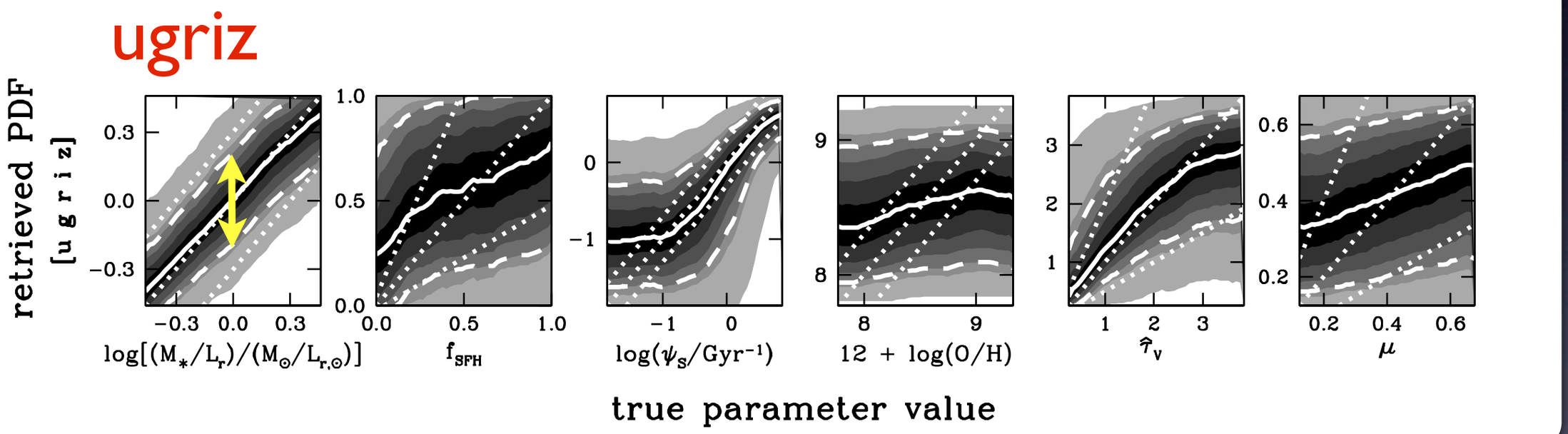
SPECTRAL FIT

rest-frame optical spectrum
S/N~20, R=100

- mass-to-light ratio
- fraction of stellar mass formed in the last 2.5 Gyr
- specific SFR
- gas-phase oxygen abundance
- dust attenuation optical depth
- fraction dust in the ISM

Parameter retrieval from different types of observations

broad-band photometry *ugriz*
S/N=30
5,000,000 models, 10,000 pseudo-observation



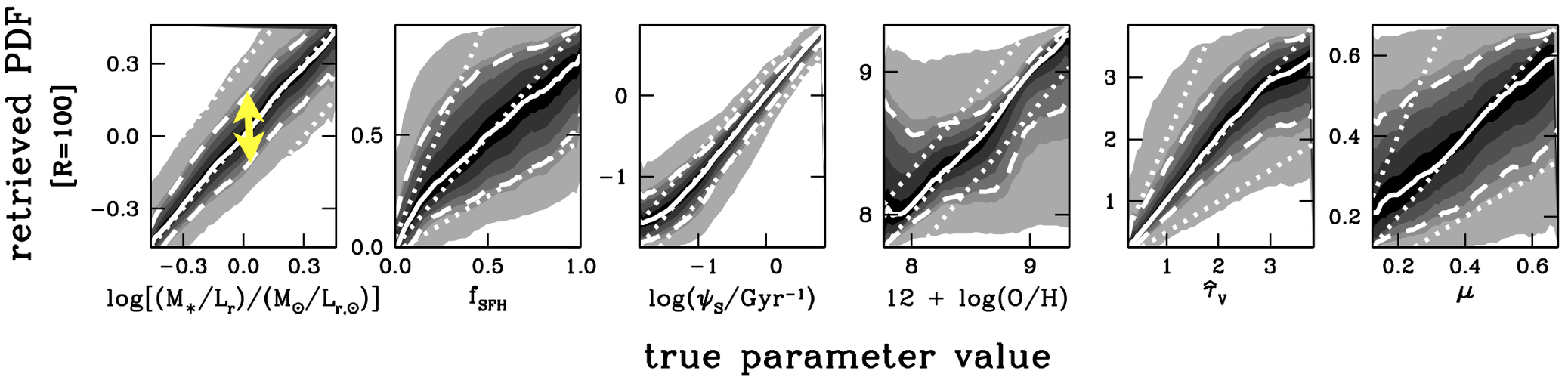
16% - 84% confidence interval

(50% median = best estimate)

Parameter retrieval from different types of observations

spectral fit low-resolution (R=100, FWHM=50 Å)
S/N=20
5,000,000 models, 10,000 pseudo-observation

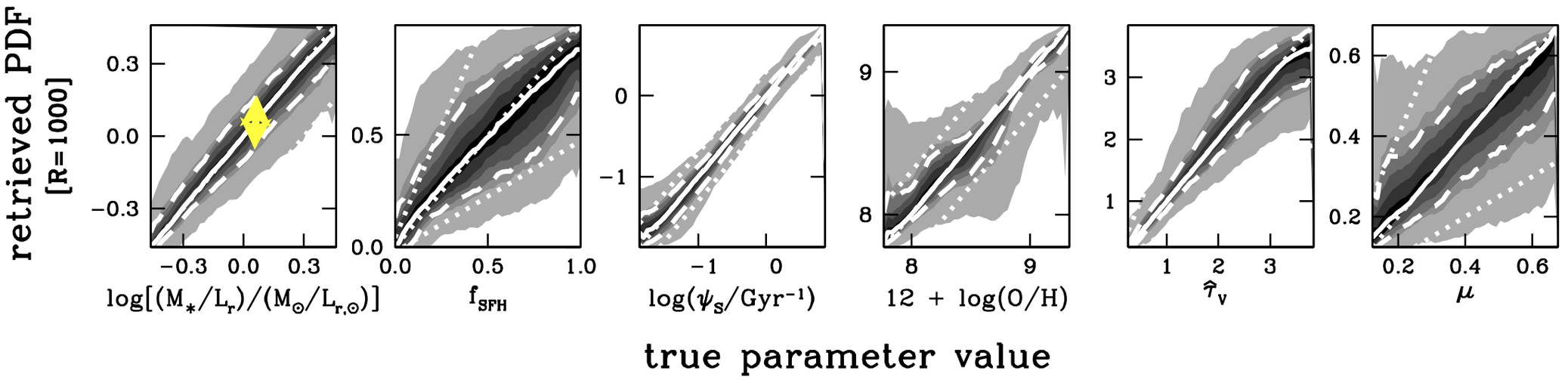
R=100



Parameter retrieval from different types of observations

spectral fit medium-resolution (R=1000, FWHM=5 Å)
S/N=20
5,000,000 models, 10,000 pseudo-observation

R=1000



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Current applications

- apply this approach to the analysis of different types of observations across the wavelength range covered by spectral evolution models

  ★ low-redshift SDSS galaxies - spectroscopy

  ★ 0.2 < z < 1.4 DEEP2 galaxies - photometry & emission lines

  ★ 0.7 < z < 3.5 3D-HST galaxies - photometry & grism spectroscopy

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The SFH of galaxies at z<1.4

DEEP2

combine photometric and spectroscopic observations to assess the "*shape*" of the star formation history for different galaxy stellar masses and redshifts

Pacifici et al. (submitted)

with Susan Kassin, Jonathan Gardner, Ben Weiner

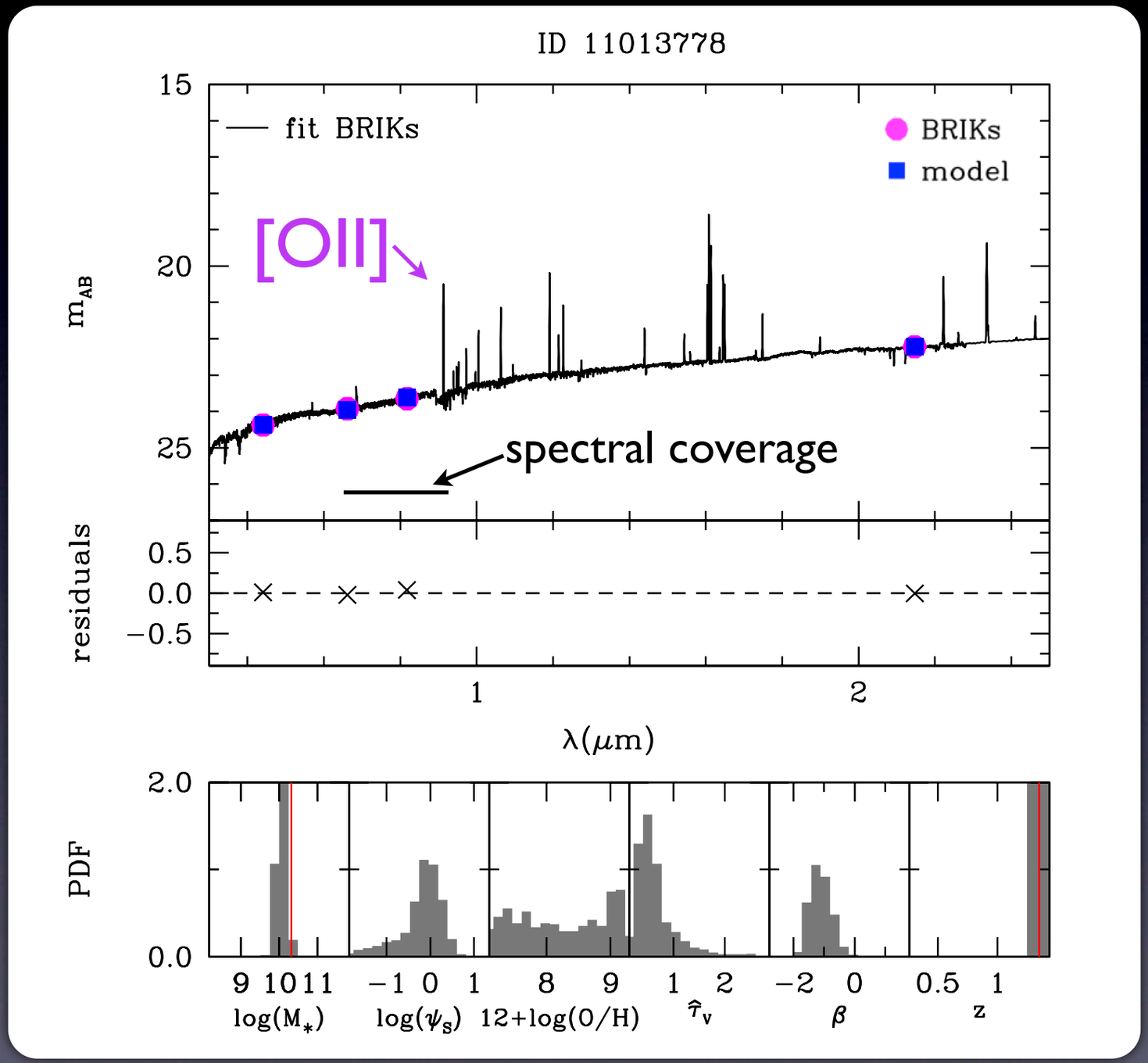
The SFH of galaxies at z<1.4

DEEP2

B R I Ks

emission-line measurements

redshift



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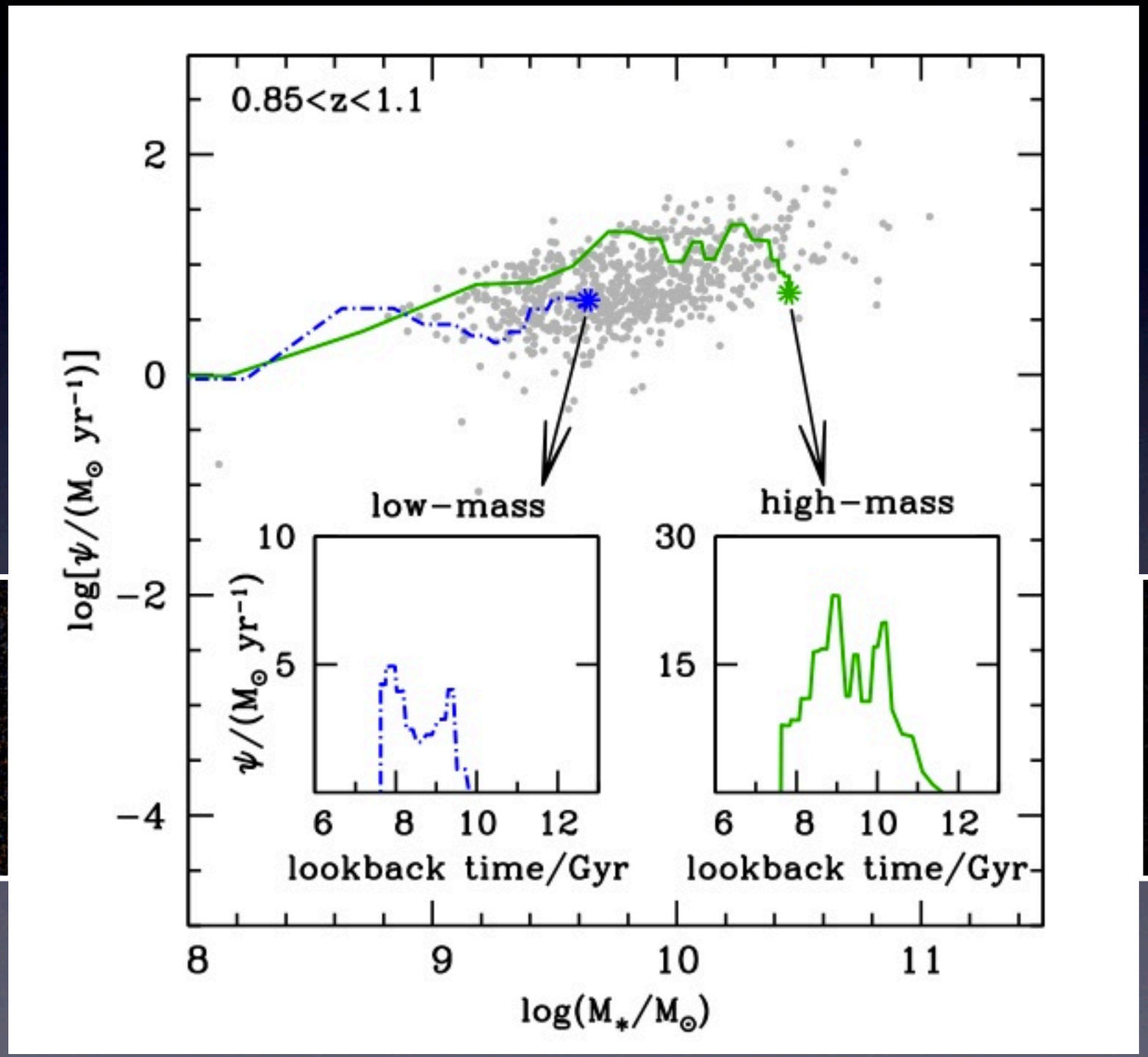
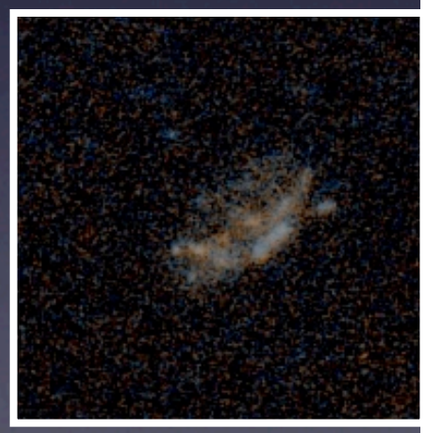
The SFH of galaxies at z<1.4





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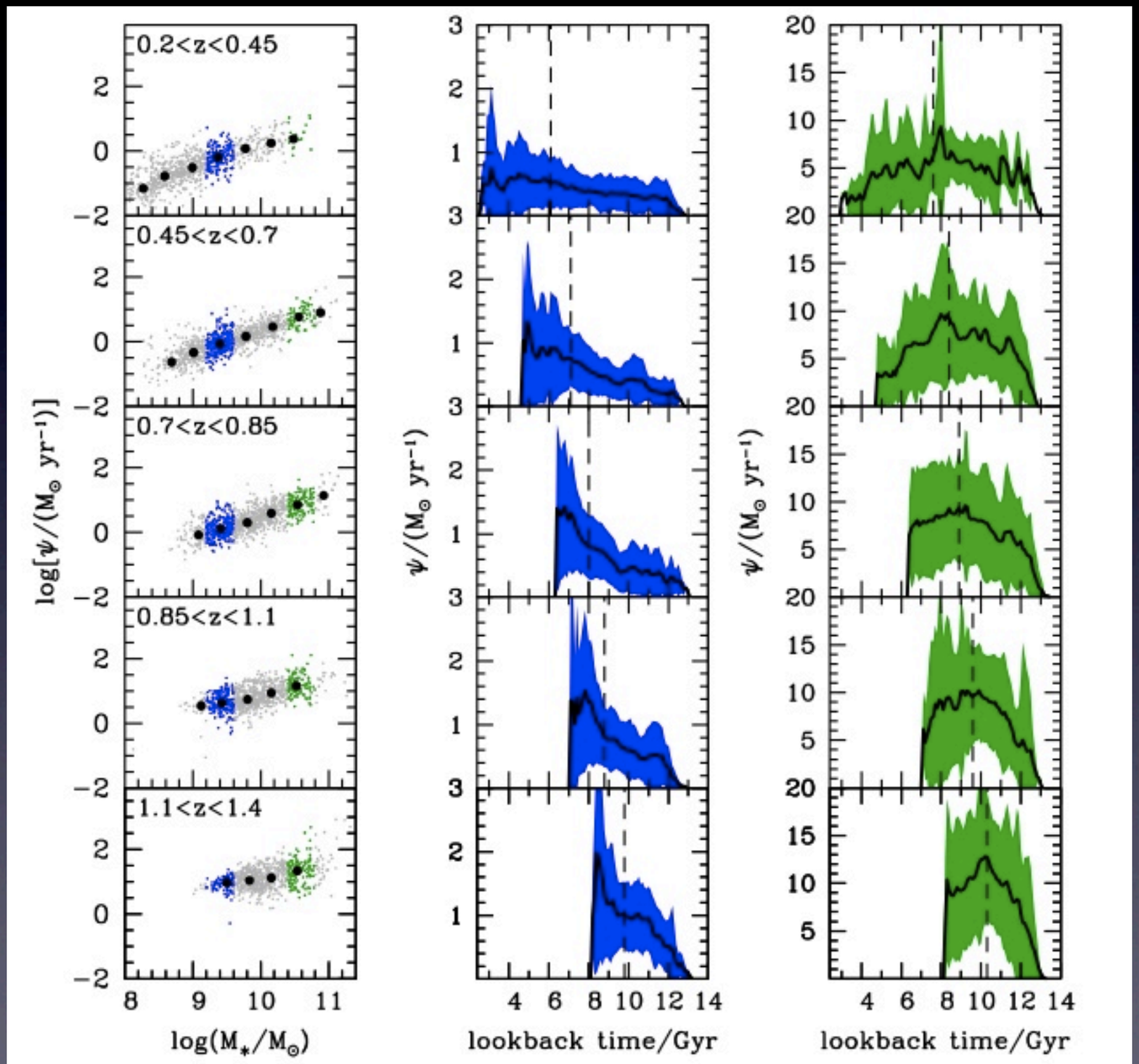
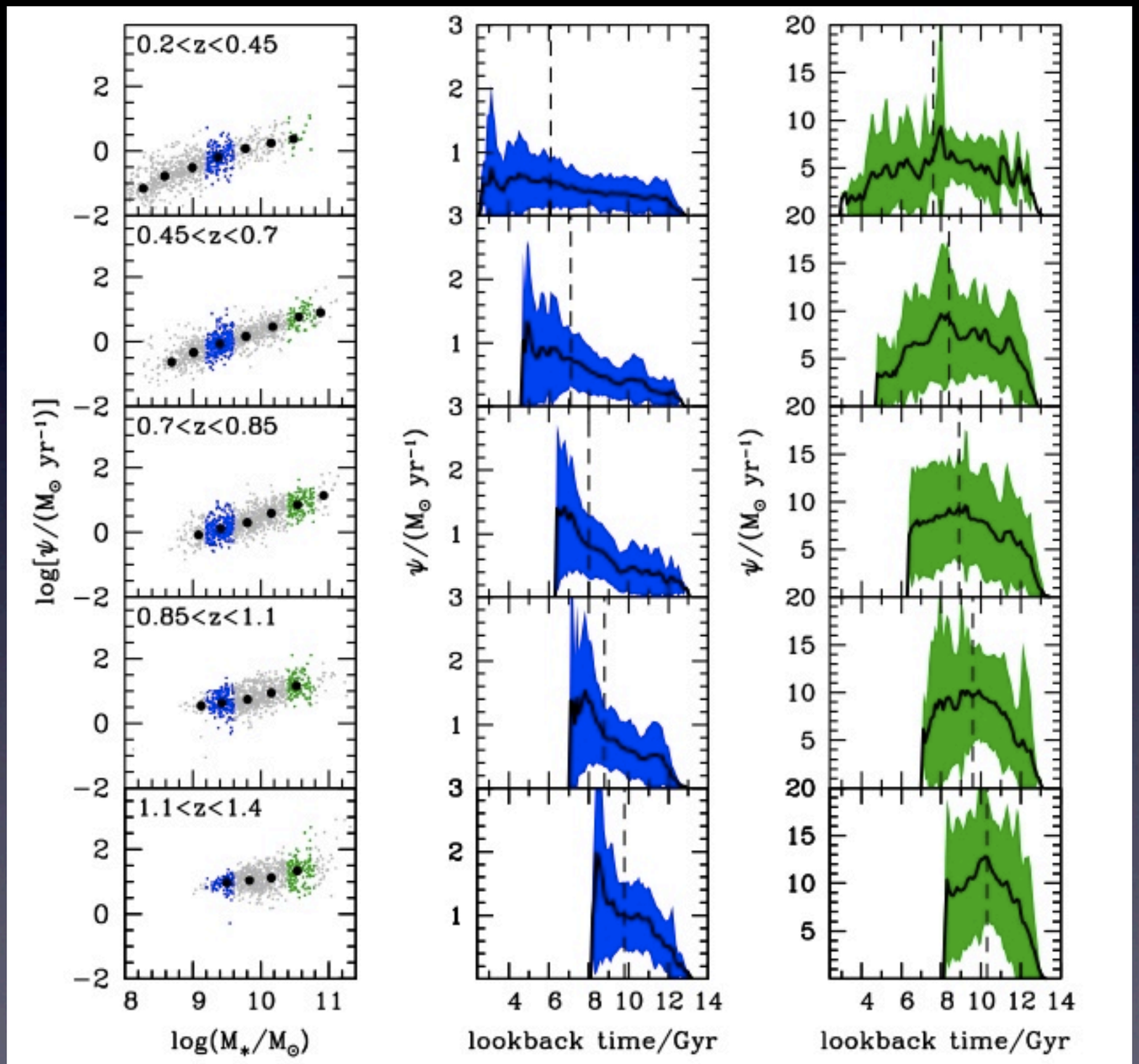


SFR
vs
stellar mass

The SFH of galaxies at z<1.4



SFR
vs
stellar mass

low-mass galaxies:
rising SFH

high-mass galaxies:
bell-shaped SFH

Summary & Conclusion

- Developed new approach to assess the relative merits of different types of observations
  - large library of model galaxies covering broad ranges of parameters
  - *pseudo-observations* at different resolutions and signal-to-noise ratios
  - low-resolution spectroscopy is very promising

- Applicability of the approach to any type of observation to constrain main parameters (SDSS, 3D-HST, DEEP2, HUDF)

- Future
  - explore different semi-analytic models
  - extend the models including dust emission and AGNs
  - explore the UV rest frame (absorption features)

Thanks

This work was funded in part by the Marie Curie Initial Training Network ELIXIR of the European Commission under contract PITN-GA-2008-214227