Impact of star formation history on the measurement of star formation rates

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A&A, in press (arXiv:1409.5792)

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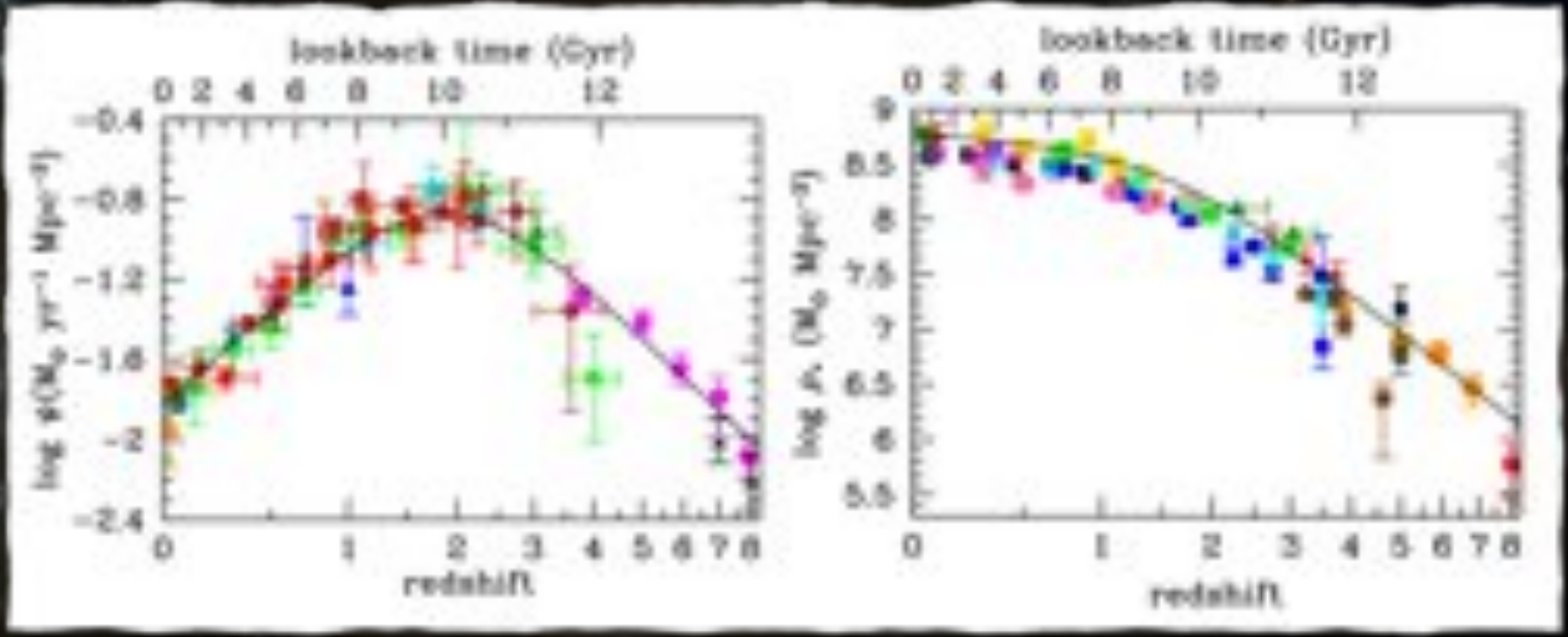
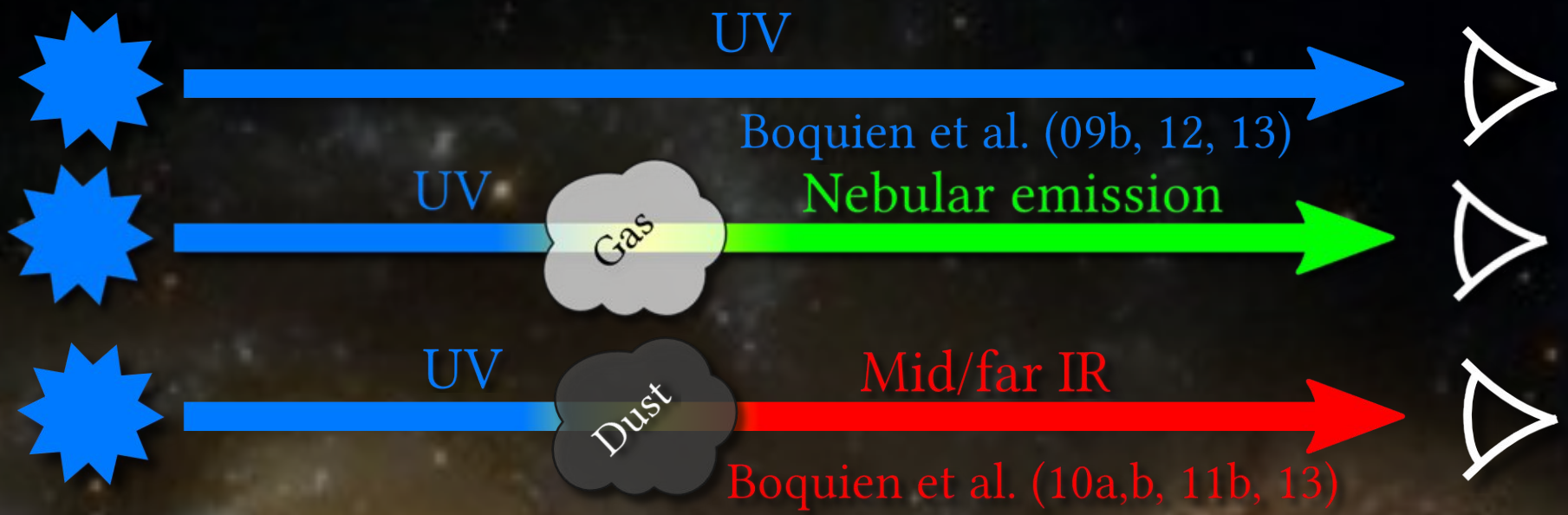
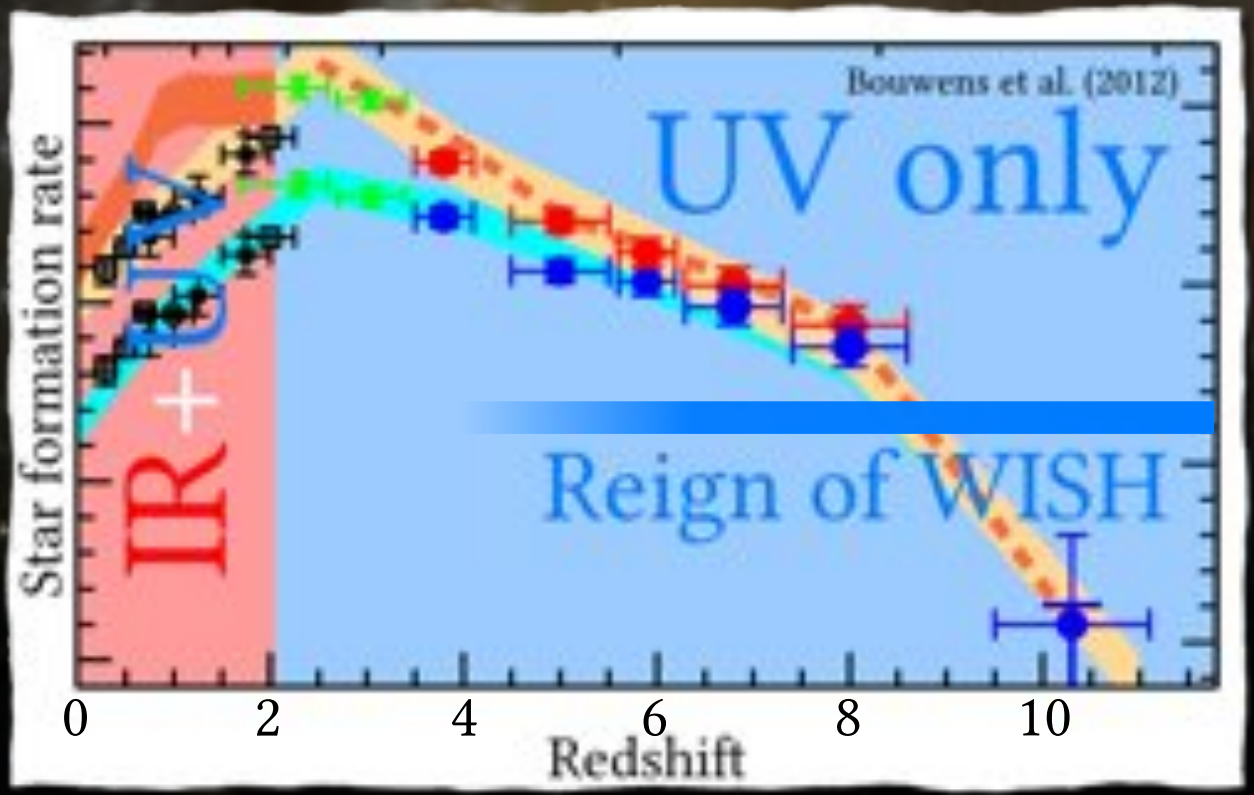
Galaxy evolution: a tale of two stories



Madau & Dickinson (2014)

How to measure star formation across the universe





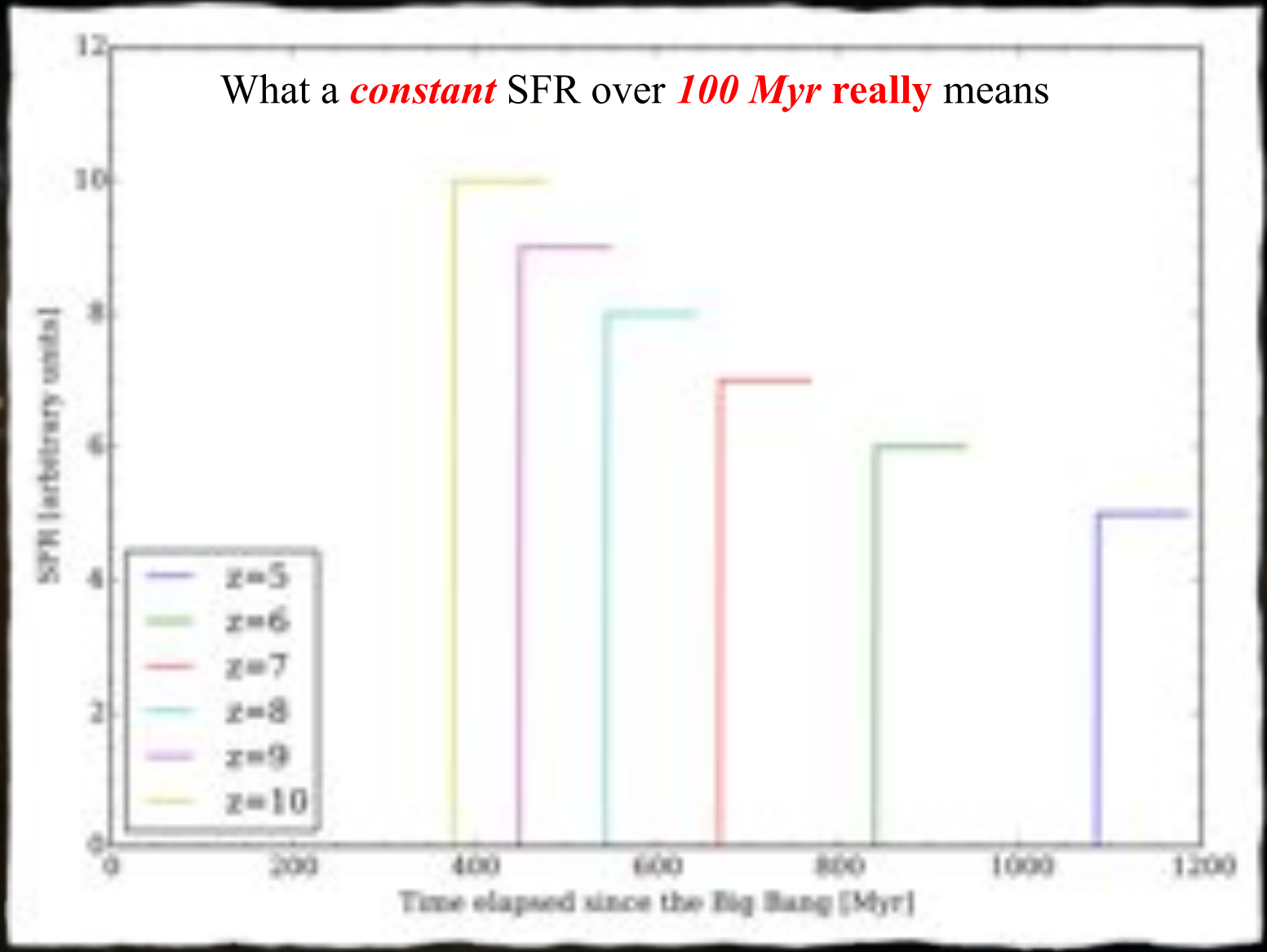
3 key points to measure the SFR:

① Initial mass function

② Dust attenuation

③ Star formation history

Two (strong) assumptions on the SFH

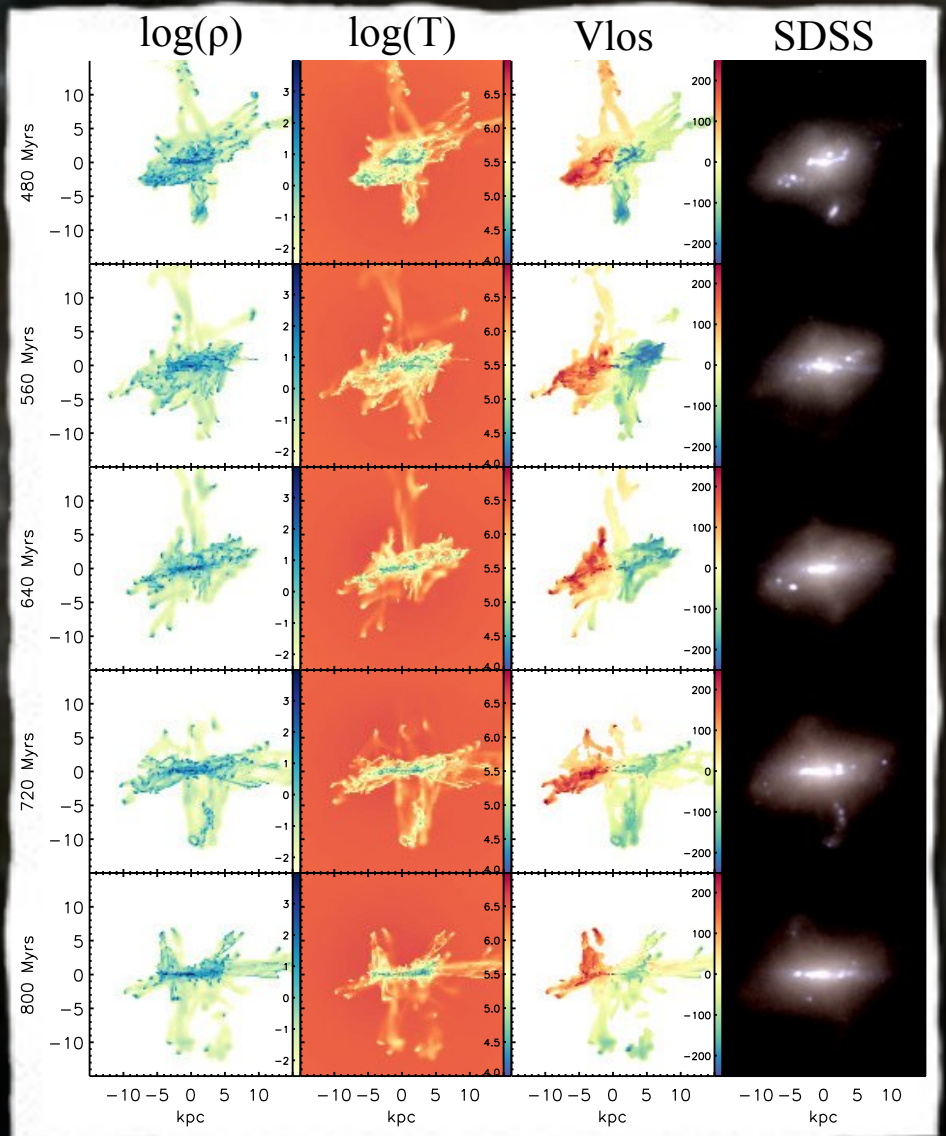


All galaxies at a given redshift have been forming stars for ***exactly 100 Myr***?
At a ***perfectly constant rate***? And ***never more than 100 Myr***? Really? Likely ***not***!

Testing the influence of the SFH on SFR: experimental setup

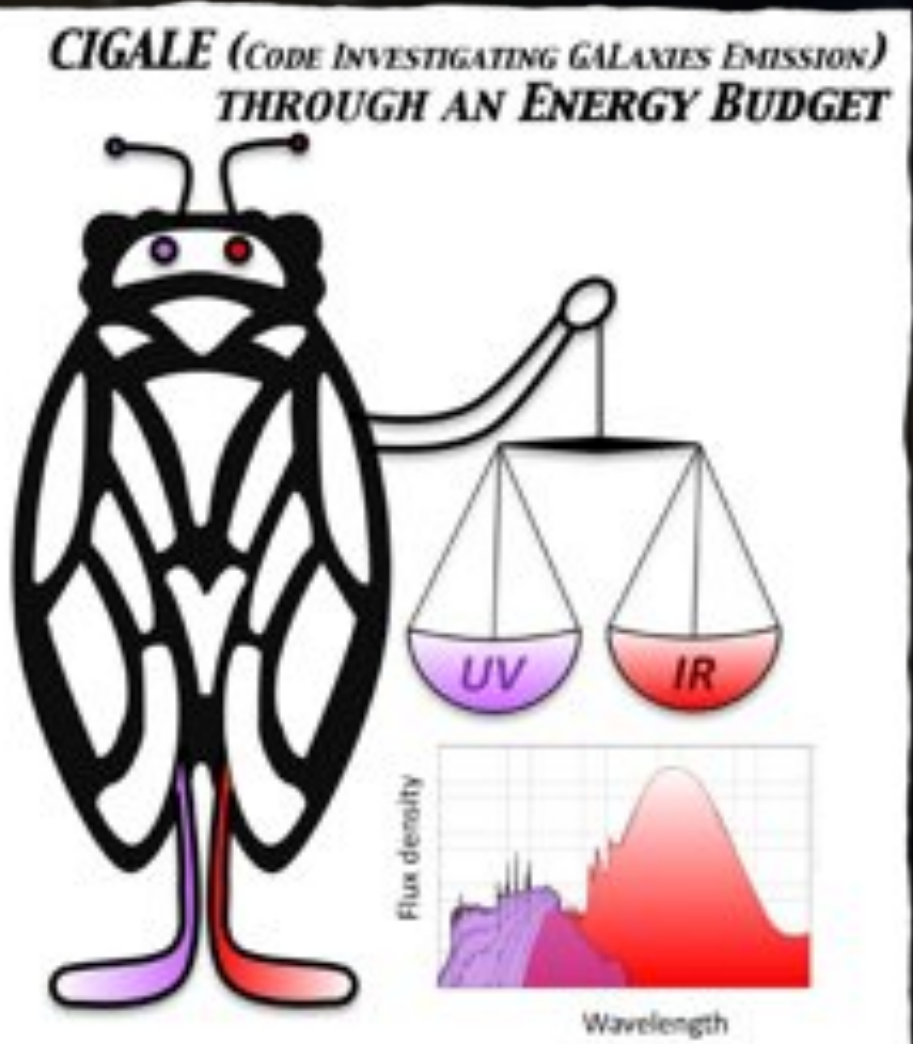
Key idea: let's take realistic SFH from which we compute luminosities in star formation tracing bands so we can estimate the "observed" SFR from these bands in the absence of dust

Realistic SFH
MIRAGE simulations



Perret et al. (2014)

SED generation & SFR estimators calibration
CIGALE modelling code

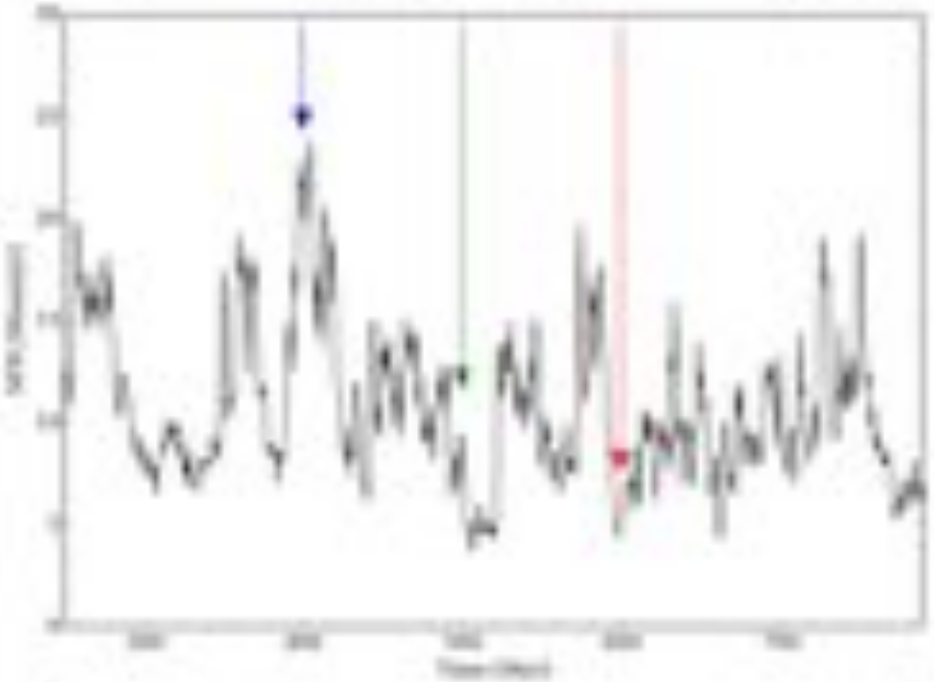


Boquien et al. (in prep.), Burgarella et al. (in prep.)

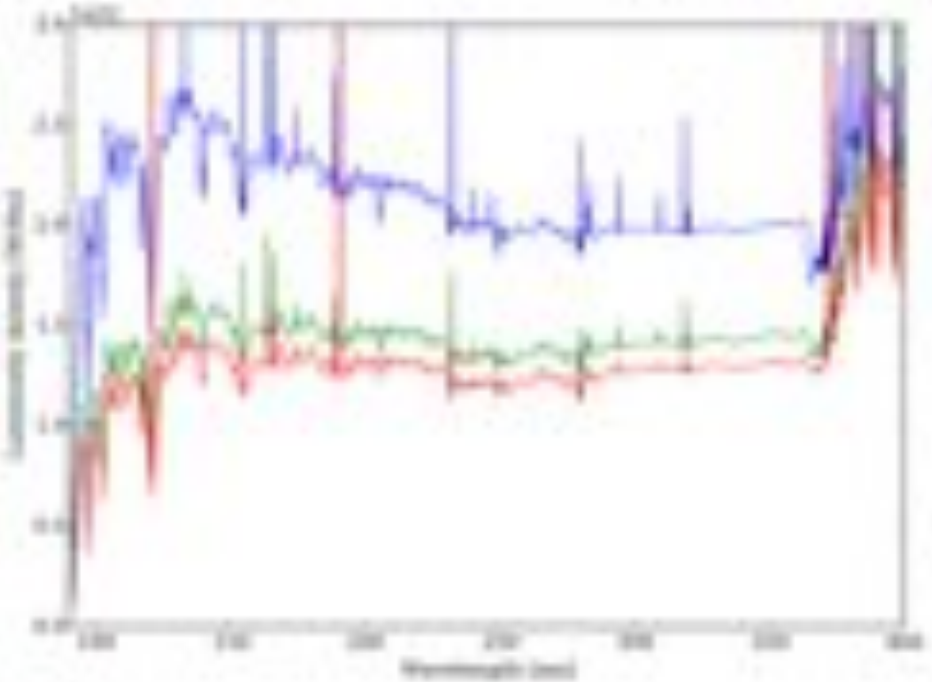
New python version (beta) freely available: http://cigale.lam.fr

Comparing real and estimated SFR for one simulation

MIRAGE SFH



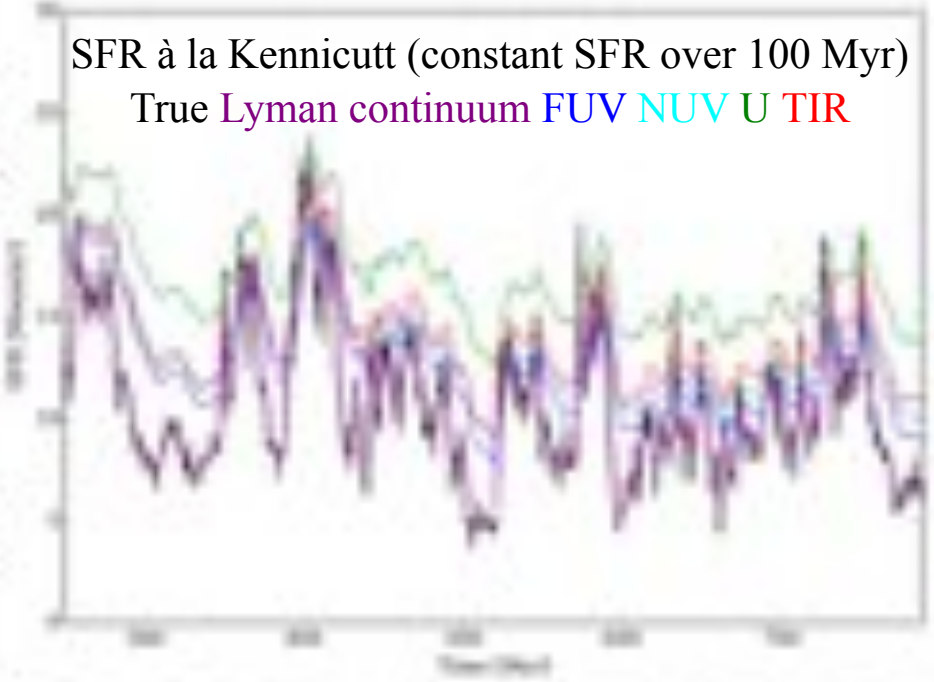
CIGALE spectra



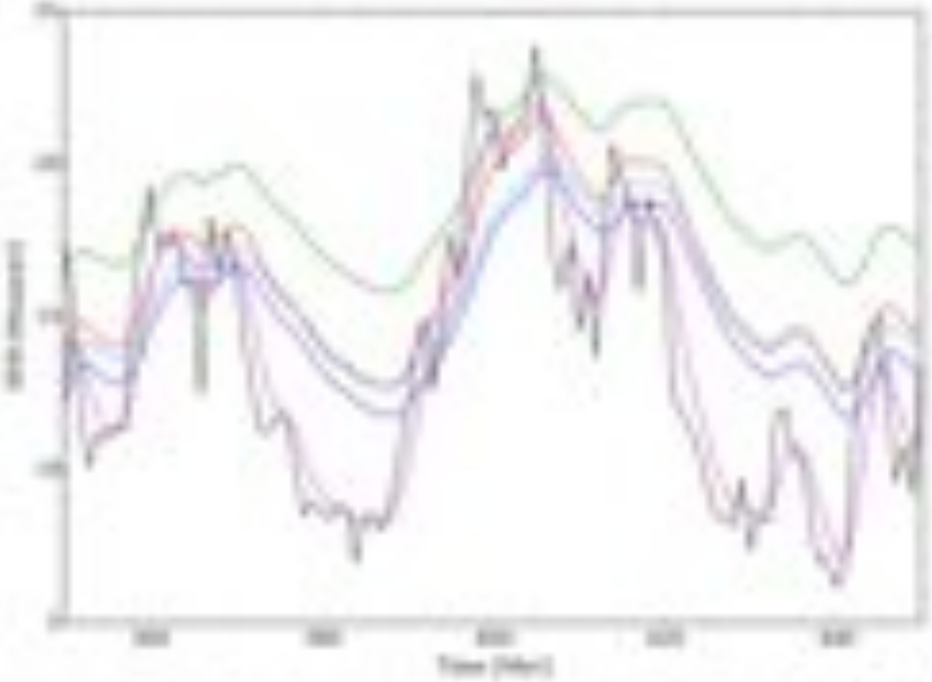
SFR à la Kennicutt (constant SFR over 100 Myr)

True Lyman continuum FUV NUV U TIR

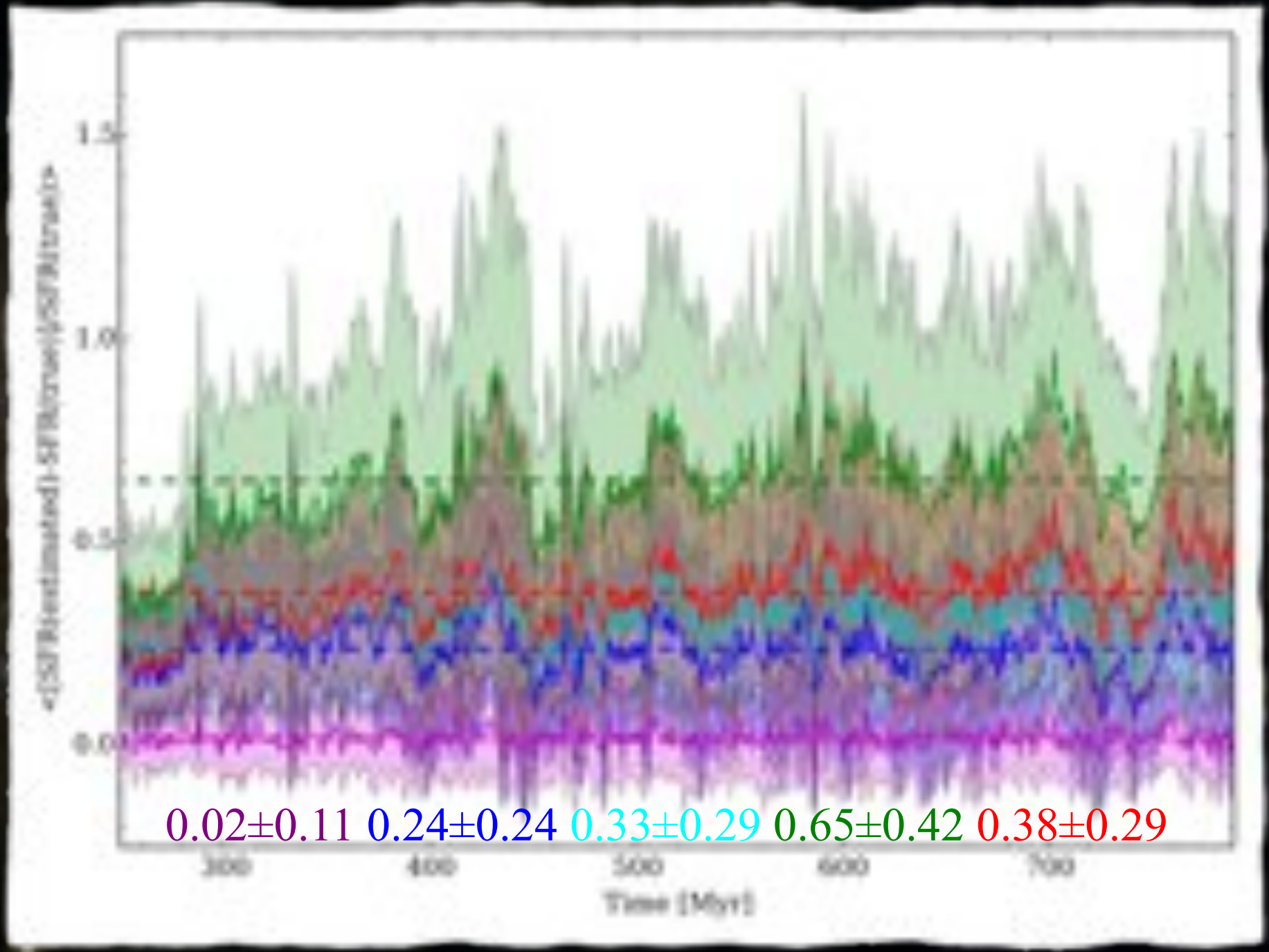
Real+estimated SFR



Real+estimated SFR (zoom)



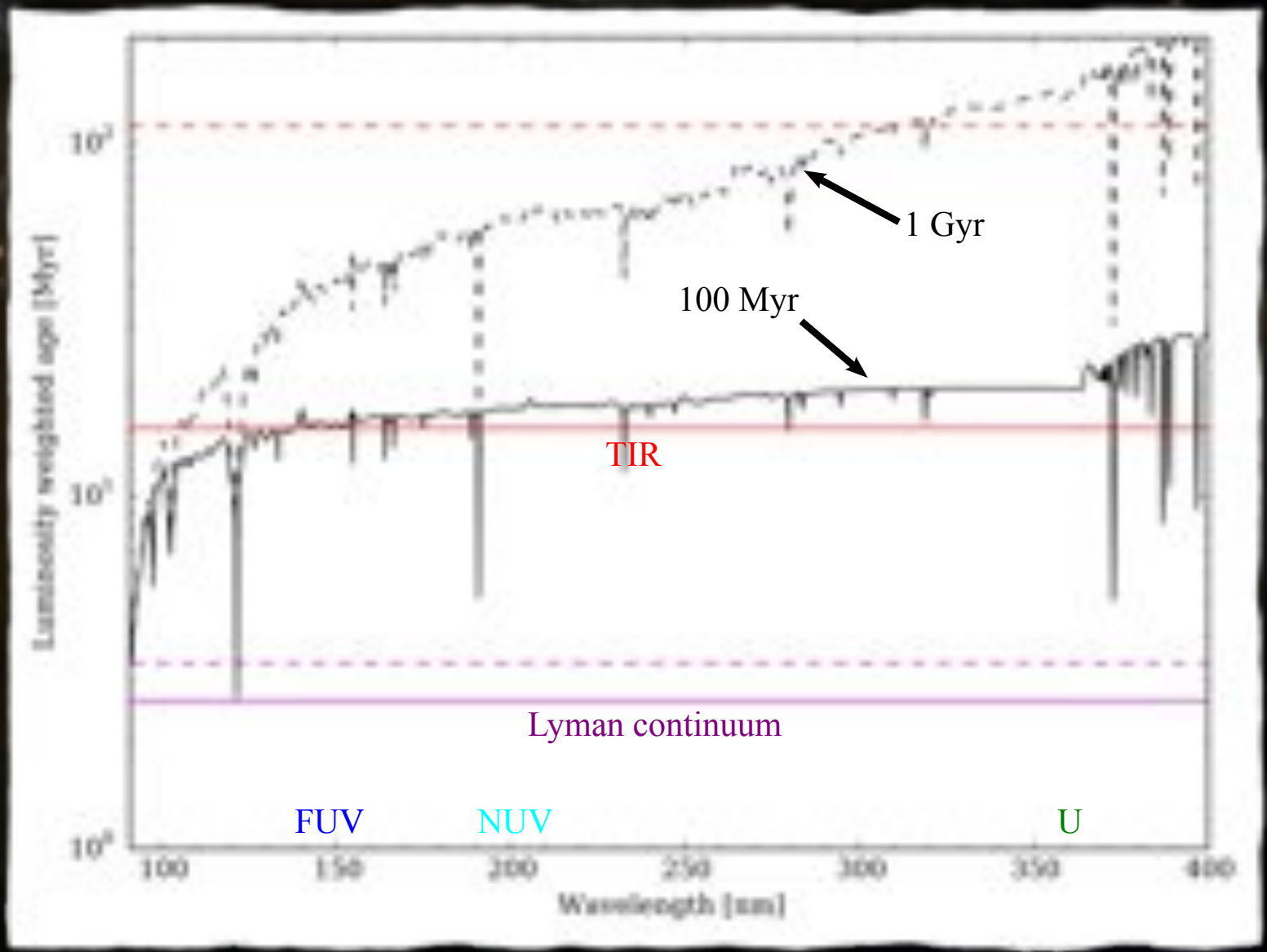
Comparing real and estimated SFR for the whole sample



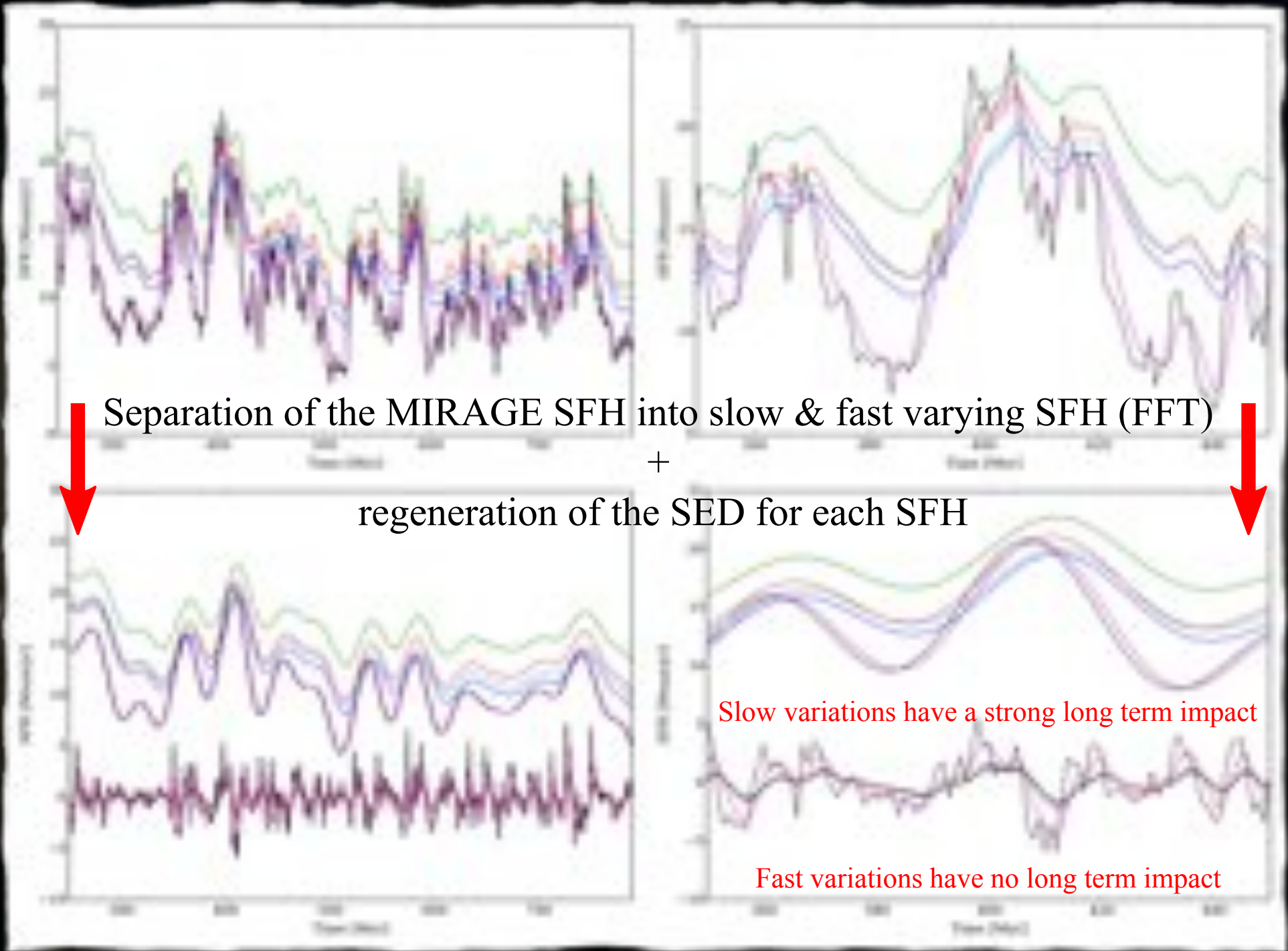
A short digression on timescales

"The Hα gives a measure of the mean SFR over 10 Myr and the FUV over 100 Myr"

Wrong!



Impact of the variation of the SFR



Separation of the MIRAGE SFH into slow & fast varying SFH (FFT)

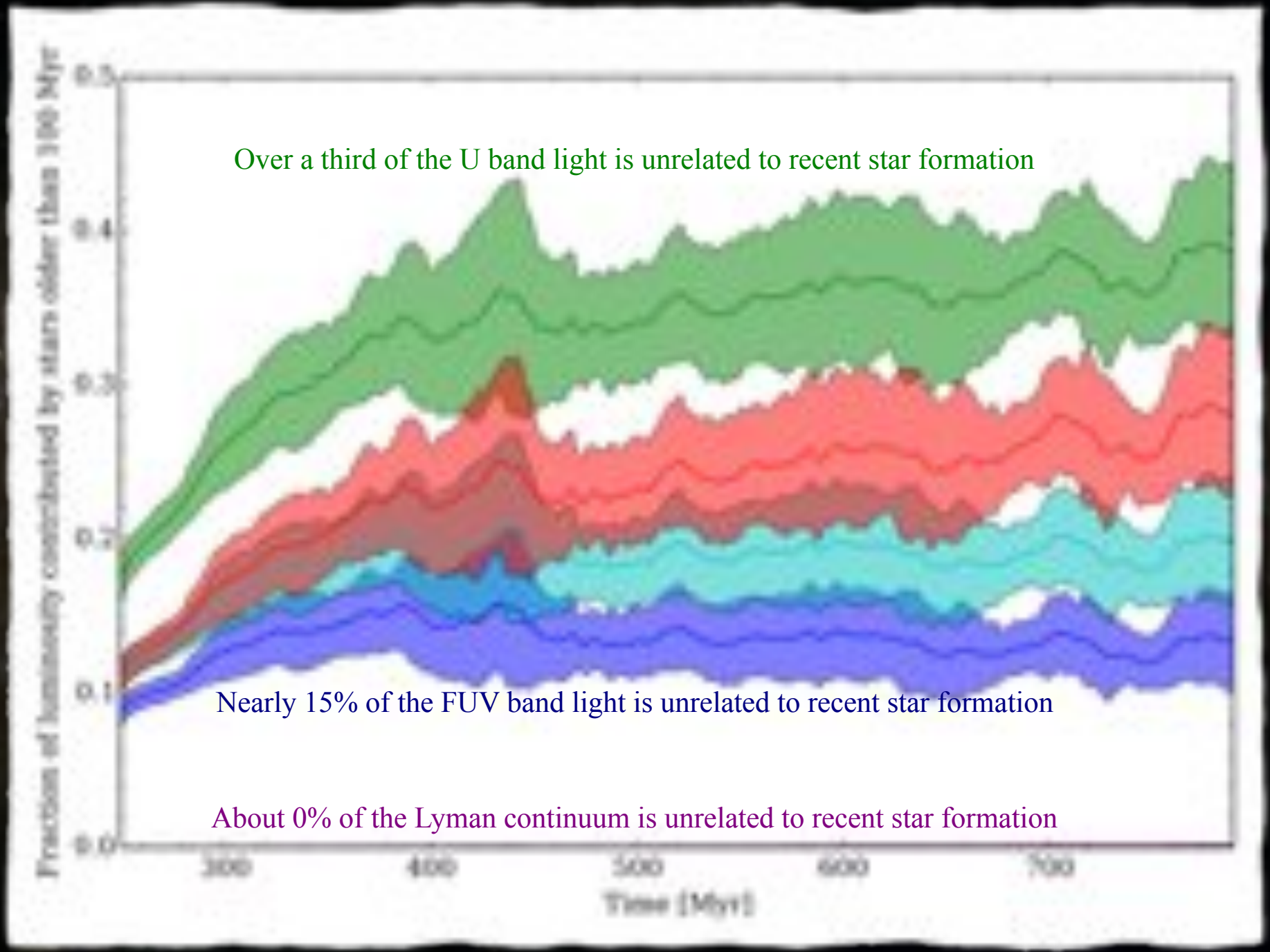
+

regeneration of the SED for each SFH

Slow variations have a strong long term impact

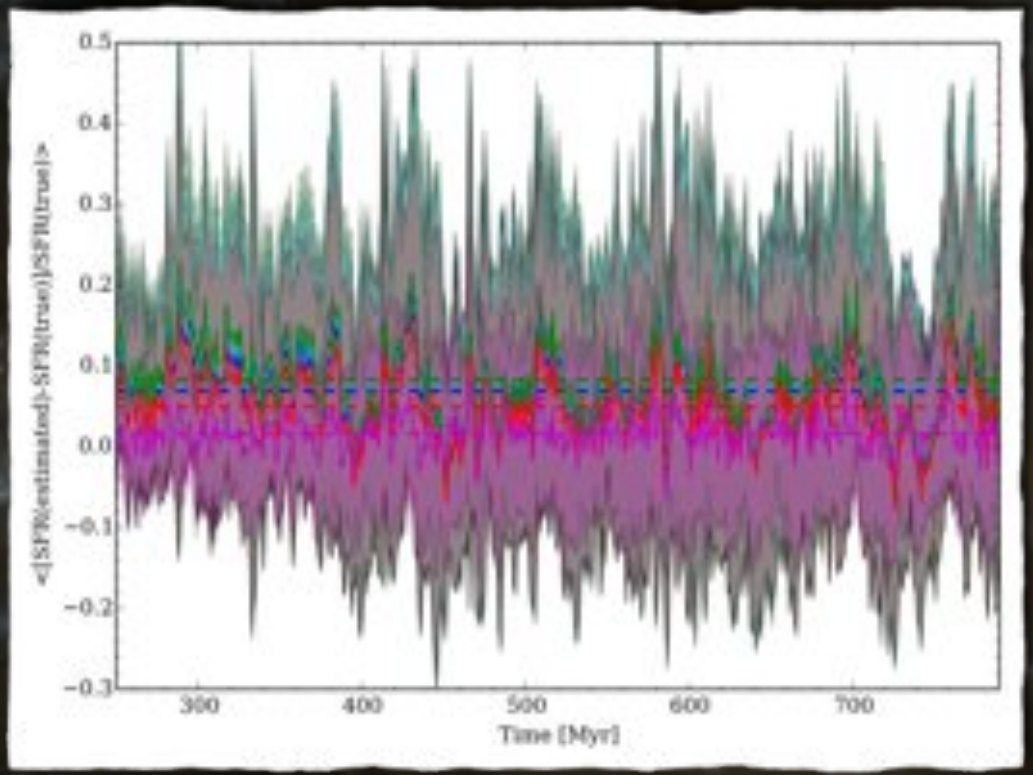
Fast variations have no long term impact

On the relative contribution of long lived stars

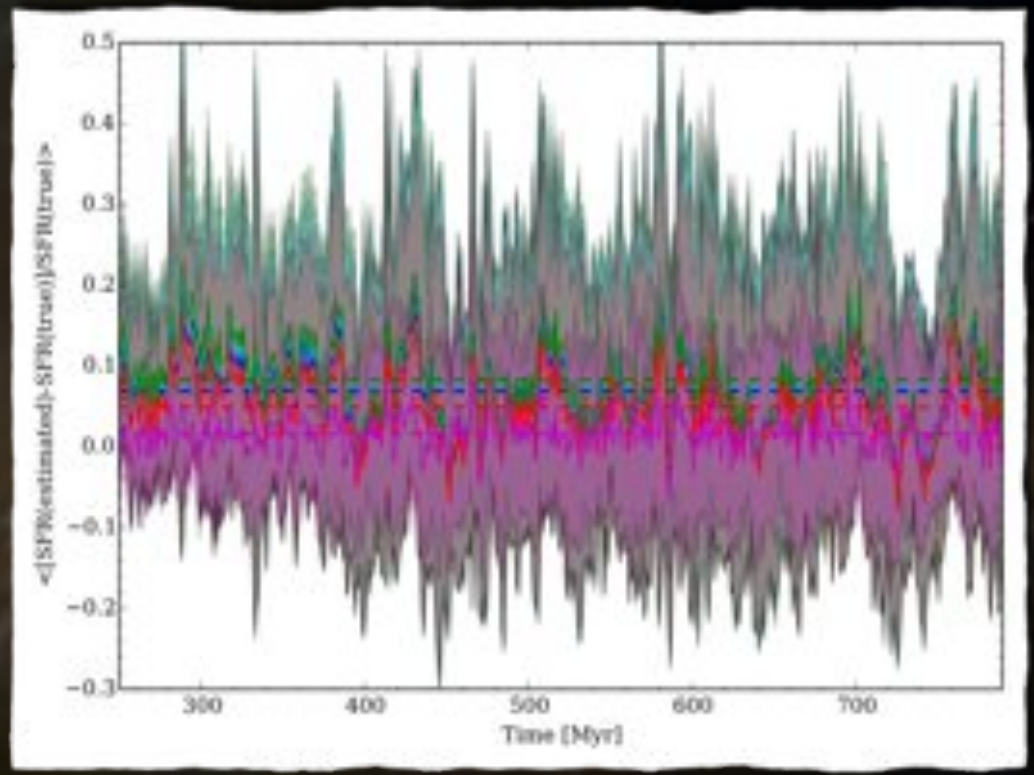


Better SFR estimates

SFR calibration over 100 Myr
only taking into account stars < 100 Myr



SFR calibration over 1 Gyr
taking all the luminosity into account



Assuming a constant SFR over 1 Gyr provides ***on average*** good estimates of the SFR

Three conclusions and a take home message

① On average all estimators except for the Lyman continuum overestimate the SFR from typically ~25% for SFR(FUV) to ~65% for SFR(U), when such estimators have been calibrated assuming a constant SFR over 100Myr.
This is chiefly due to the contribution of stars living longer than 100 Myr.

② Rapid variations of the SFR contribute to an increase of the uncertainty on the instantaneous SFR but have little long term effect on the measurement of the SFR.

③ Slow variations of the SFR on timescales of a few tens of Myr and longer lead both to an increase of the noise on the measurement of the instantaneous SFR, and to systematic overestimates of the SFR for all tracers except for the Lyman continuum.

Take home message:

Classical estimators have major shortcomings if we want to do precision galaxy evolution.
More work is needed to exploit WISH to its full capacity.

Shameless advertisement

RAS Specialist Discussion

Understanding Galaxies from their SED: Models to Observations

10 October 2014
Burlington House

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