Stellar Populations in intermediate/high z galaxies with E-ELT-MOS

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Shaping E-ELT Science and Instrumentation

28th February 2013 - Ismaning

Galaxy evolution with stellar population studies

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- “Archaeological” studies in nearby galaxies
  - stellar populations result of SFH and chemical evolution
  - scaling relations and the discovery of “downsizing”: more massive galaxies got their stars formed earlier, action moved to less massive galaxies with time

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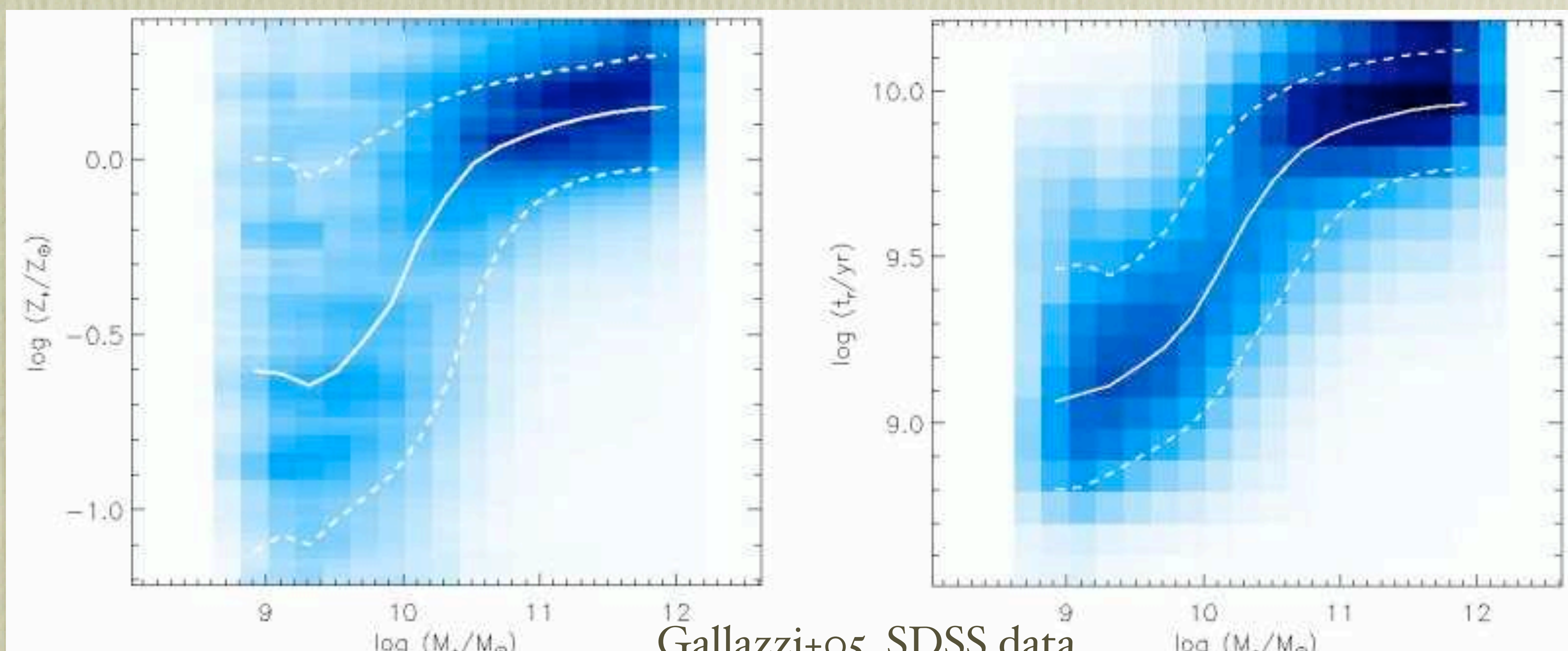

Gallazzi+05, SDSS data

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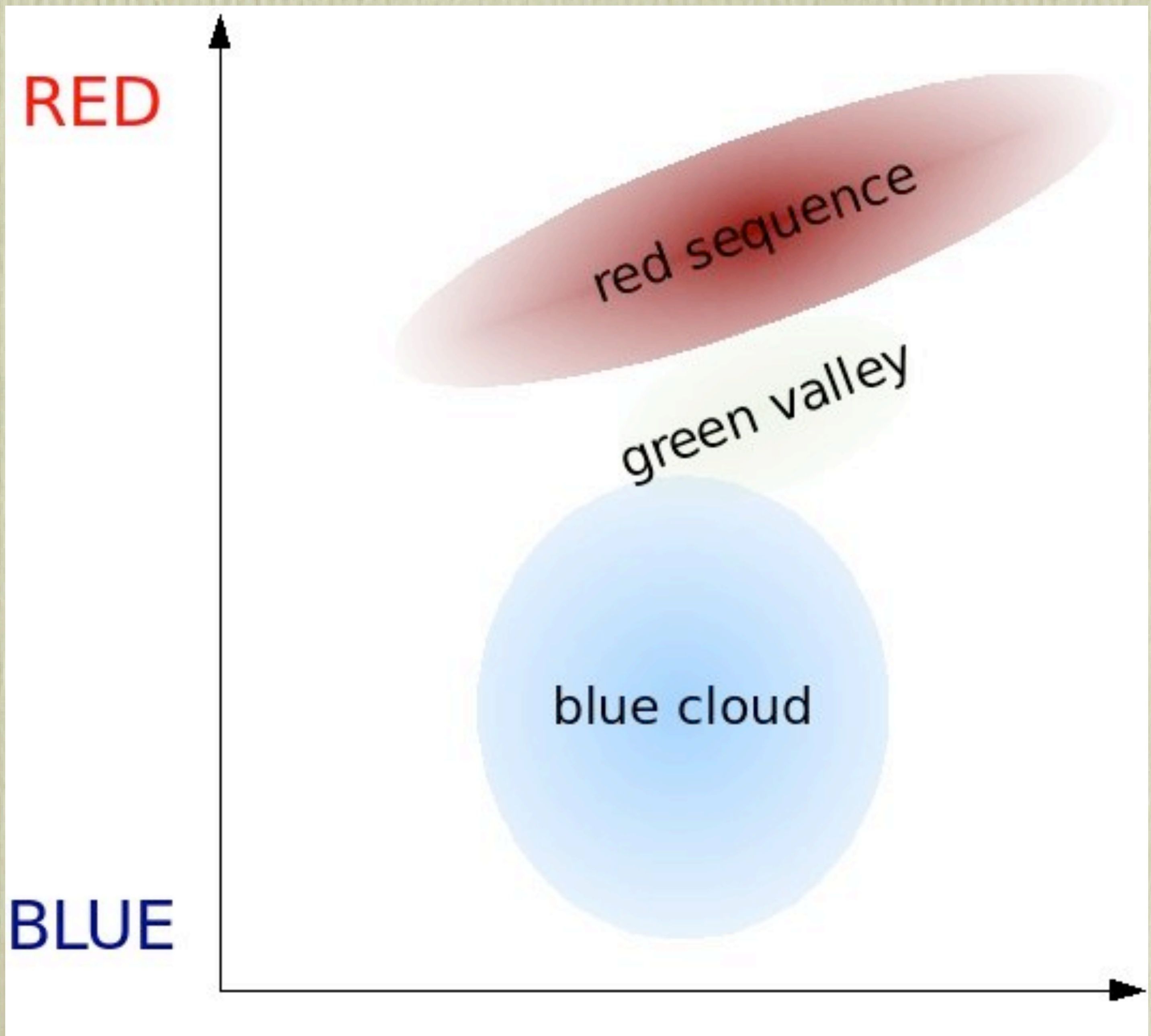
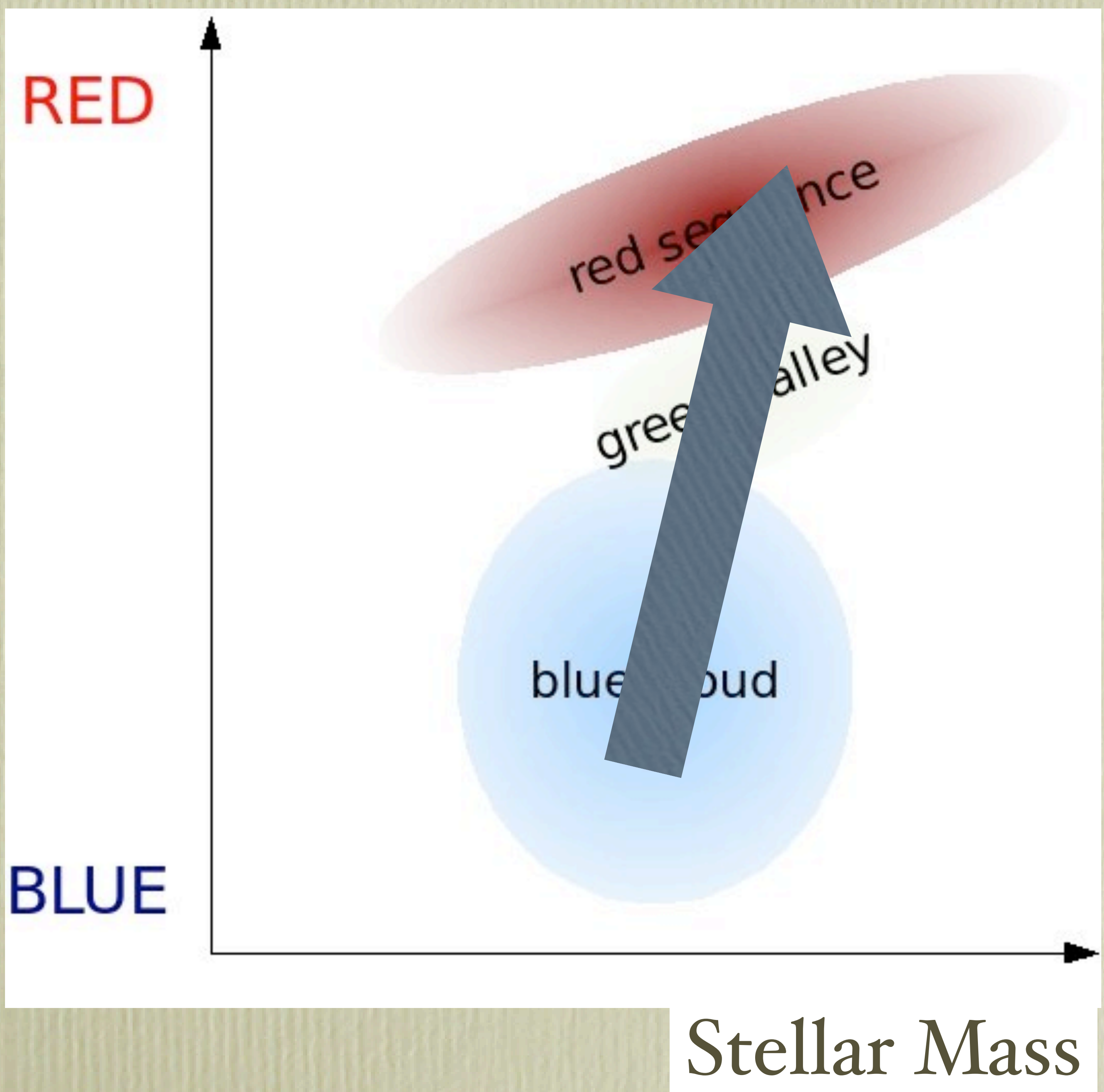
- Tracing galaxy assembly and evolution *in time*
  - stellar mass assembly: evolution of stellar mass function
  - evolution of scaling relations
  - galaxy population flows: the demographic of mass build up and transition from star-forming to passive

What evolves into what?



Stellar Mass

What evolves into what?



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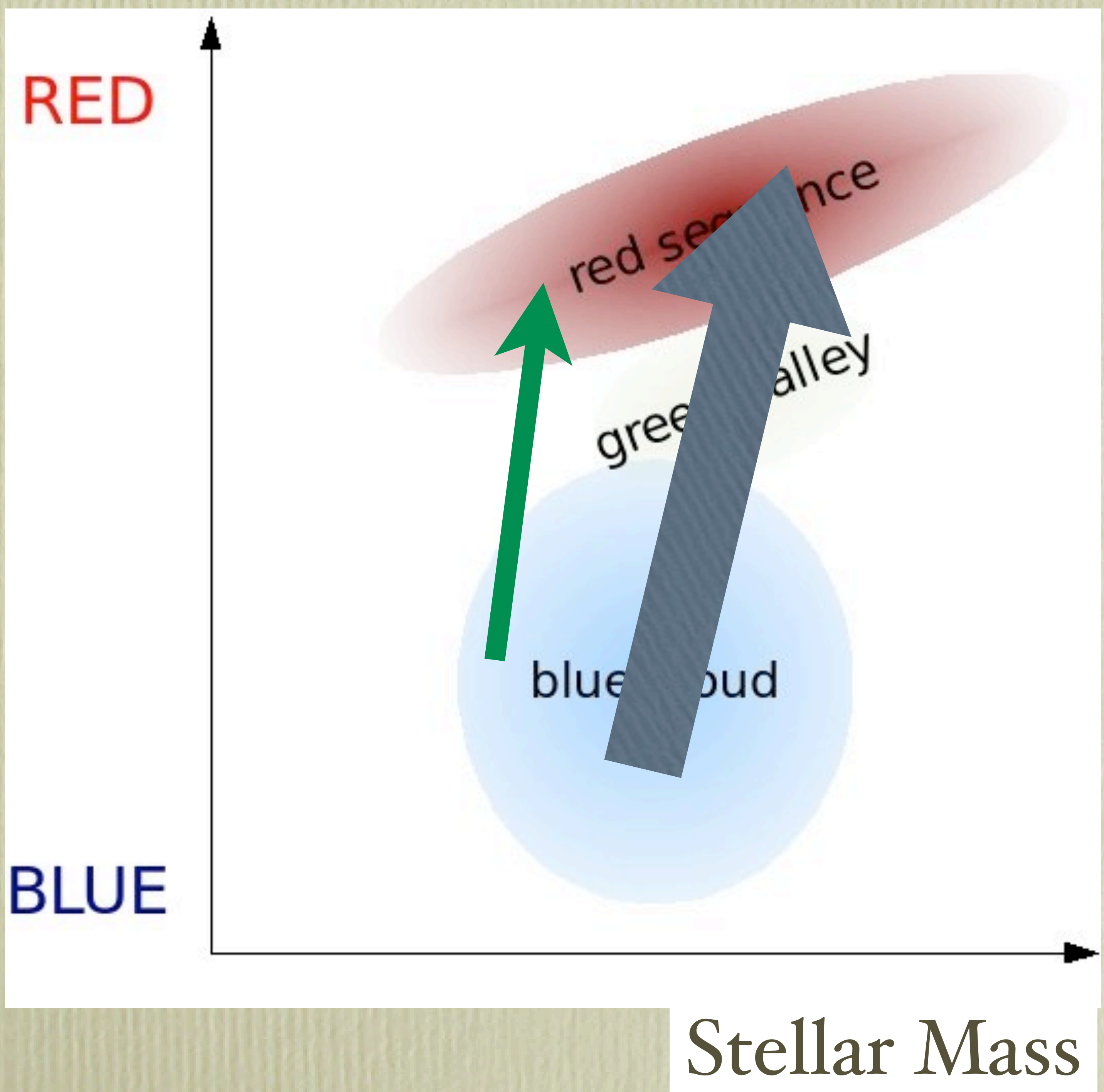

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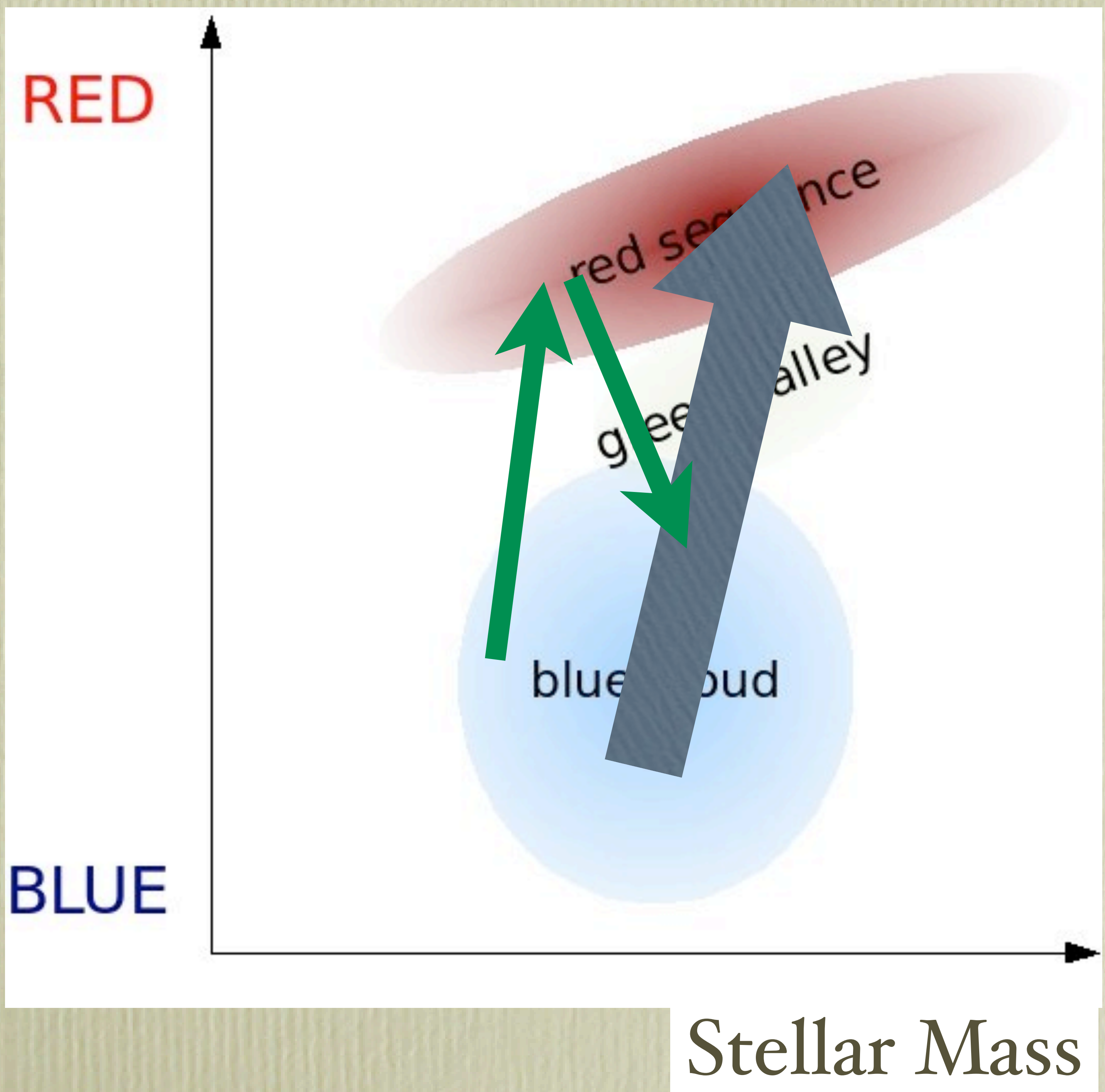

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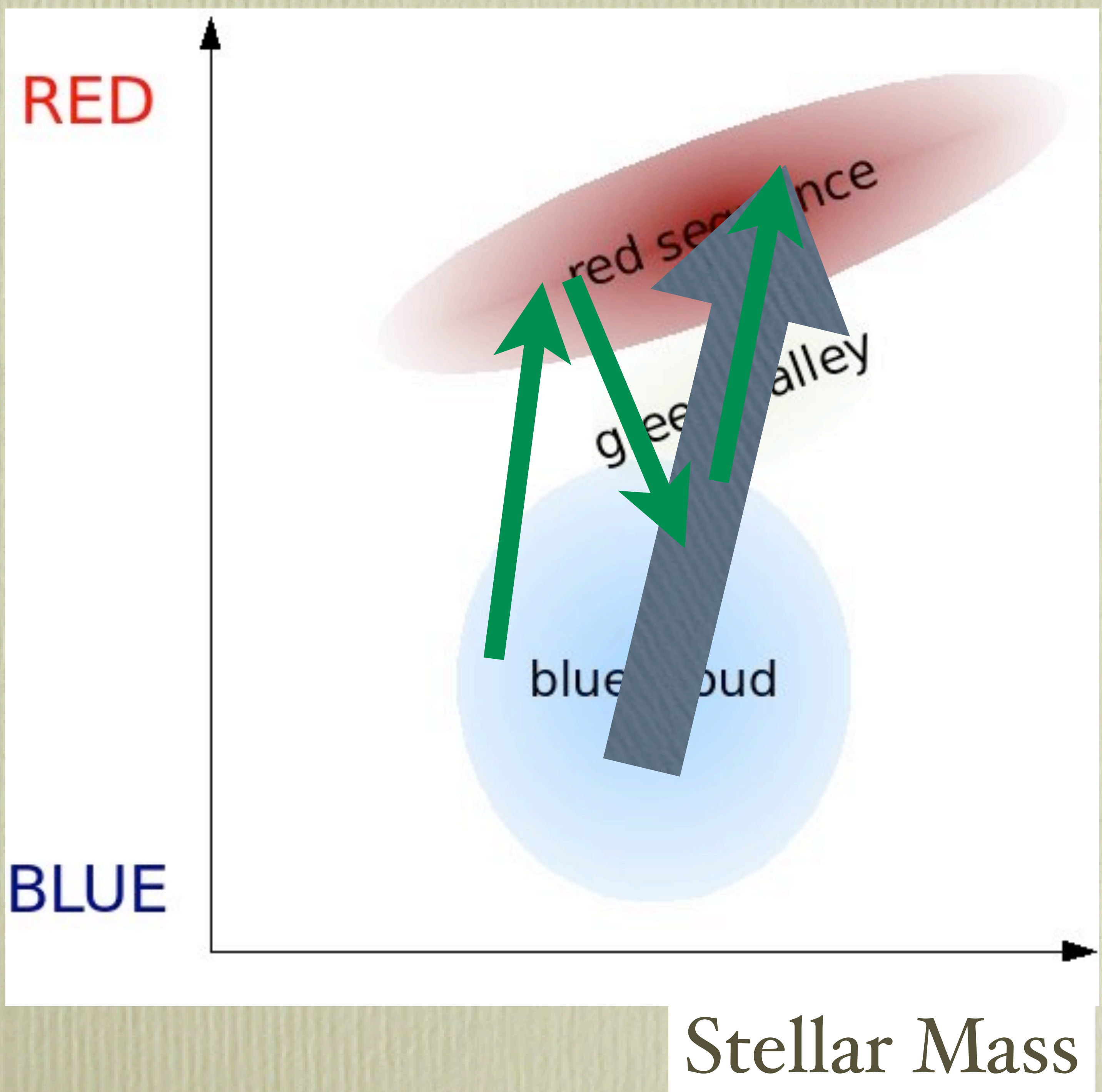

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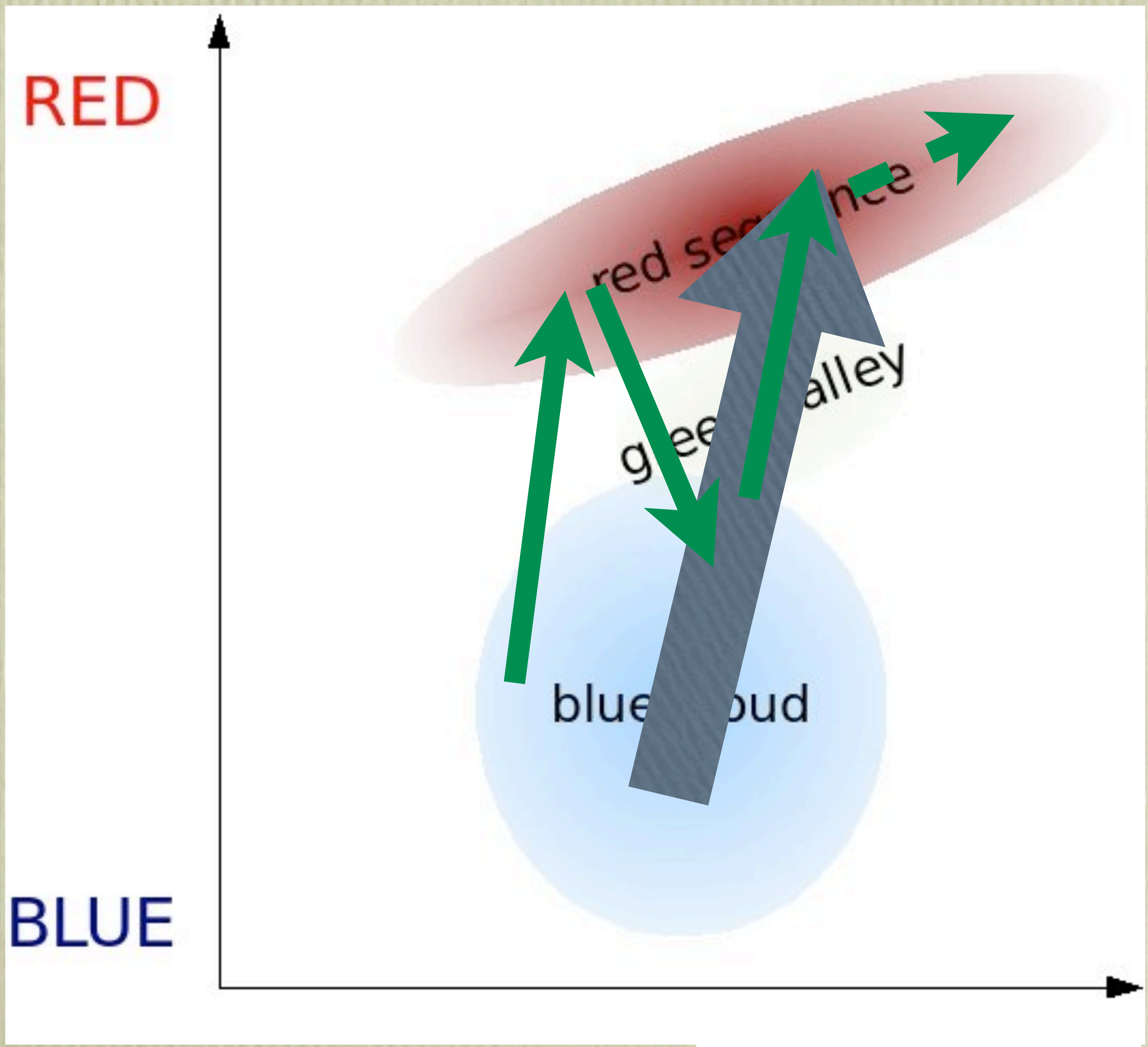

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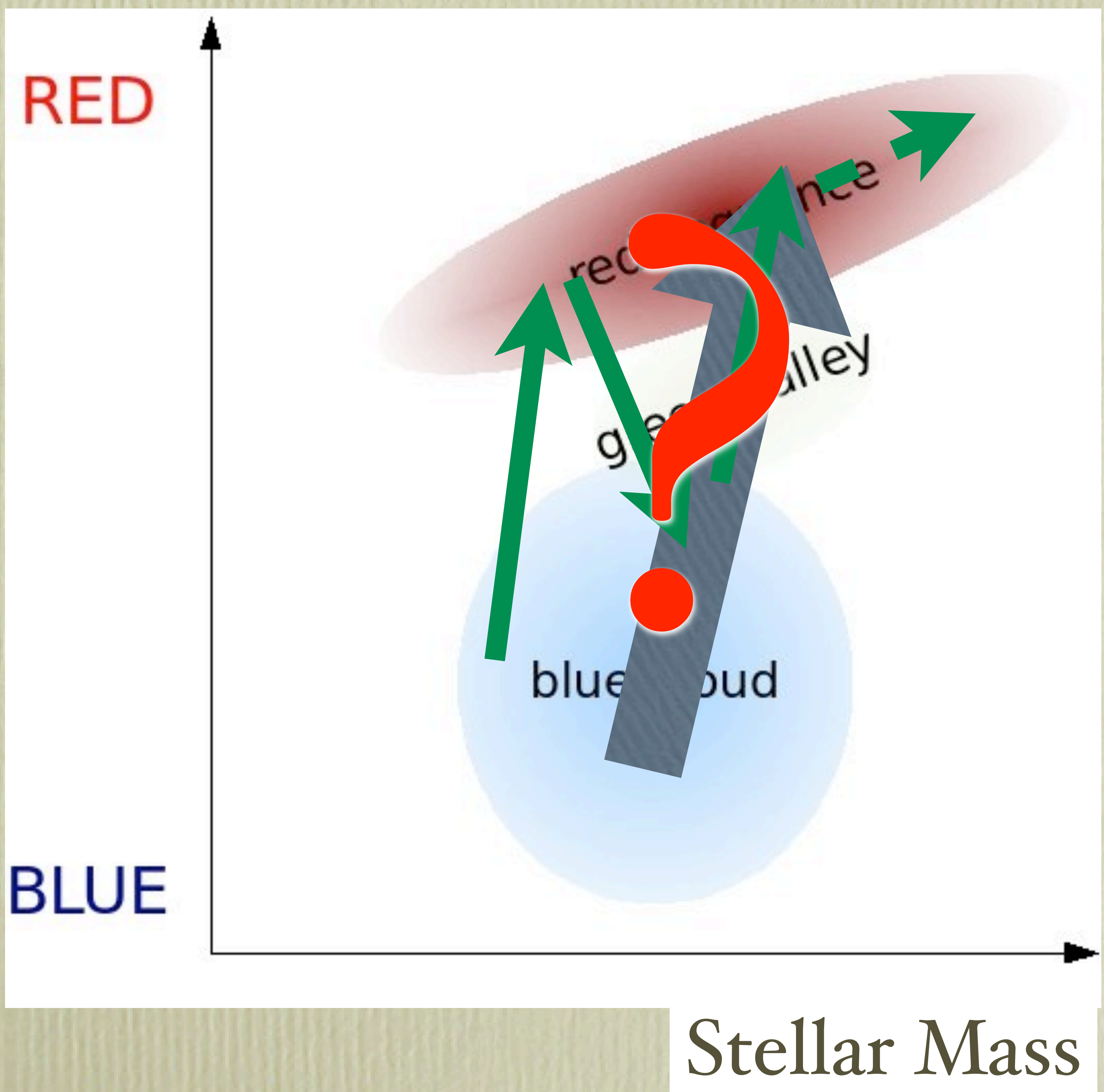

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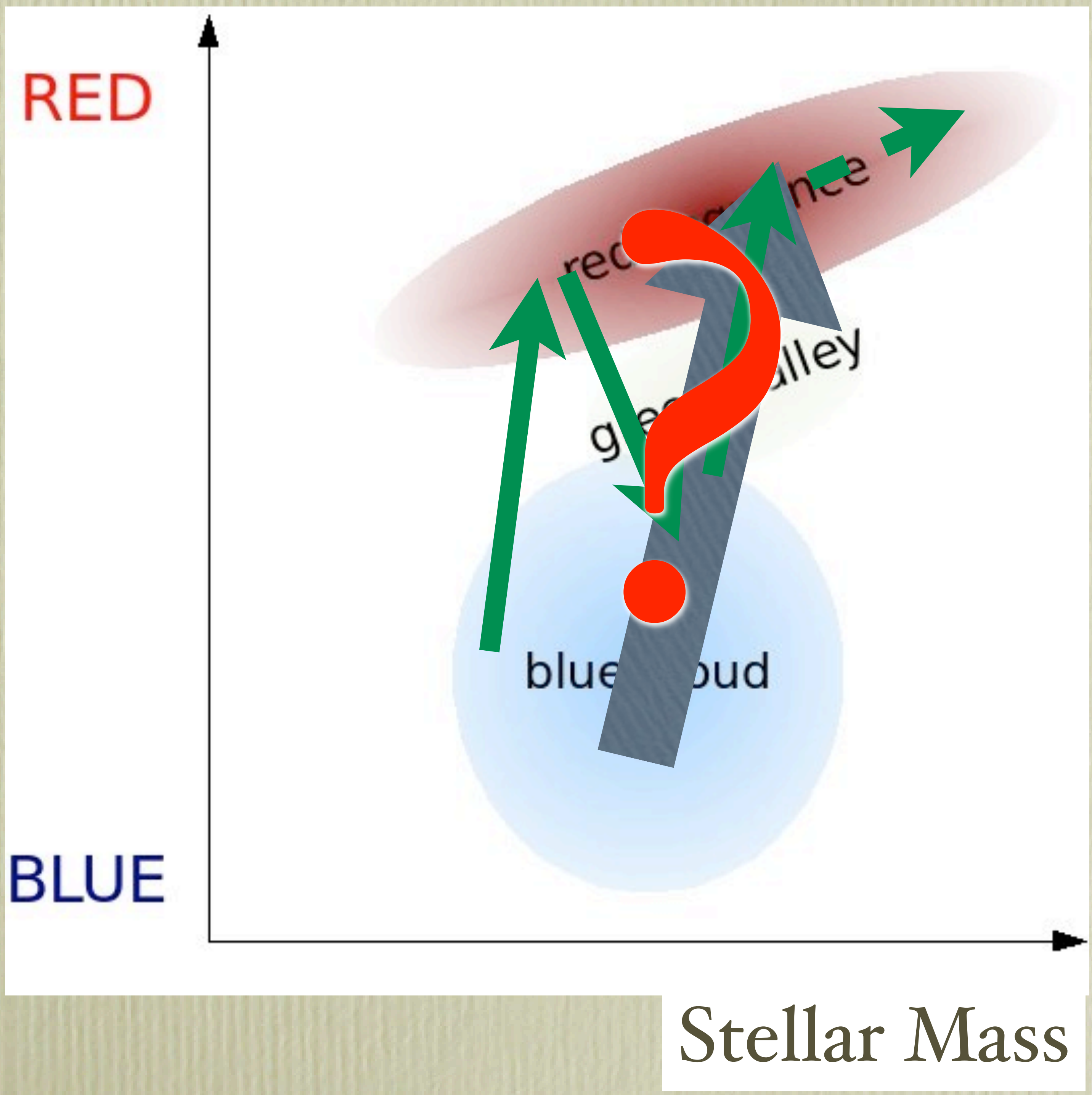
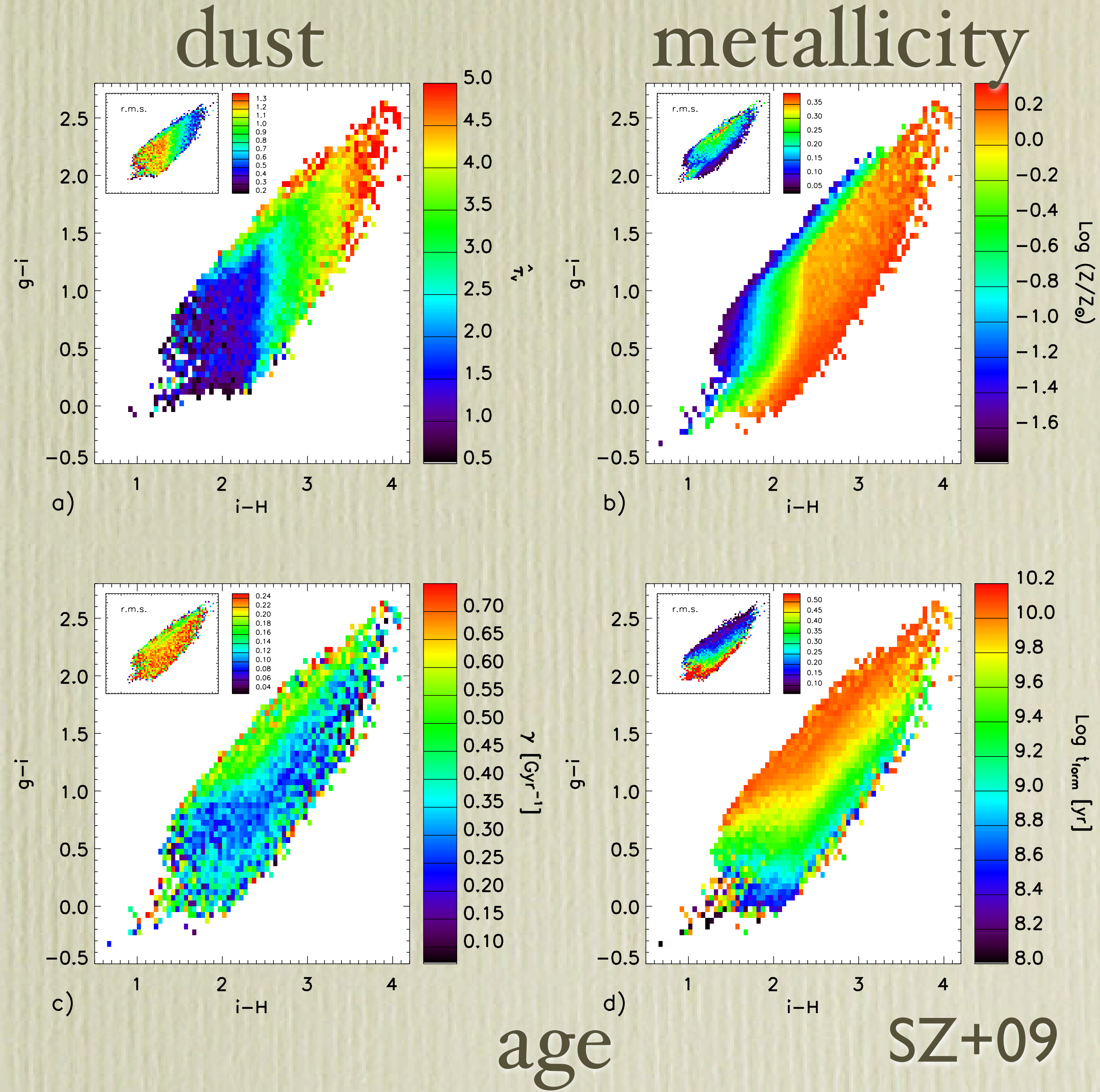


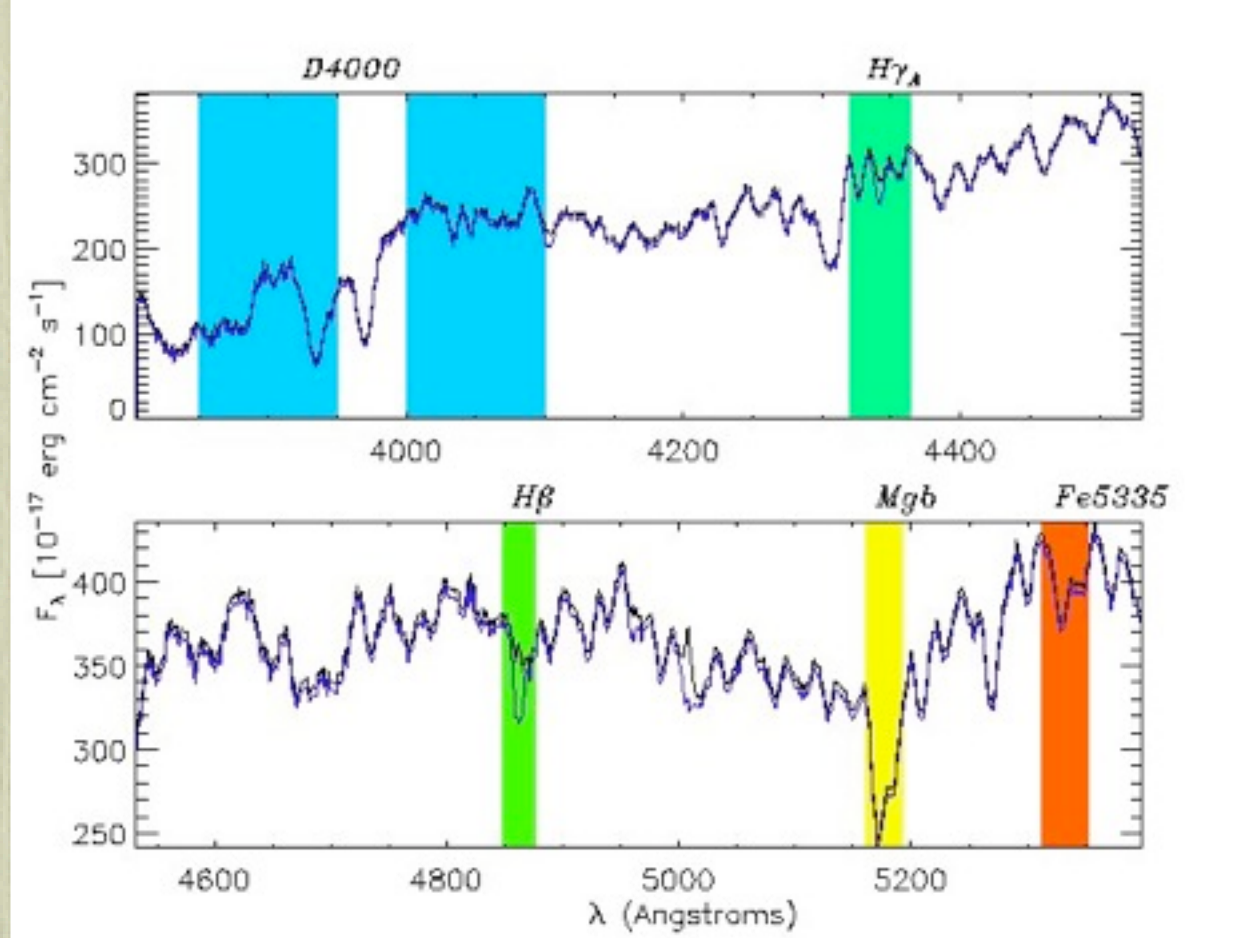
- Knowing "age" and "metallicity" at different epochs (i.e. making the link between star formation history and chemical evolution) can tell us where galaxies are coming from

Study of stellar populations requires Spectroscopy

- Photometry largely insufficient (especially at high z!), unless only M*, even with >30 bands
  - dust-age-metallicity degeneracy
  - emission line contamination
- Need spectral absorption diagnostics or full spectra



Absorption (line) diagnostics



- only hope to break (at least partly) **parameter degeneracies** (Worthey, Ottaviani, Trager et many al's)

- method is well established in the **r.f. optical region 3800-5500Å**

- requires NIR at z>1

5 indices, SNR>~20

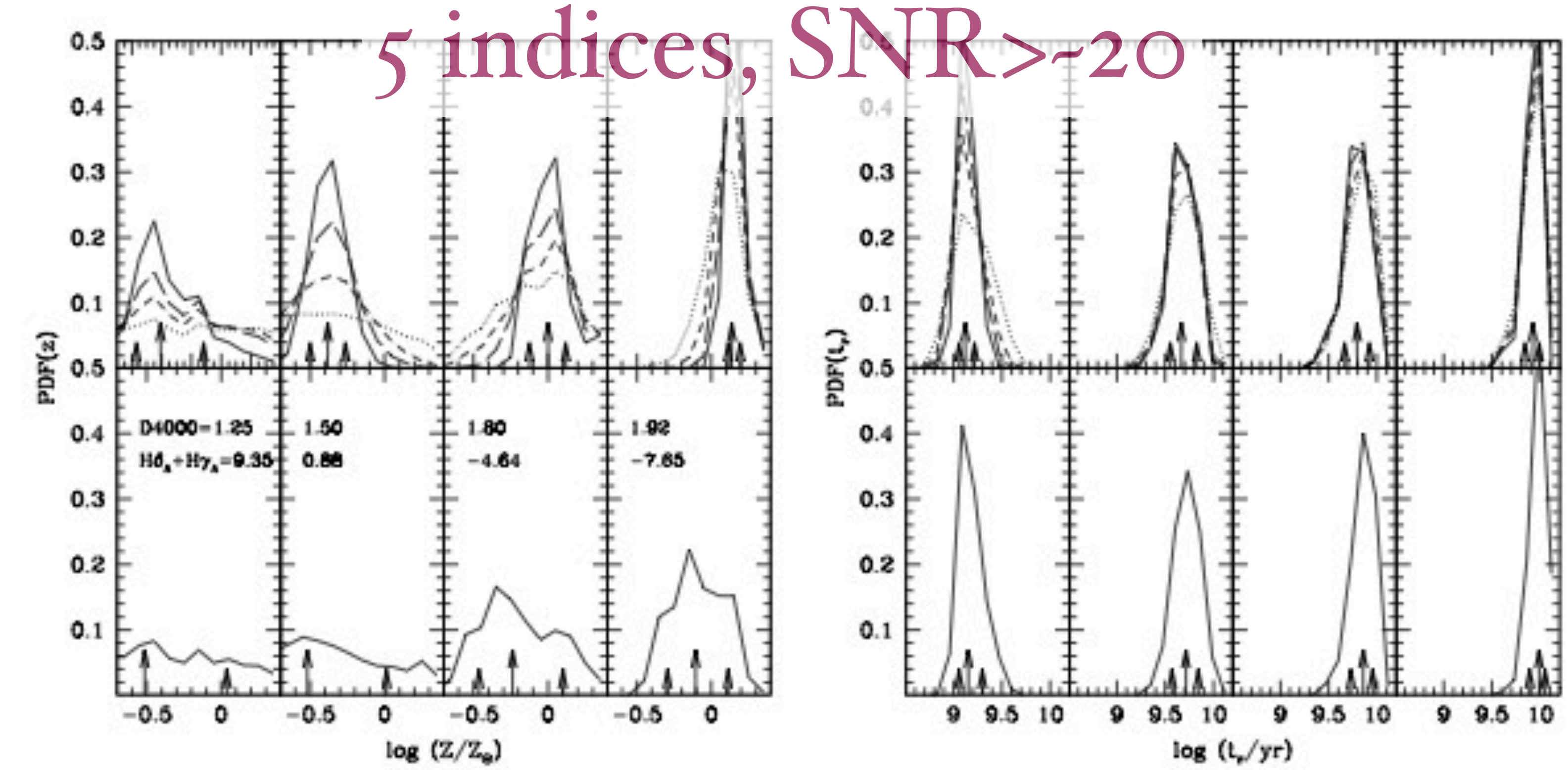


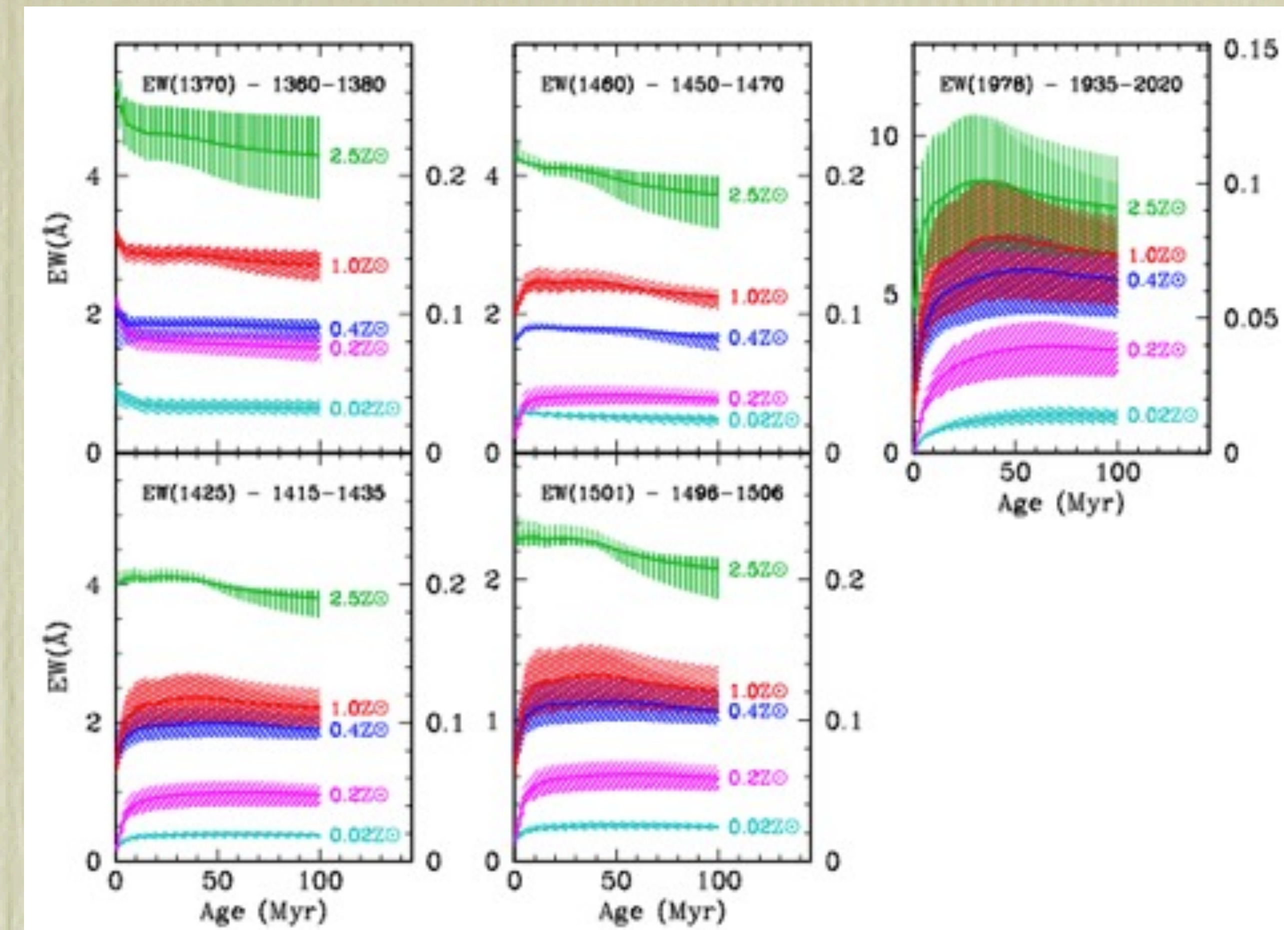
Figure 3. Probability density functions of stellar metallicity (left-hand plot) and r-band light-weighted age (right-hand plot) for 4 SDSS galaxies with high-quality spectra (median S/N per pixel larger than 30) and different D4000 and $H\delta_A+H\gamma_A$ strengths (indicated in the bottom panels of the left-hand plot). The solid PDFs in the bottom panels were obtained when including only the age-sensitive indices D4000, $H\beta$ and $H\delta_A+H\gamma_A$ to constrain the fits. Those in the top panels were obtained after including also the metal-sensitive indices [Mg_2Fe] and [MgFe]′. In each panel, the arrows indicate the median (longer one) and the 16th and 84th percentiles (shorter ones) of the PDF. The long-dashed, short-dashed and dotted PDFs in the top panels show the constraints obtained when degrading the original galaxy spectra to a median S/N per pixel of 30, 20 and 10, respectively (see text for detail).

Gallazzi+05

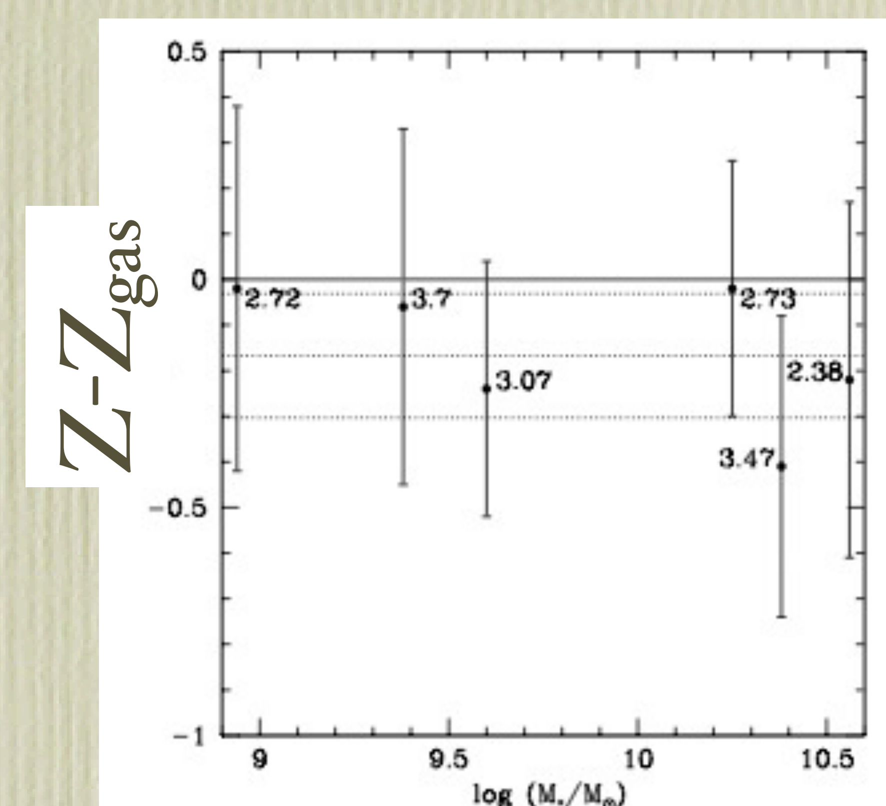
Why going red?

- Reliable stellar metallicity indicators now available in the rf UV (see Sommariva +12), which allow to study galaxies at z>~3 with optical spectroscopy

- BUT don't forget: **LIGHT-WEIGHTED QUANTITIES**!!! r.f. UV "sees" only the LAST generation of stars (very similar to gas metallicity!): NOT representative of the metals locked up in the bulk of stars

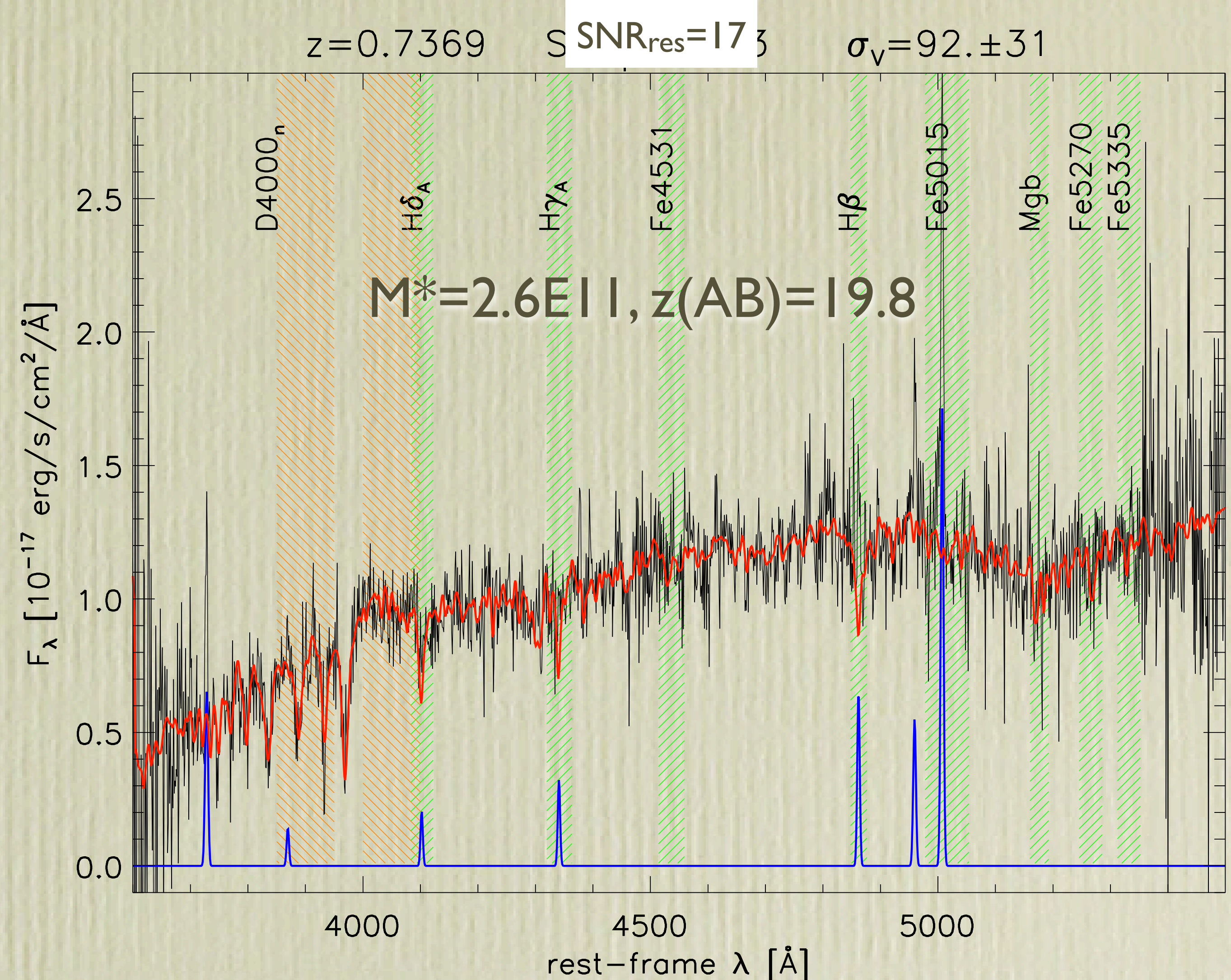


Sommariva+12



State of the Art: z~0.7

- ~10 hrs on 6-8m class telescope SNR~20 per resolution element



Gallazzi+13 in prep.
but see also works on cluster galaxies (FDF, EDisCS, Jørgensen+13...)

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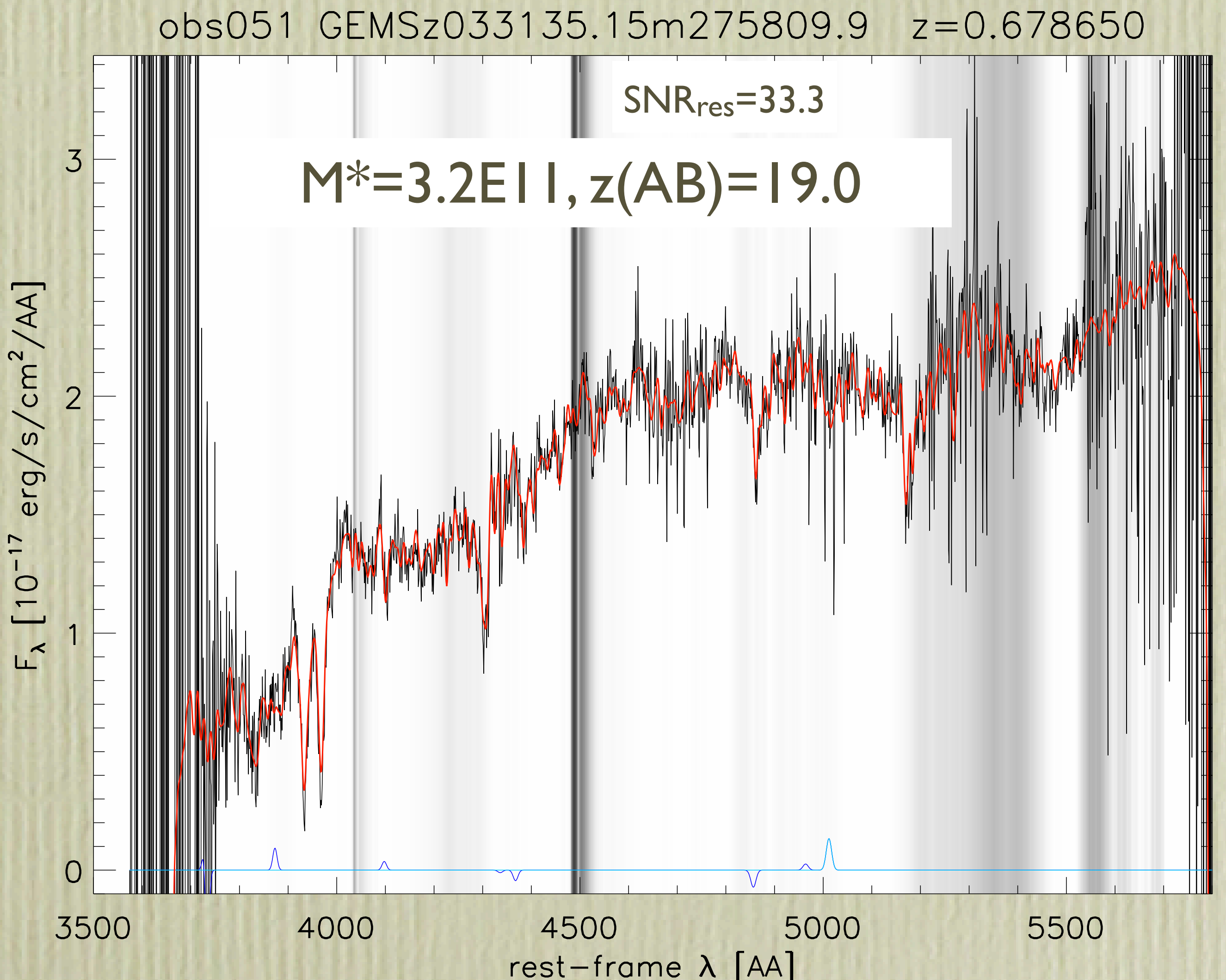

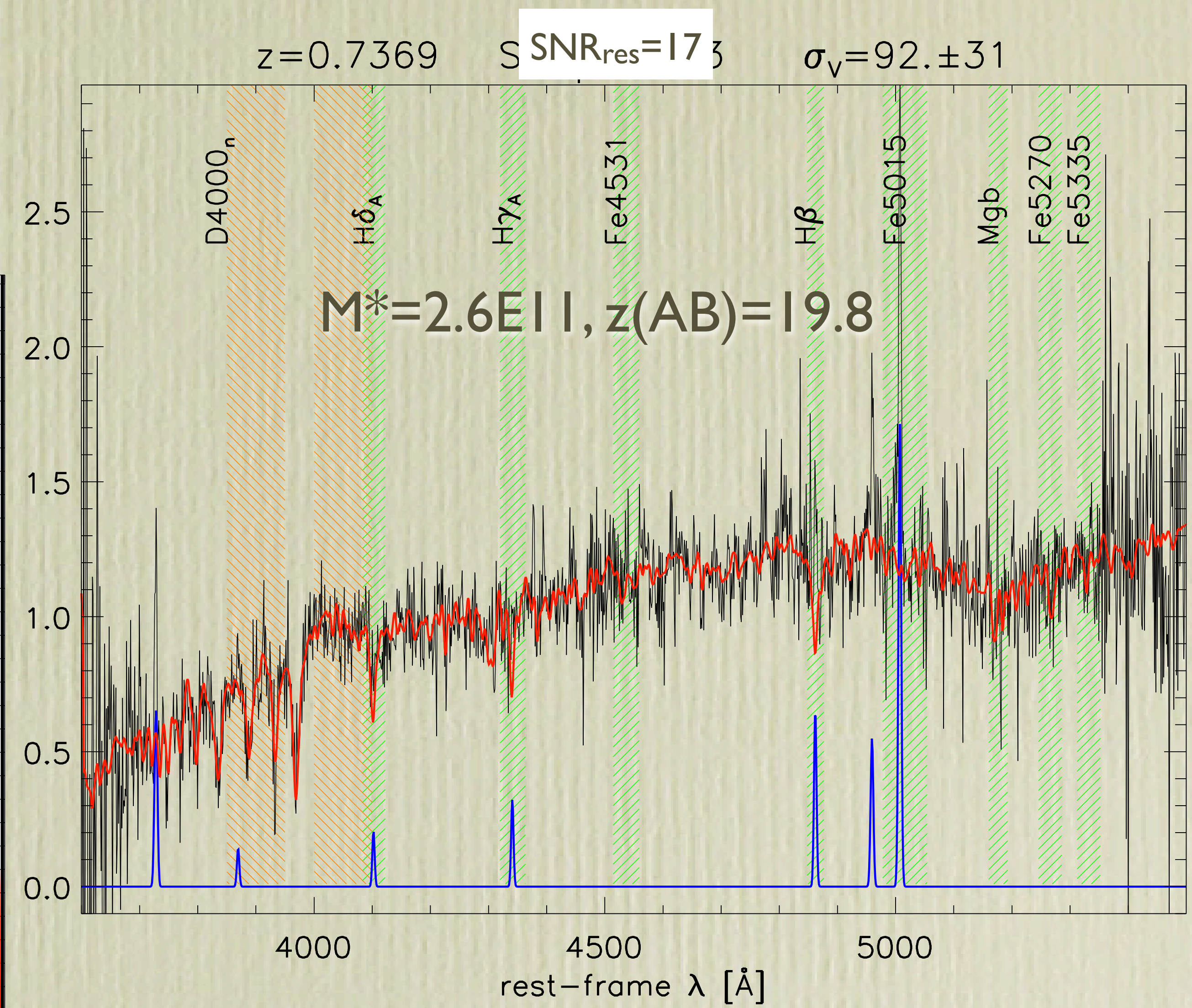

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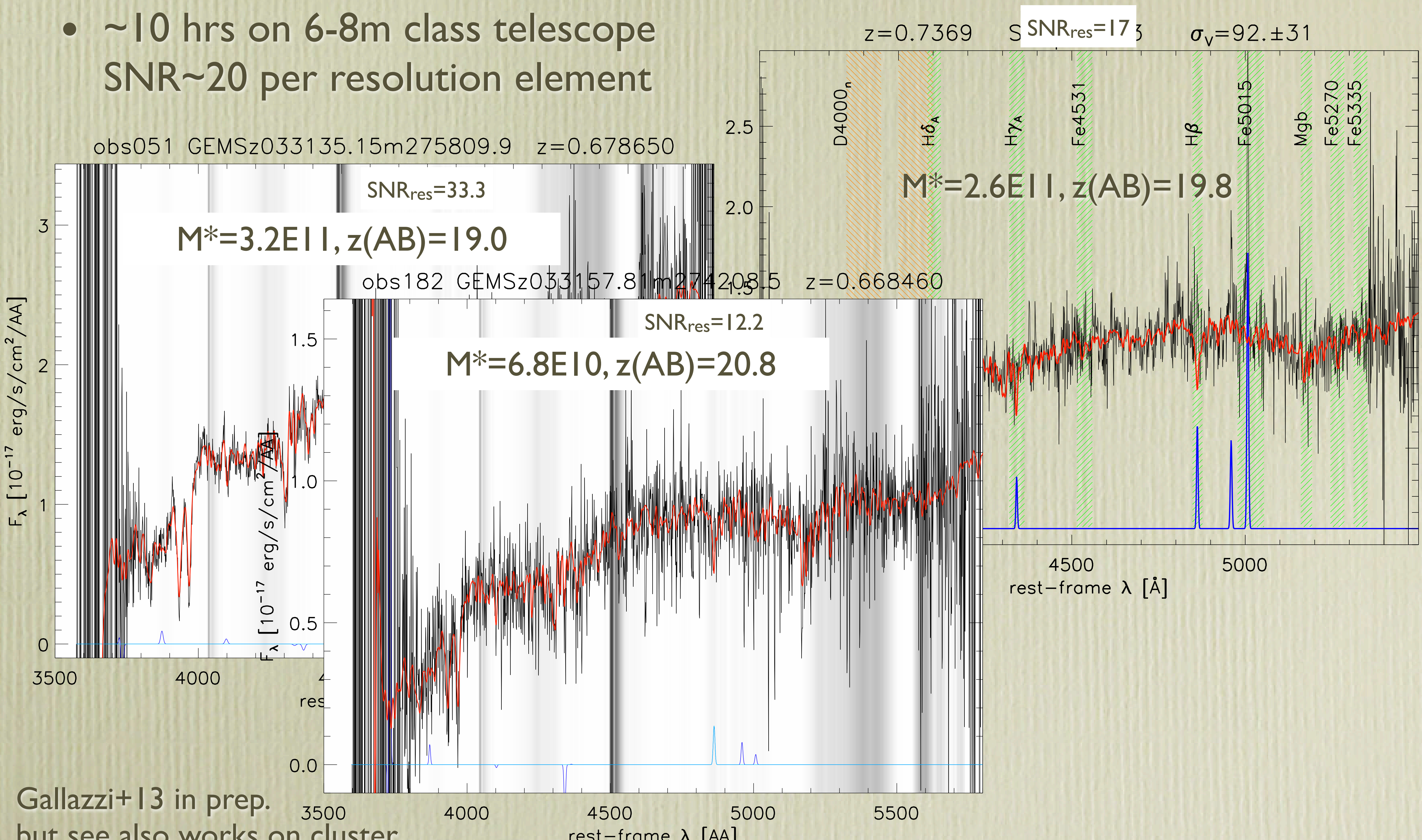

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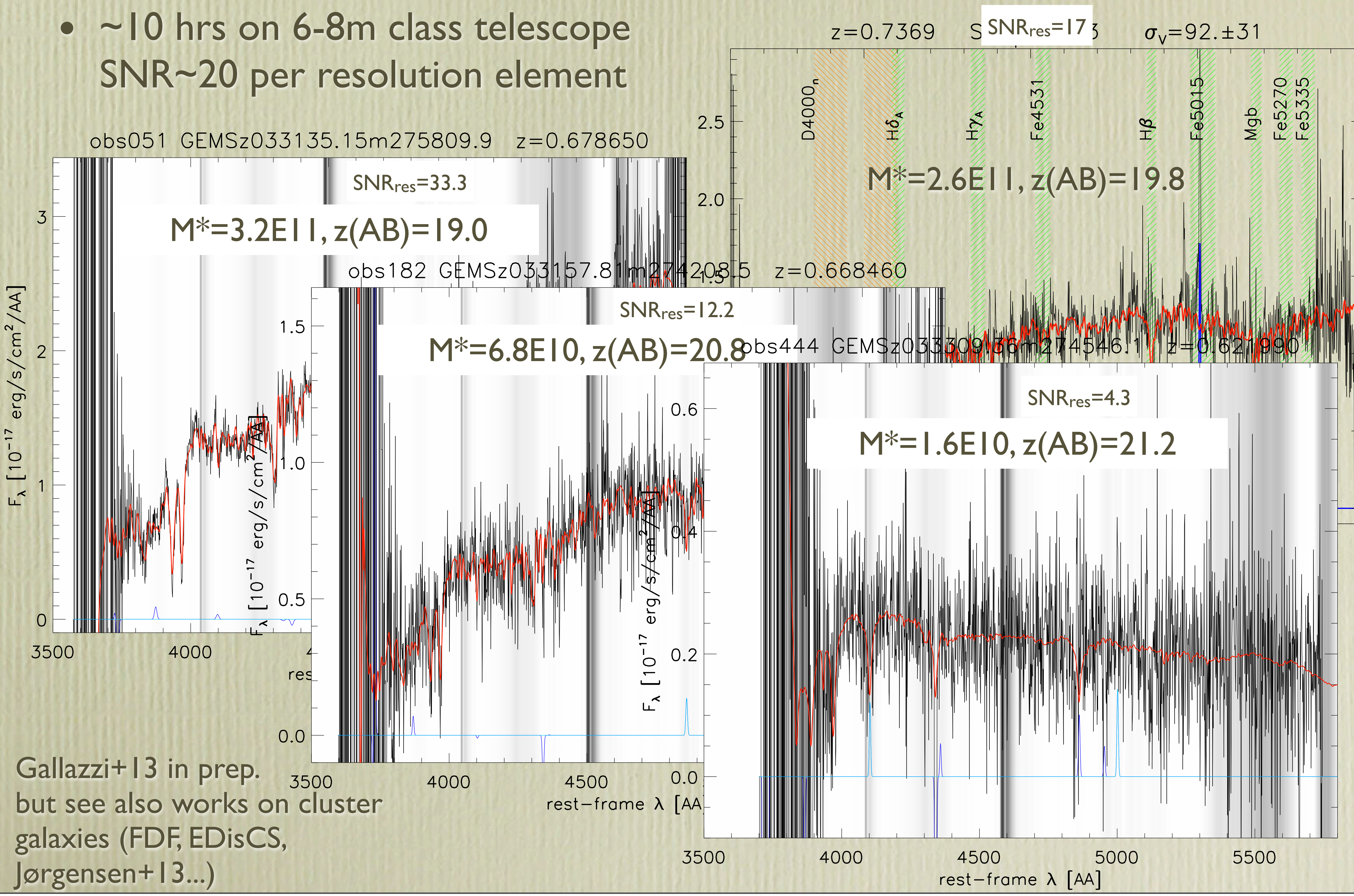

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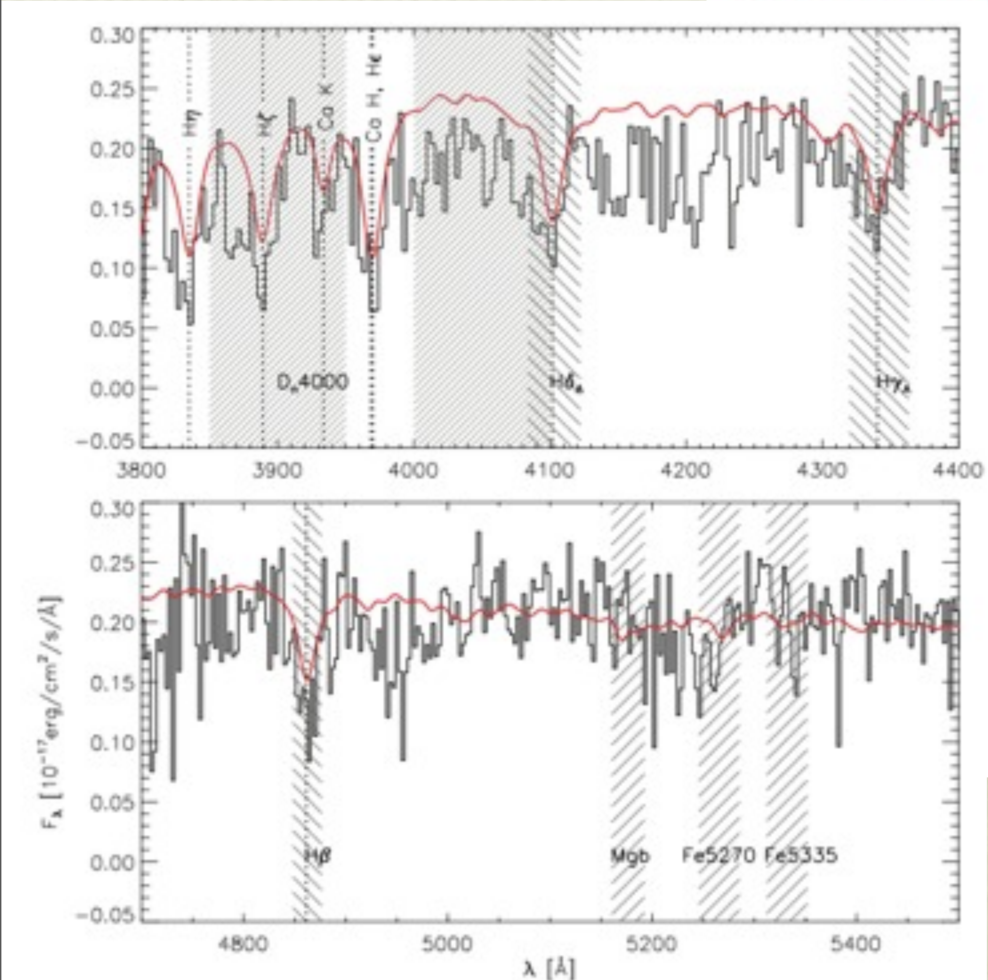
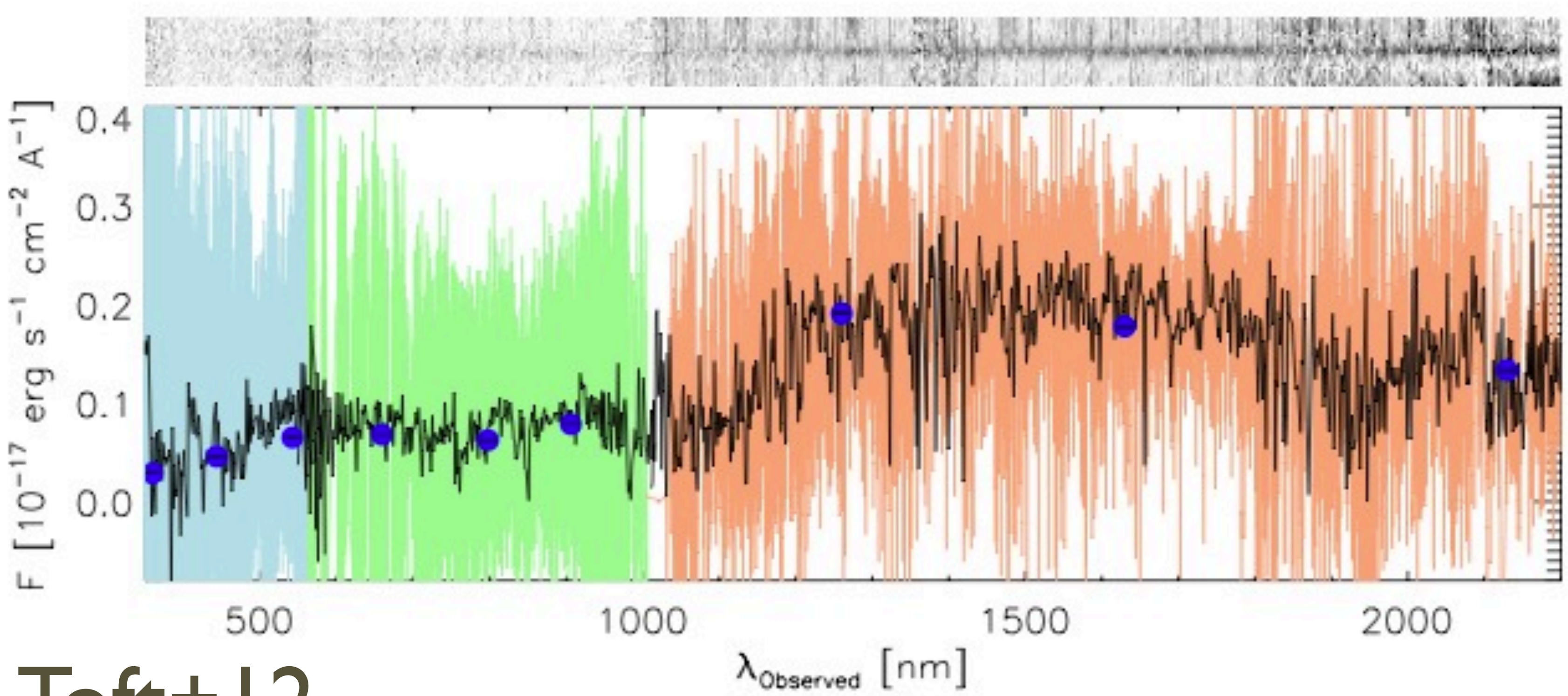
State of the art: z~2

The Astrophysical Journal, 754:3 (18pp), 2012 July 20

XSHOOTER 5 hrs!





Toft+12

3Å(rf) binning

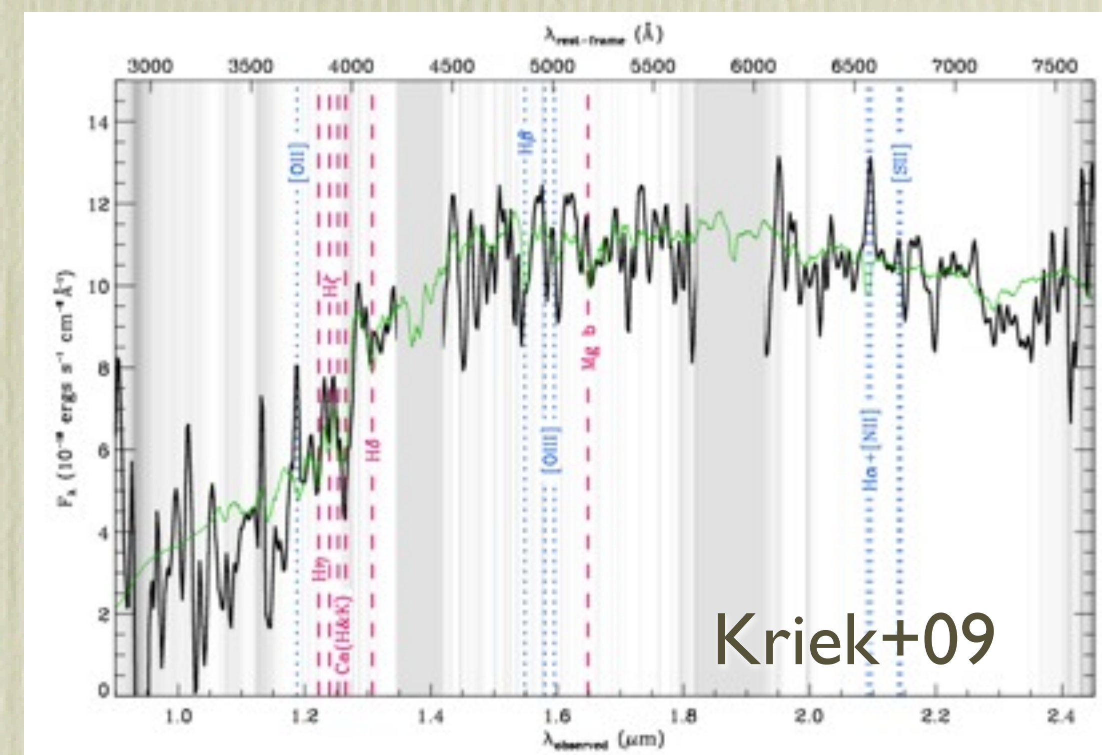
H(AB)=20.5 (~2E11 M_{Sun})

OK for age, v_disp, not for metallicity

H(AB)=21.1

Gemini-GNIRS 29hrs!!!

50Å binning



Kriek+09

Need for ELT

- Need large collecting area to reach good SNR in the continuum!
  - Toft+12 observations can be done in <<1hr at the ELT
  - few hrs at ELT can deliver SNR>20 for z>2 galaxies (H~21) at ~3Å resolution, needed for chemistry
  - H~24 galaxies at decent SNR in ~20hrs, corresponding to ~<10^{10} M_{sun}
  - high SNR measurements of EMISSION lines come for free with this kind of requirements
    - interesting comparison between stellar and gas-phase Z (assuming we can calibrate gas Z indicators...)

Why not stacking?

- Smaller telescopes
- wide field fiber fed MOS (á la BOSS/SDSS)
- more statistical representativeness
- BUT...

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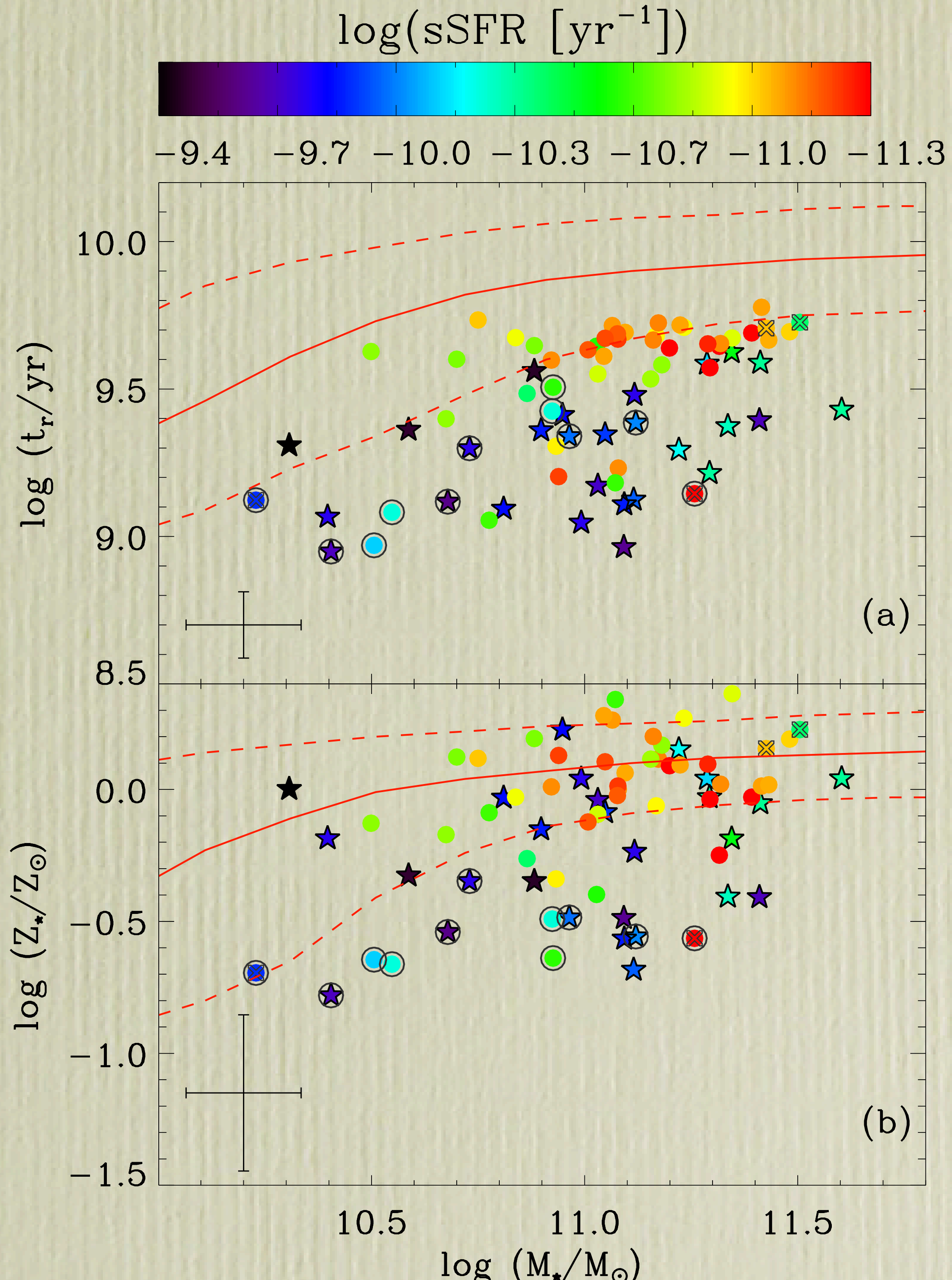

z~0.7

Gallazzi+13, in prep.

Need and requirements for MOS

- Study statistically representative samples and cover a range in mass and sSFR: >~100 per redshift bin, environment...
- ~1" aperture/slit (~8kpc diameter, SDSS-style)
  or
- 2-3" IFU (cover the entire galaxy)
  - best AO performance not required: resolution >0.1" enough if don't want to resolve the structure

Depends (also) on sky subtraction efficiency

- Multiplexing >(>)30 over 7 arcmin diameter FoV
  - following e.g. Caputi+11 or Ilbert+10, we expect ~30 gals H(AB)<23.5 at z~3
  - e.g. 18 pointings to cover E-CDFS, 540 galaxies at z~3 !!
  - numbers increase for lower z: >1,000 gals @z>1.5
- Spectral coverage: depending on z, cover 3500-5500Å rf
  - z~1: 7000-11000 (R-J)
  - z~2: 10500-16500 (yJH, gap at 4500-4800Å rf, not terrible)
  - z~3: 14000-22000 (HK, gap at 4500-4900Å rf, not terrible)
    - without K, science at z>2.5~3 might be limited
- Resolution: 2-3000 fine for science, but higher resolution (>~4000) required for optimize "clean" sky fraction in the NIR