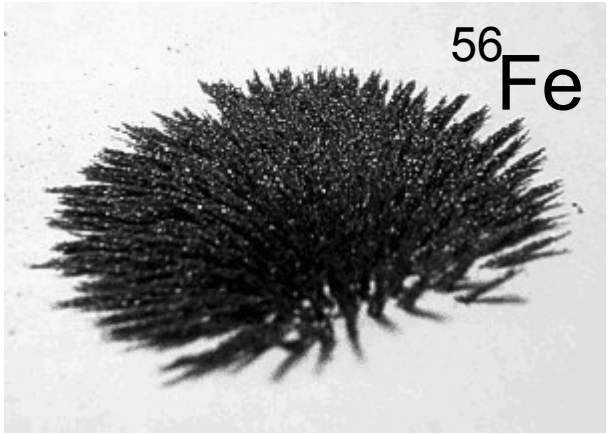
The star formation history (SFH) and constraints on type Ia SNe progenitor time delays.

Förster F., Wolf C., Podsiadlowski Ph., Han Z. 2006, MNRAS



PPARC
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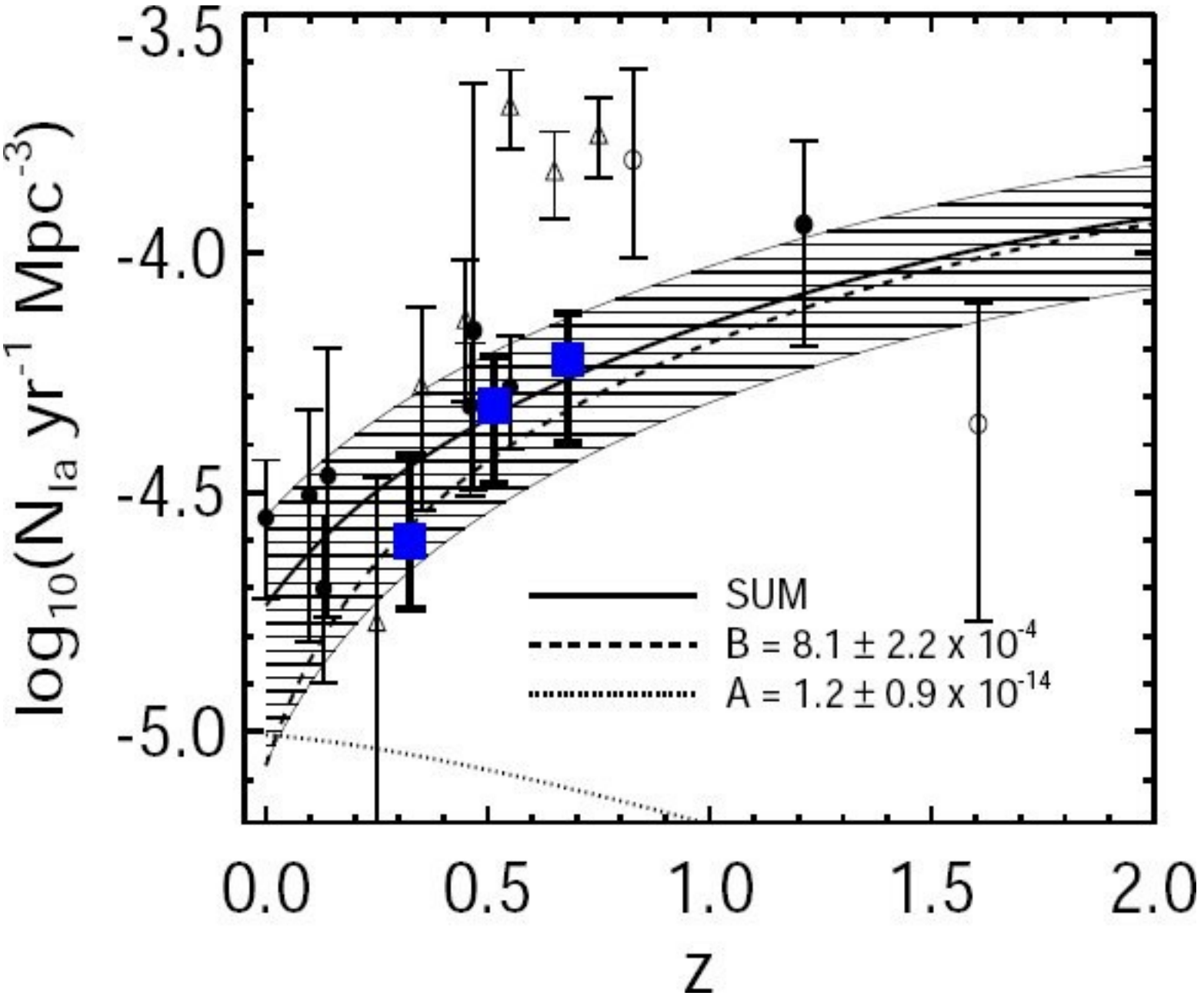
Francisco Förster Burón – University of Oxford

Neill et al. 2007 (SNLS)



1. Comparison between SFH and SNR

$$SNR_{Ia}(z,\tau) = \int_{t(z_R)}^{t(z)} SFR(t')\,\phi_\tau(t-t')\,dt'$$

parametrized time delay distribution (arbitrary)

depends on the choice of SFH

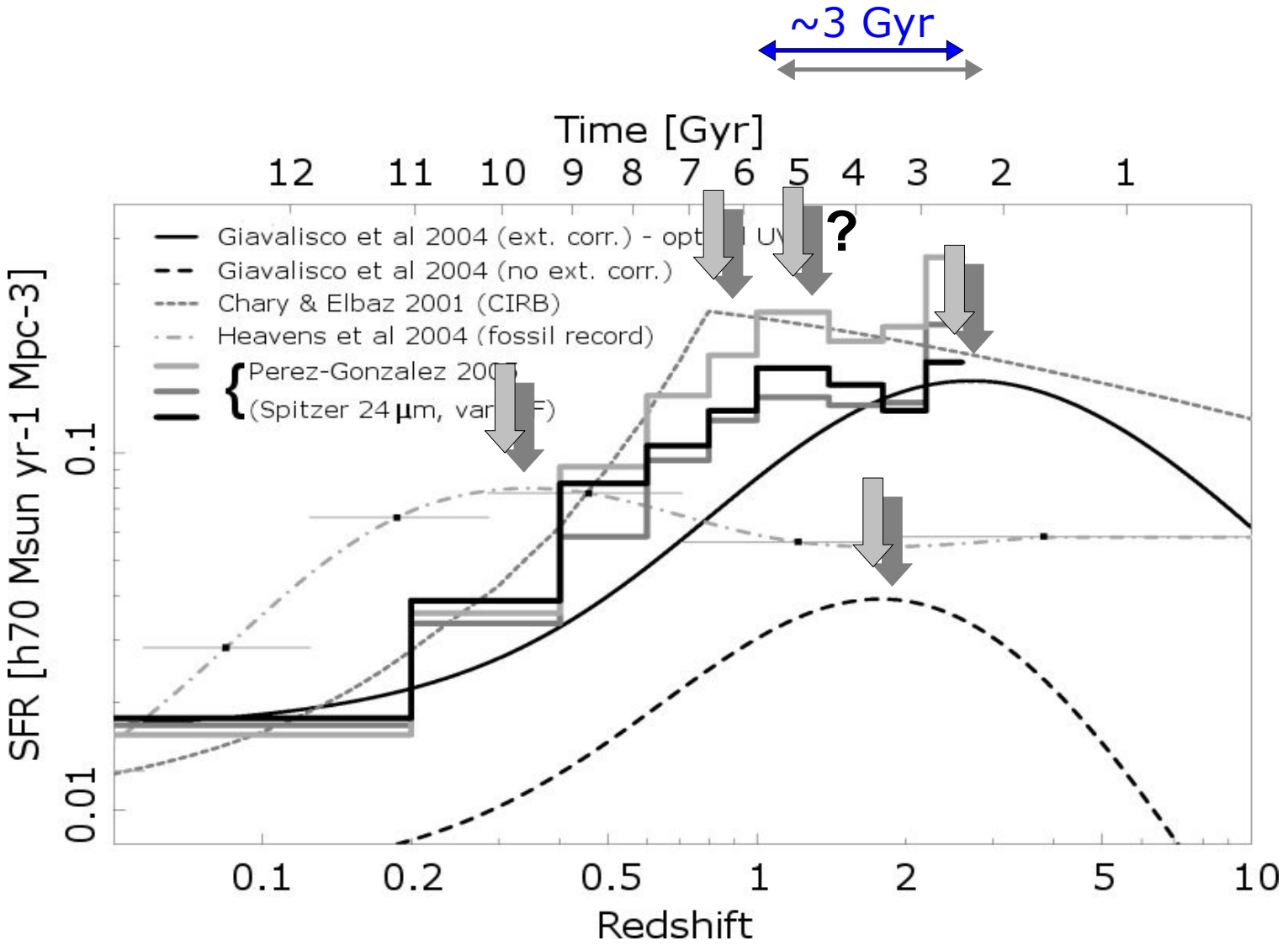
$$\frac{dn_{Ia}(z)}{dz\,d\Omega} = SNR_{Ia}(z,\tau)\,\frac{tc(z)}{1+z}\,\frac{dV(z)}{dz\,d\Omega}$$

observing time times the probability of detecting a SNe.

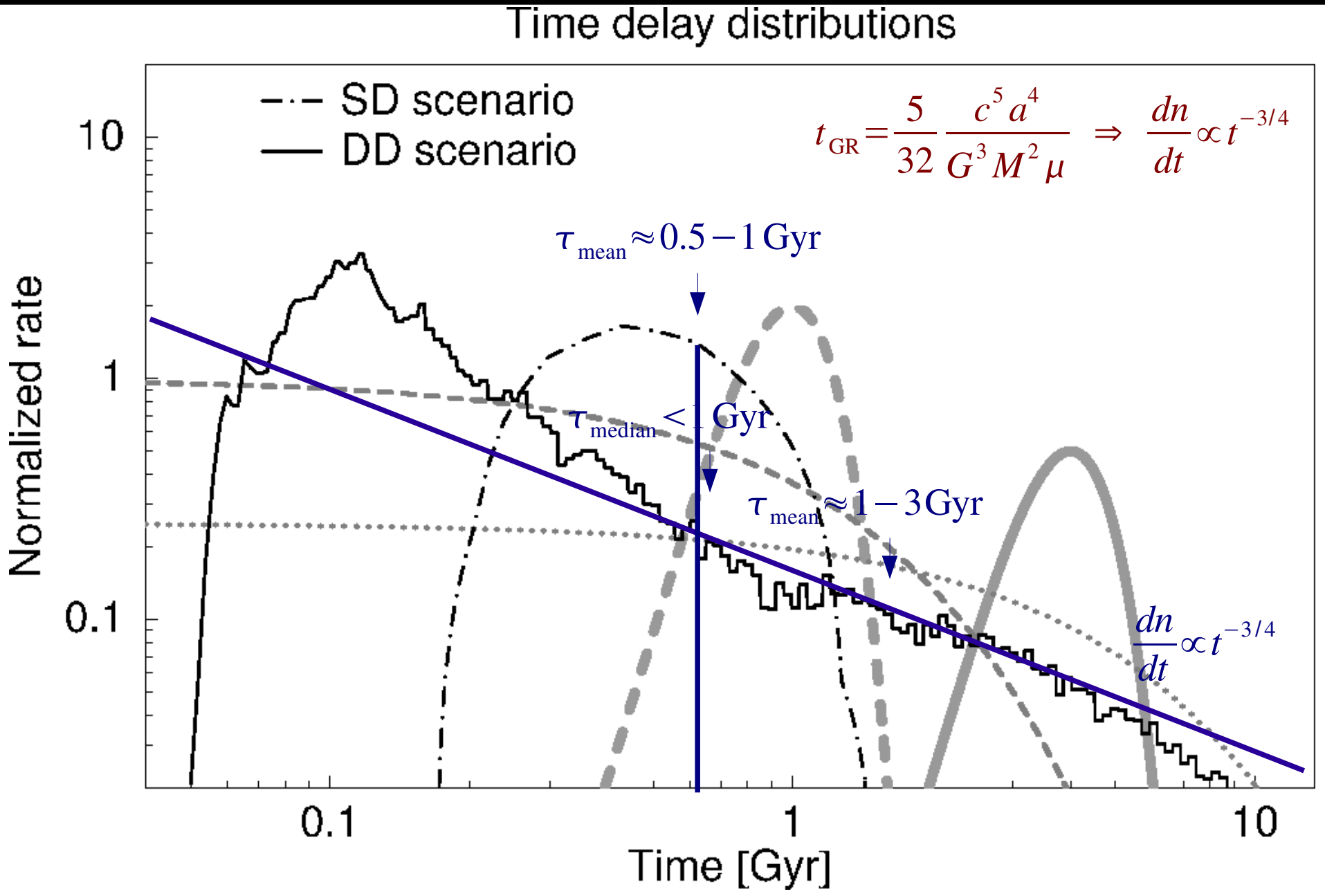
$$P(data|\tau) \propto \prod_i \frac{dn_{Ia}(z_i)}{dz\,d\Omega}\,;\; P(\tau|data) \propto P(data|\tau)$$ (or GoF test)

Gal-Yam & Maoz 2004; Strolger et al. 2004; Barris & Tonry 2006

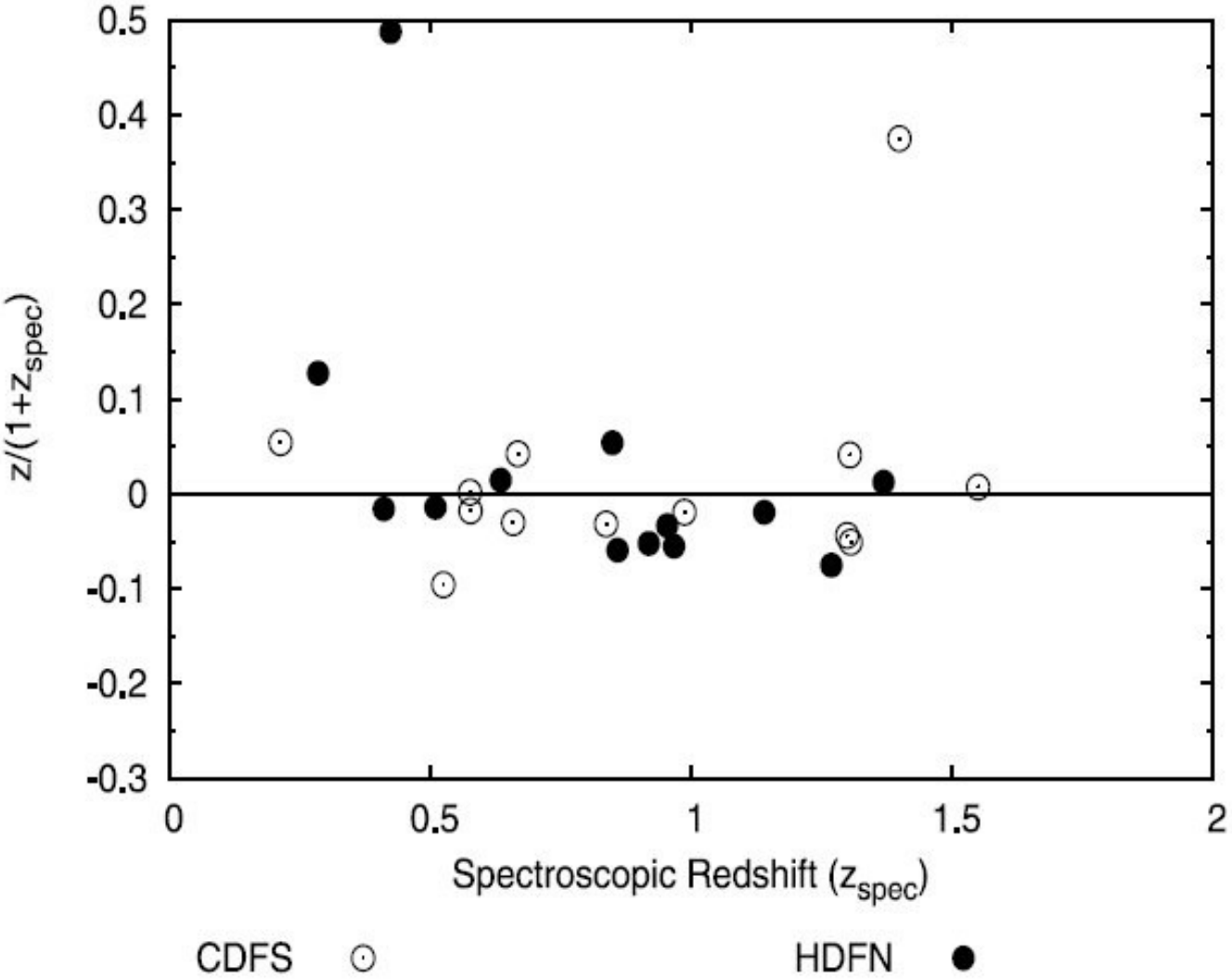
But SFH is uncertain...



Time delay distributions



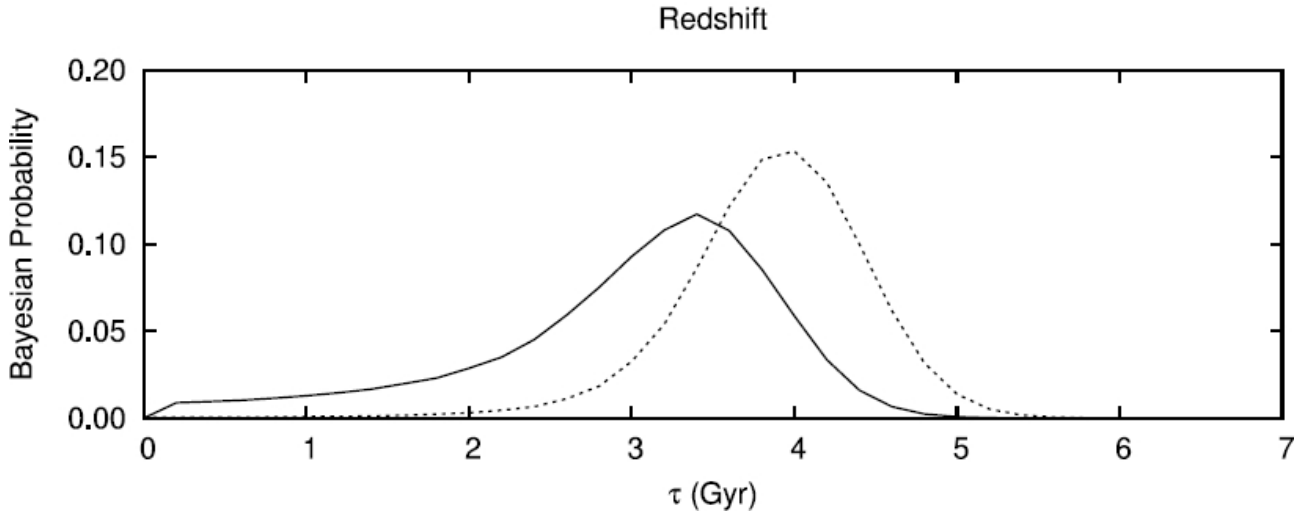
GOODS SNe Ia


0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
z/(1+z_spec)
0
0.5
1
1.5
2
Spectroscopic Redshift (z_spec)
CDFS
HDFN

GOODS SNe Ia

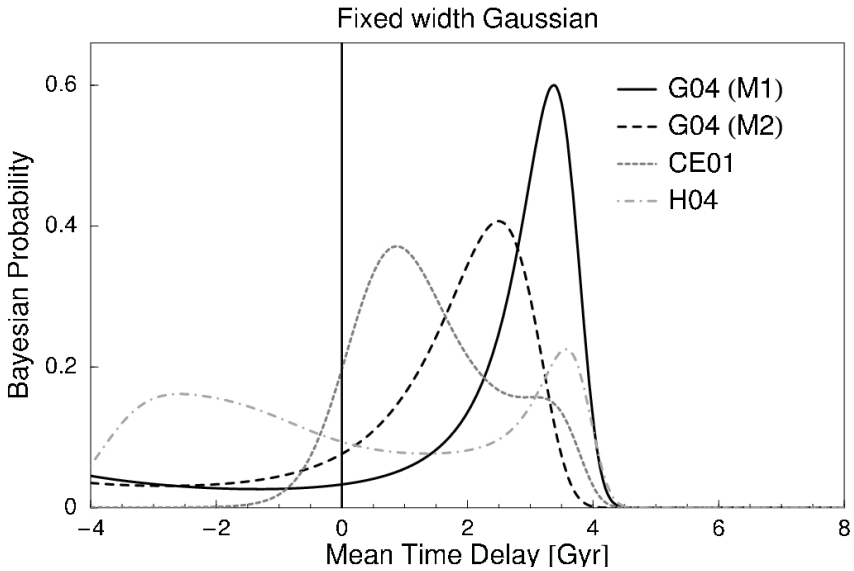
- Assume Giavalisco et al 2004 SFH (with and without extinction corrections) and compare to parametrized model.

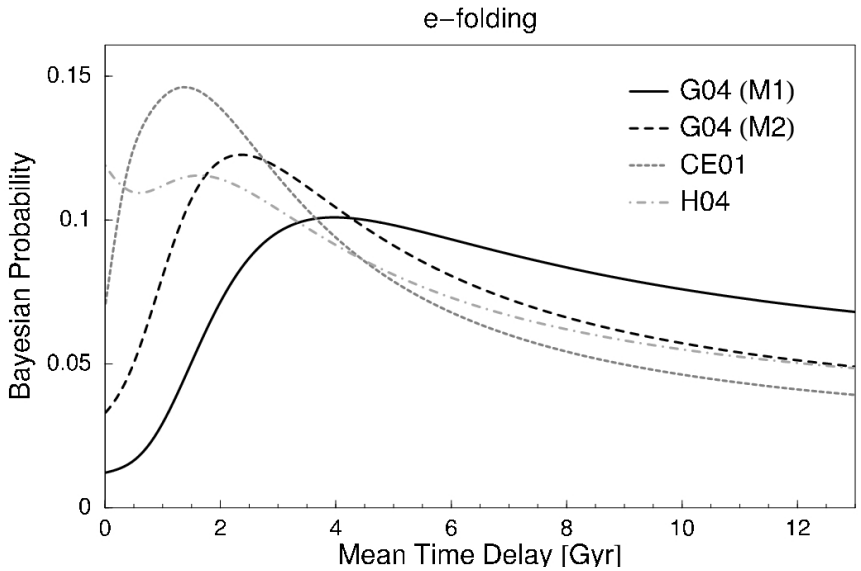
Statistic	SFR Model	*e*-folding	*e*-folding w/MCO	$G(\tau, 0.5\tau)$	$G(\tau, 0.2\tau)$
Maximum likelihood τ	M1	5.4	4.4	3.0	**3.4**
	M2	2.8	2.6	2.4	2.6
95% Interval τ	M1	>1.6	>1.6	0.2–6.6	1.0–4.4
	M2	>1.0	0.8–10	0.2–4.8	0.4–3.6

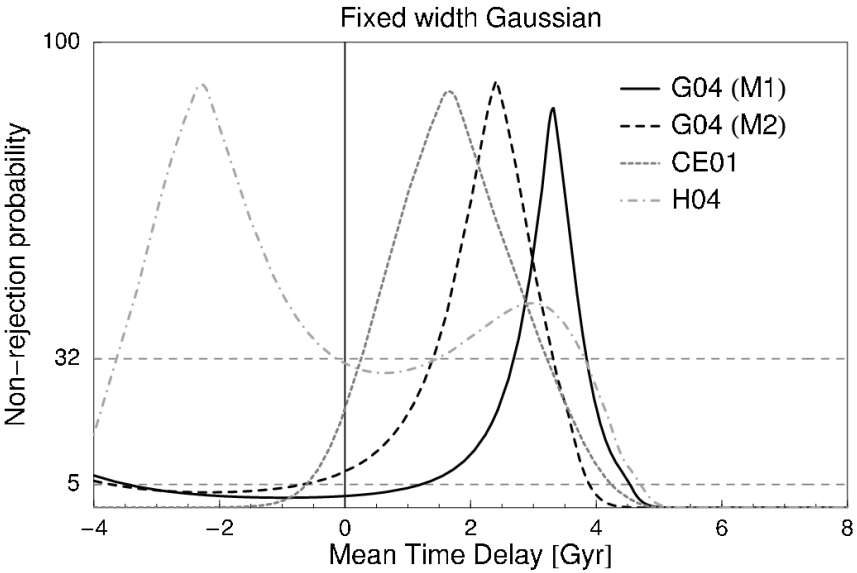


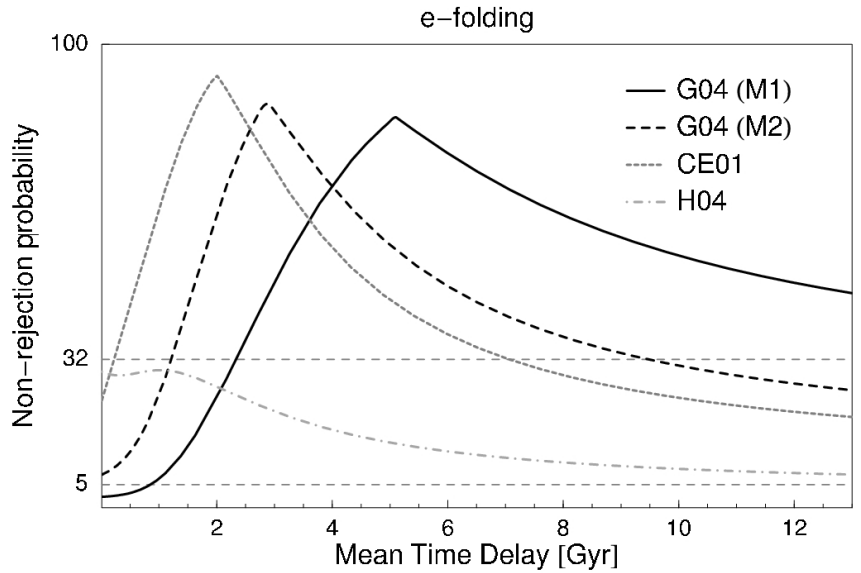
Strolger et al. 2004

Analysis with more SFHs?









BPS constraints

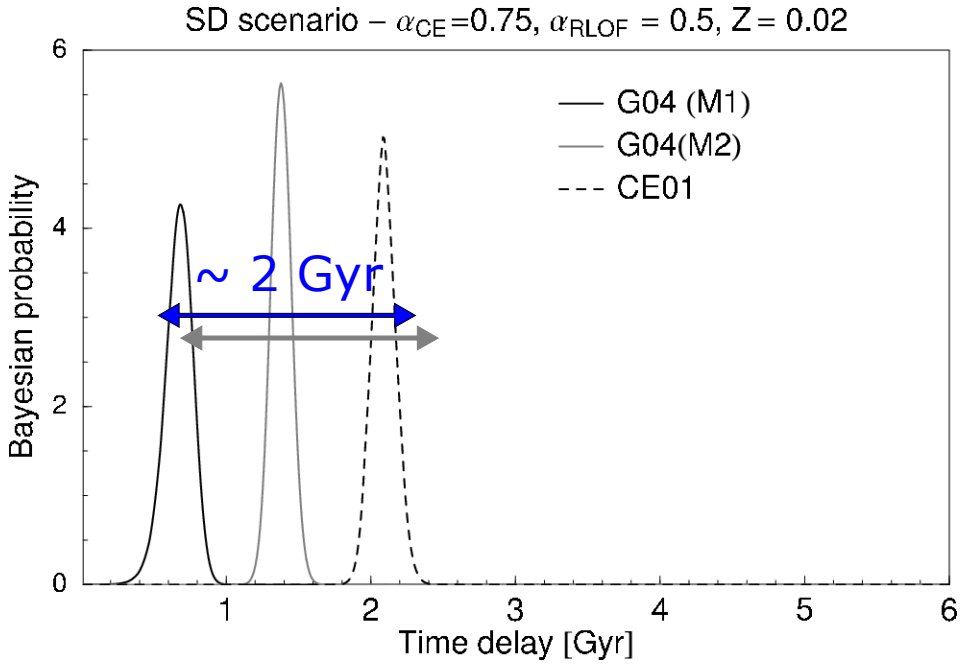
- Assume SFH, BPS parameters and perform KS test
- non rejection probabilities (per cent) bellow:

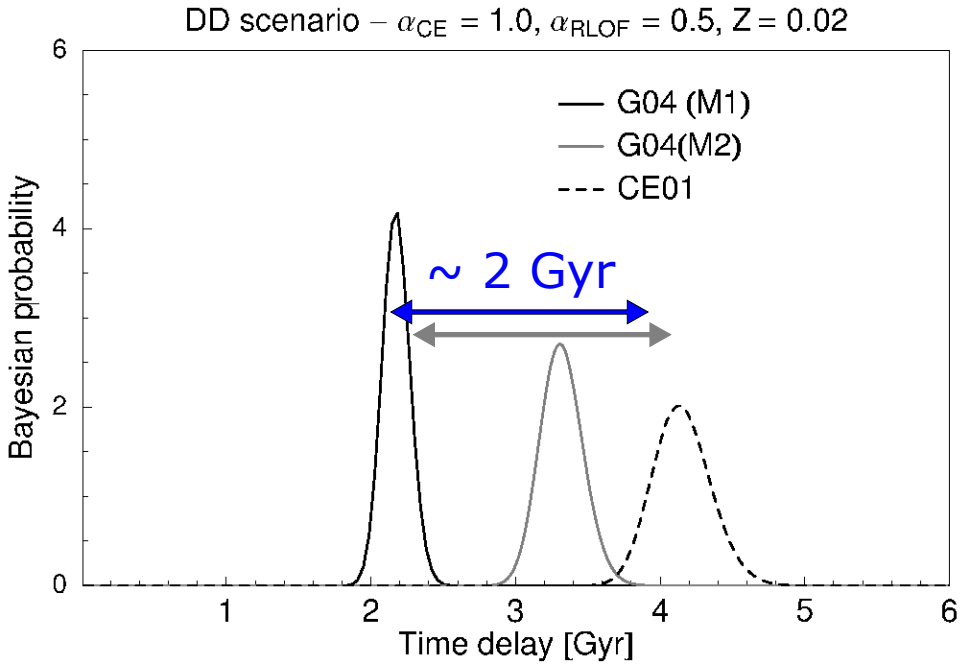
	SD scenario – α_{CE}:			DD scenario – α_{CE}:		
SFH	0.5	0.75	1.0	0.5	0.75	1.0
G04 (M1)	3.1	3.0	3.1	5.7	11.4	25.9
G04 (M2)	12.2	11.7	12.4	15.8	29.1	51.6
CE01	49.8	47.8	50.8	48.1	69.2	85.4
H04	28.1	28.1	28.0	25.7	24.2	21

Förster, Wolf, Podsiadlowski & Han 2006

More SNe will not help unless SFH is known

- Assume SFH and generate 1000 random SNe Ia
- Derive time delay using a different SFH
- Systematic error can be estimated to be ~2 Gyr





BPS models from Han & Podsiadlowski 2004

2. SNe Ia in elliptical galaxies

Della Valle et al. 2005

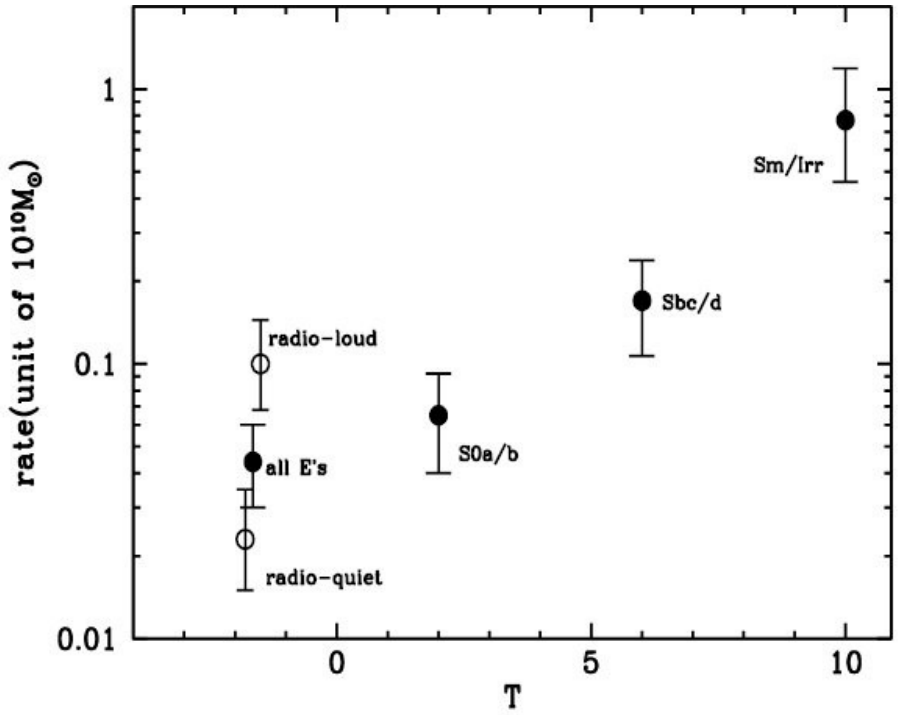


FIG. 5.—Rates of SN Ia explosions (normalized to $10^{10}\,M_\odot$) as a function of the morphological Hubble type of the respective parent galaxies. Open symbols at type approximately −2 represent the SN Ia rates of radio-loud (*upper*) and radio-quiet (*lower*) early-type galaxies. The filled symbol is the overall rate of SN Ia events in early-type galaxies, regardless of their radio properties (i.e., average of radio-loud and radio-quiet rates).

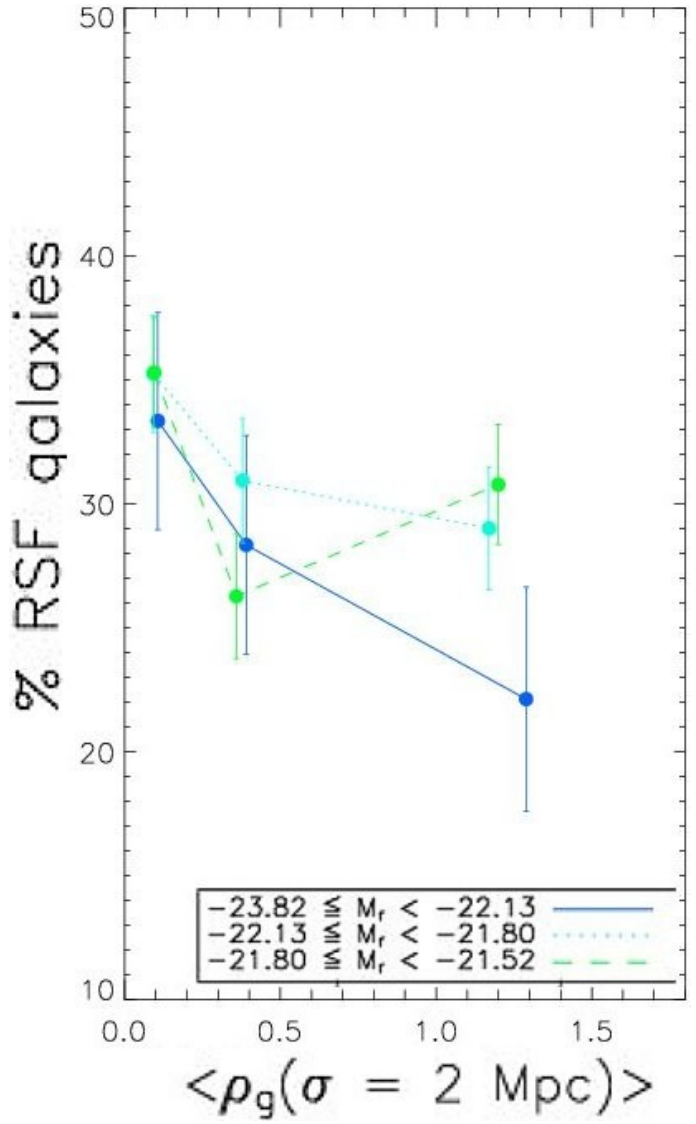
Star Formation in early type galaxies?

- Yi et al. 2004; Kaviraj et al. 2006; Schawinski et al. 2006 (GALEX):
  - The UV color-magnitude relation allows us to identify the last important episode of star formation in galaxies.
  - A significant fraction of massive early-type galaxies at low redshift exhibit levels of star formation un-detectable in the optical, but visible in the UV.
  - Lower limit to the fraction of massive early-type galaxies showing signs of recent star formation: ~30%.
  - Early type galaxies in the redshift range $0<z<0.11$ have ~1 to 3 percent of their stellar mass in stars less than 1 Gyr old.

Field ellipticals show less star formation

Is there a similar signature in the type Ia SNe rate?

Schawinski et al. 2006:



3. Discussion

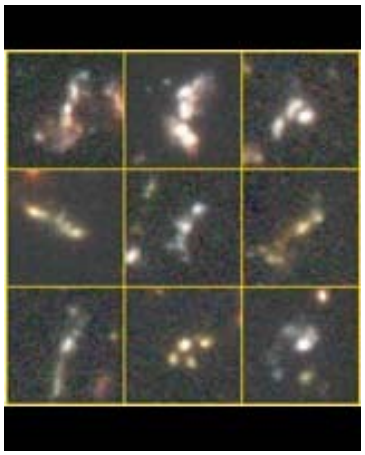
- Based on their time delays, none of the theoretical progenitor scenarios can be ruled out with more than 95% c.l., uncertainties in the SFH are too big (systematic error is ~2 Gyr).

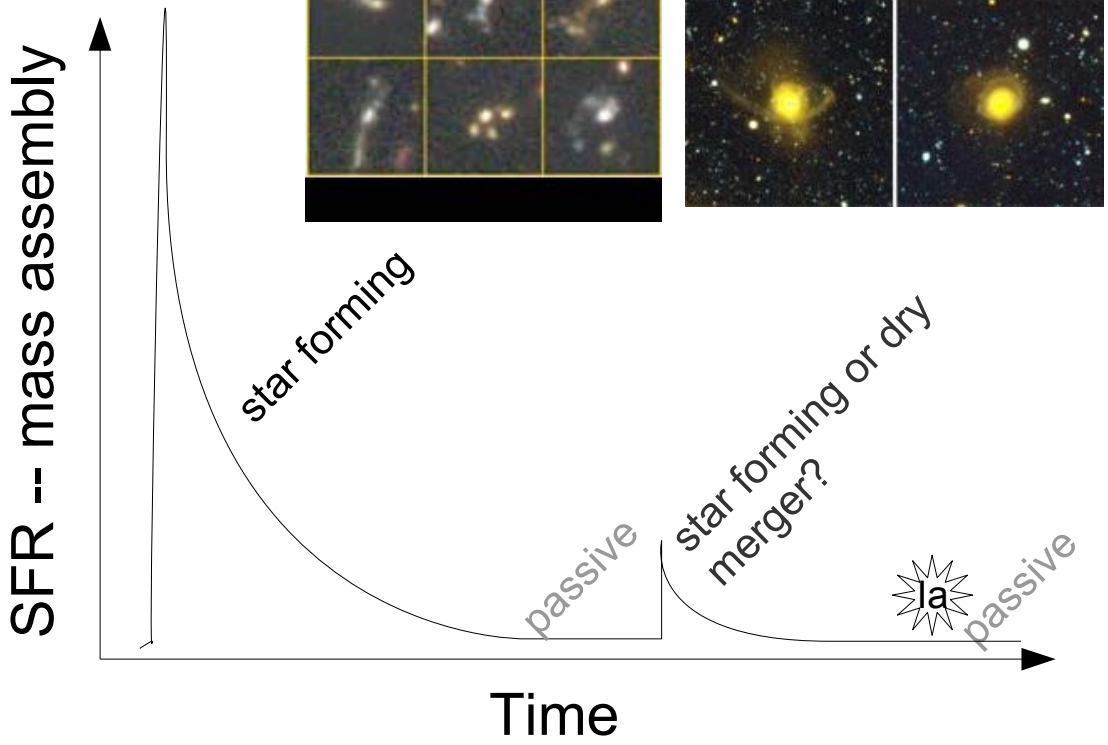
- Peak in the Bayesian probabilities at ~3.5 Gyr is due to absence of SNe at z > 1.5, which corresponds to an age of the Universe < ~4 Gyr.

- Stellar population of host galaxies may give better constraints, but recent episodes of star formation (~1 Gyr) are difficult to detect in the optical.

- Elliptical galaxies are not entirely passive. How many long time delay (several Gyr) progenitors do we need?

A note on galaxy classification





Conselice 2006:

z=0: mass, star formation and interactions/mergers are main parameters. Hubble type correlates with most properties.

z>1: most elliptical galaxies are blue and star forming, the Hubble sequence breaks.

Bridge et al. 2007:

Mergers and interactions account for at least ~40% of SFR at z~1.

"Most probably what astronomers are really viewing is precisely what they have always viewed – the edge of their own vision" - *TIME,* Apr 23, 1973