Recent results on SNe Ia (and CC) rates

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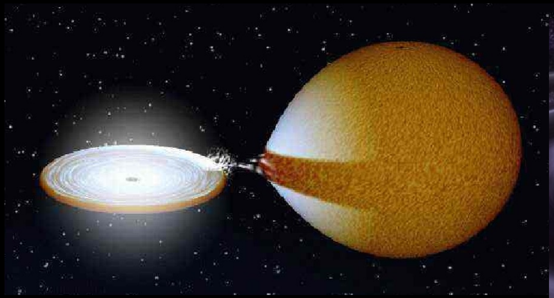
The subject

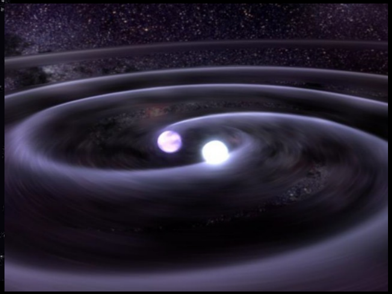
Stellar populations, galaxy models

Delay time distribution,

SNe Ia progenitors

SN rates in different galaxies



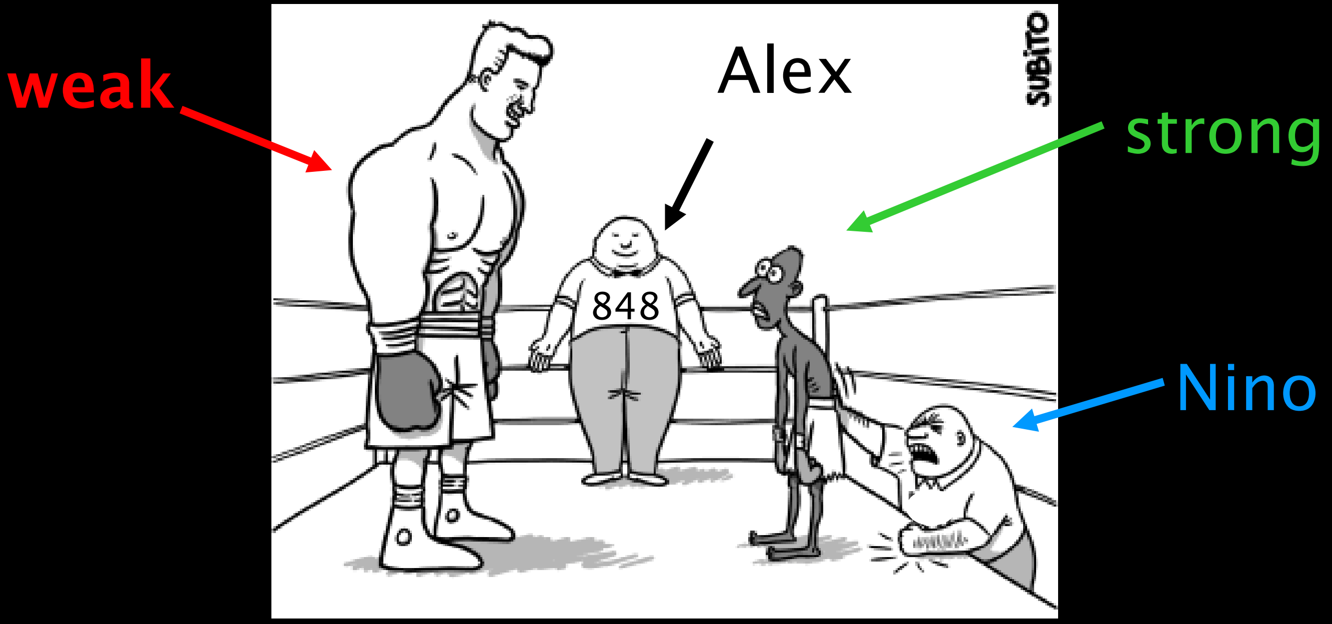


1. Comments on the “two channel model” for Ia
2. A few new results
3. Cosmic CC and Ia rates considering dust

Comments on “two channel model”

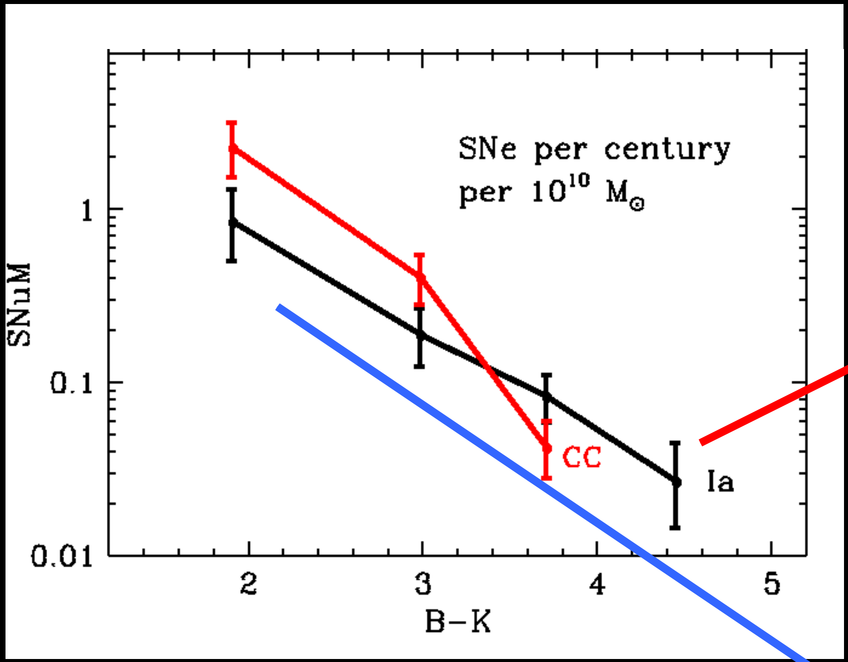
Two “flavors”:

1. “weak” : wide DTD, ~5% of Ia at $t<10^8$yr
2. “strong” : wide DTD, ~50% of Ia at $t<10^8$yr



Weak two channel model

1. Mannucci et al. (2005)
   astro-ph/0411450



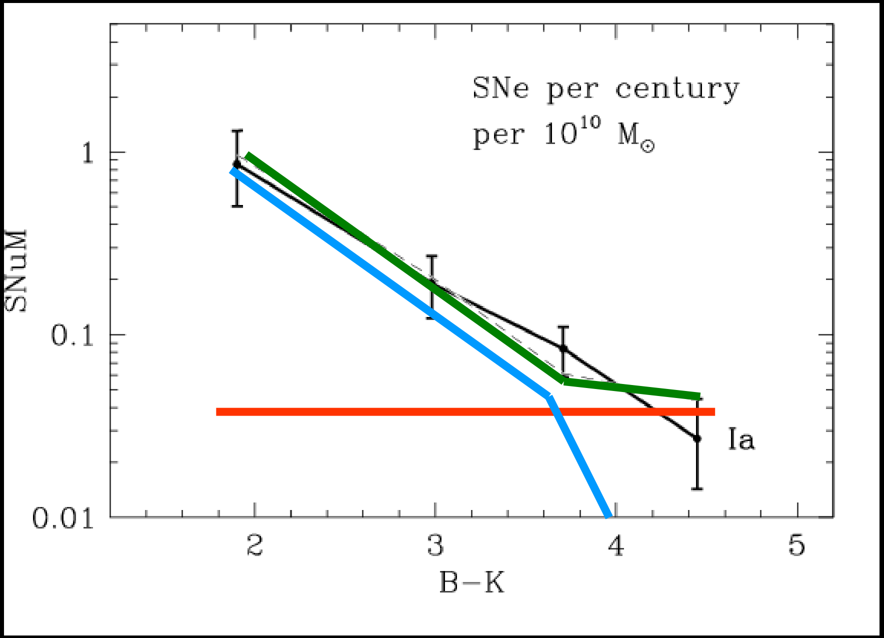
- strong dependence of the rates of galaxy colors
- CC and Ia have similar behaviors for blue galaxies
- Ia: rate(blue) = 30 rate(red)

SN Ia rate:

2. SN Ia in very red galaxies: contribution from old stars (long delay times)
3. strong correlaton with B-K: contribution from young populations (short delay times)

Weak two channel model

1. Mannucci et al (2005)
   astro-ph/0411450
   Two channels:
   "old" ~ mass
   "young" ~ SFR_{CC} (SFR)

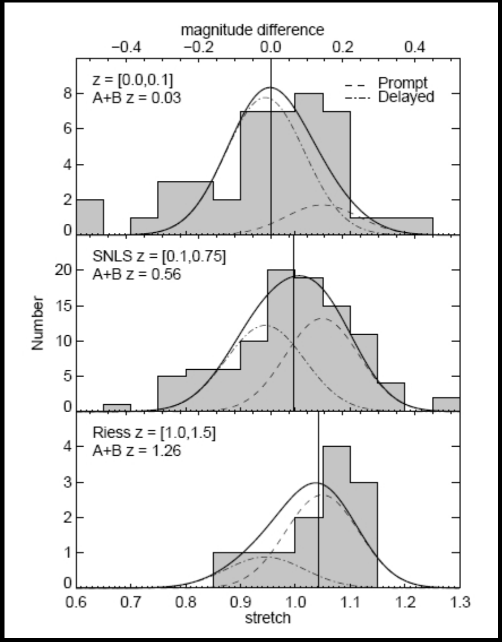


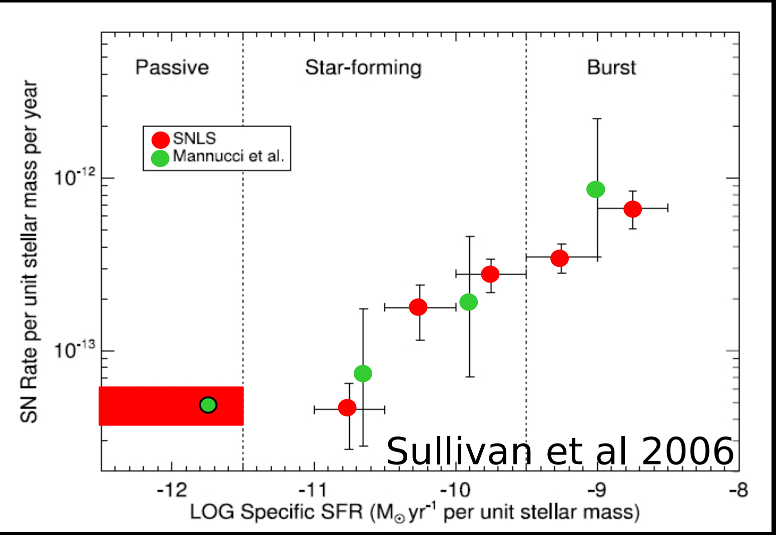
Weak two channel model

1. Mannucci et al (2005) astro-ph/0411450
2. Scannapieco & Bildesten (2005) astro-ph/0507456
3. Sullivan et al. (2006) astro-ph/0605455
4. Howell et al. (2007) astro-ph/0701912

SNR = A * mass + B * SFR

Evolution with redshift,
Metallicity





Sullivan et al 2006

Weak two channel model

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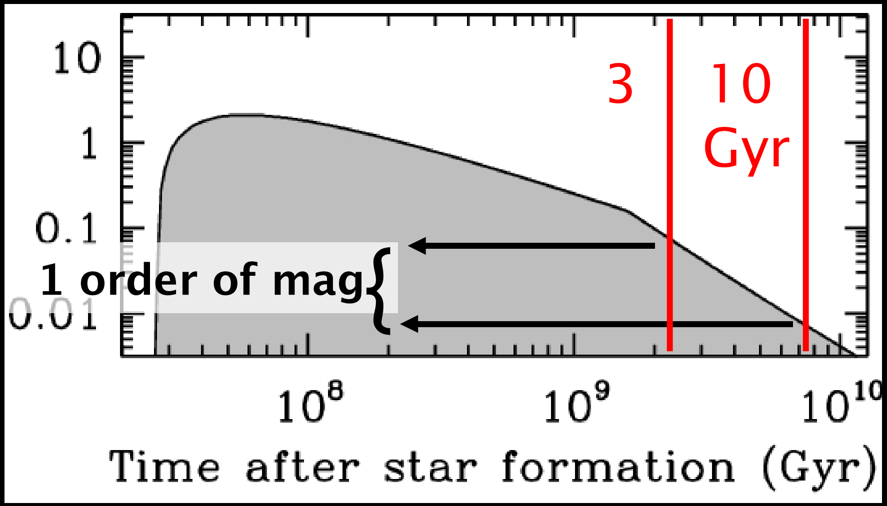
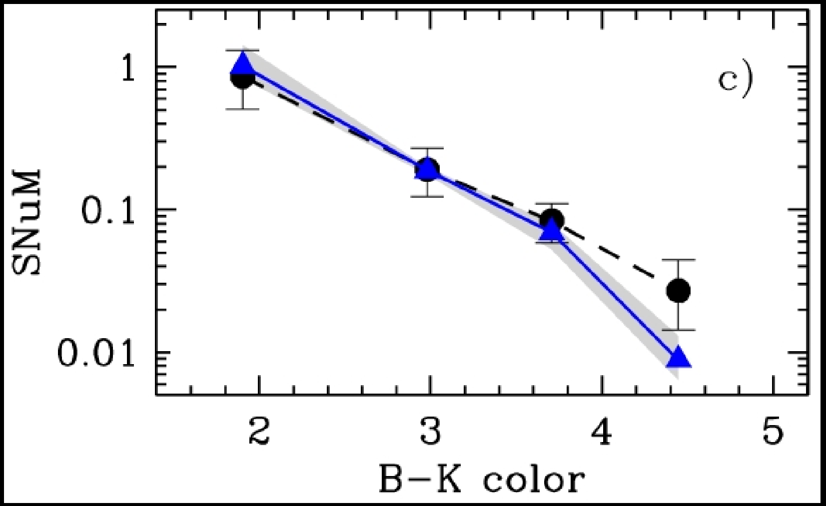
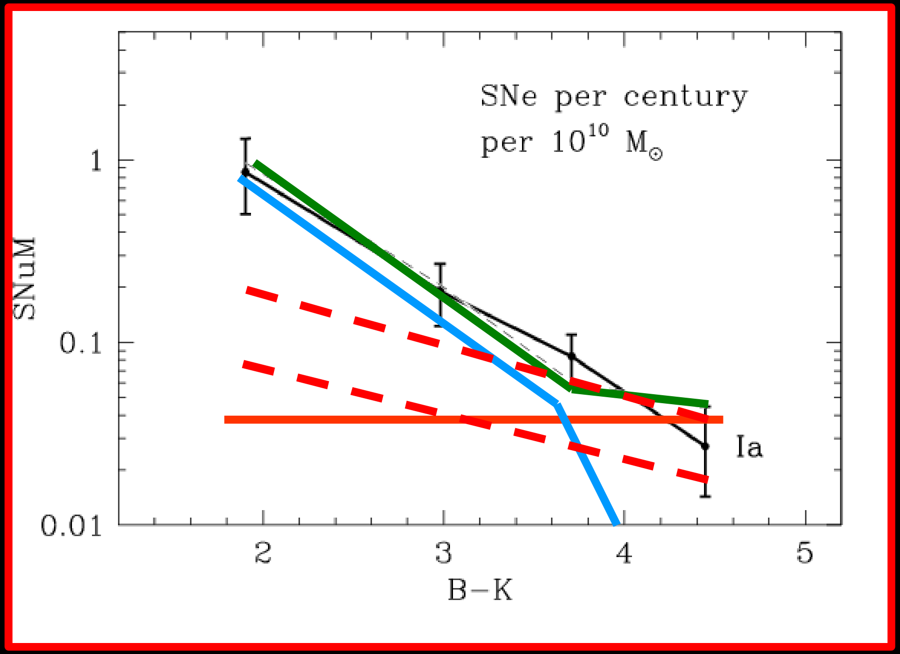




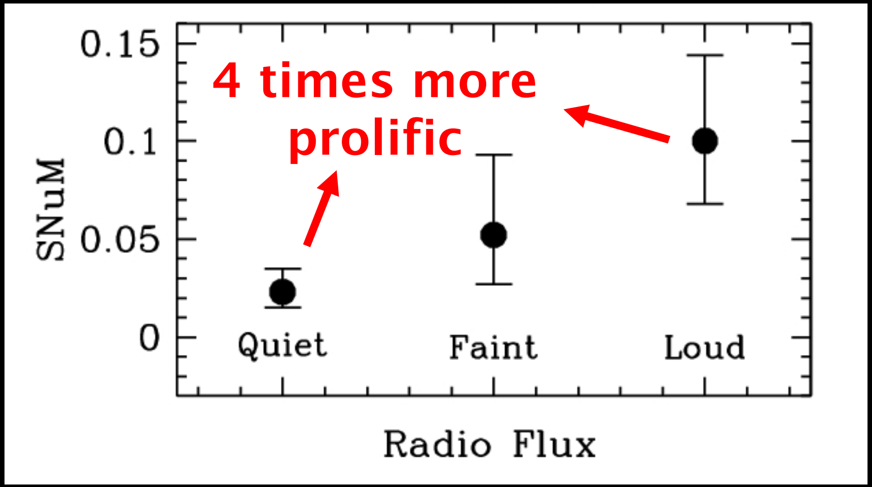
Weak two channel model



1. one single channel! but old and young progenitors
2. possible evolution of properties with age ($\Delta m15$, v_{exp})
3. mind the A+B model, use DTD !

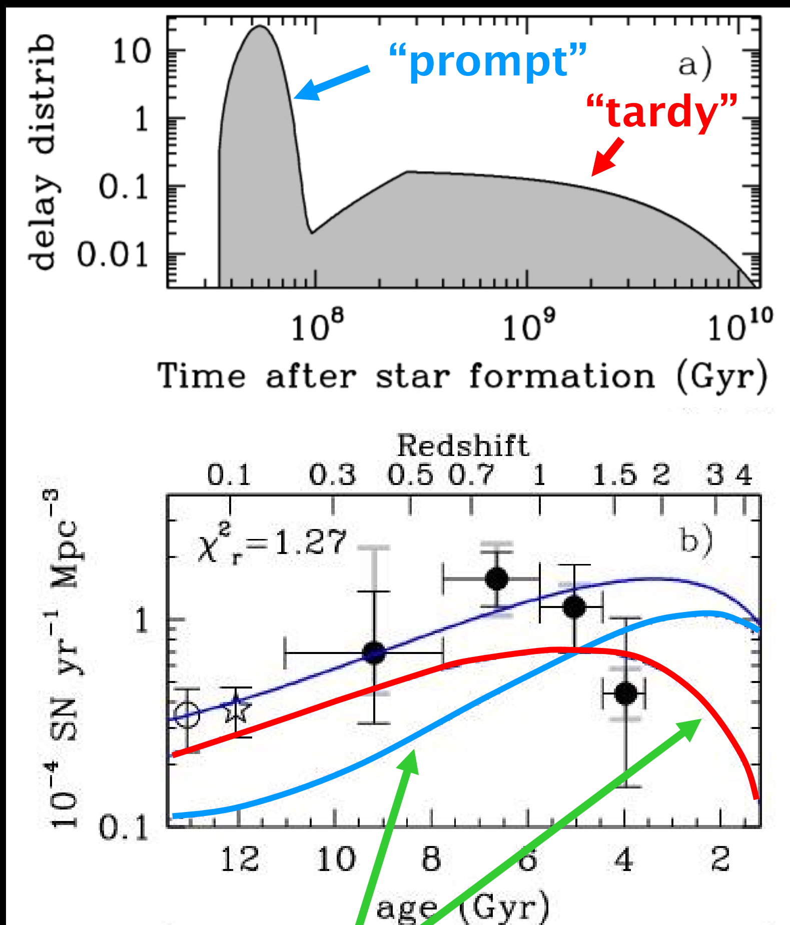
Strong two channel model

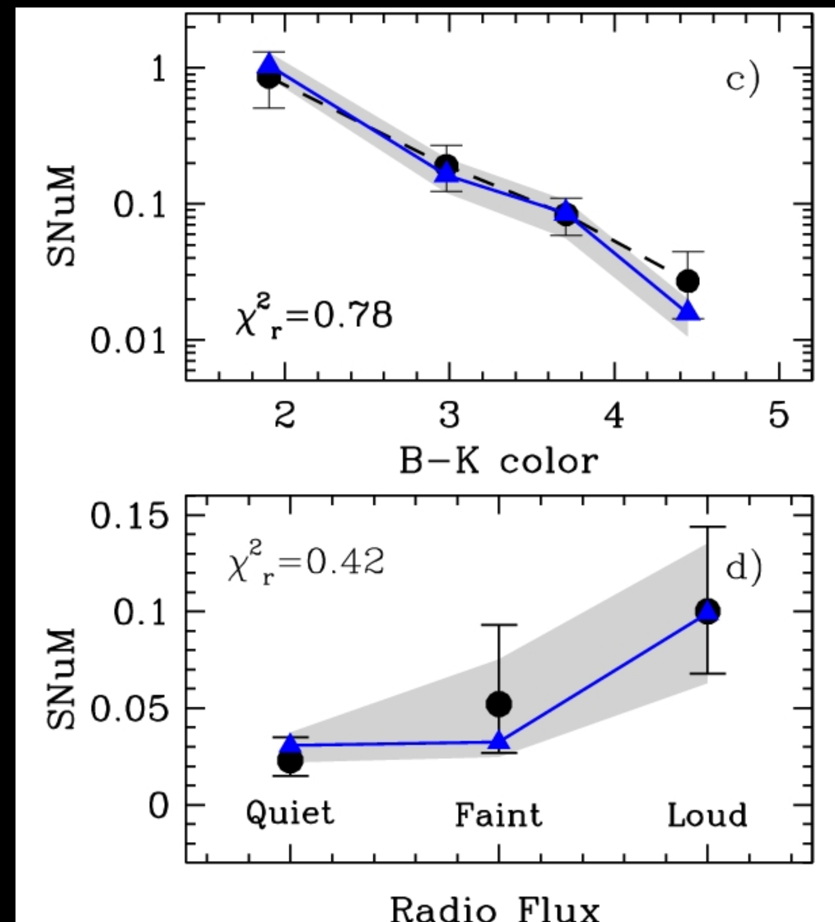
Dependence of the SN rate in early-type galaxies with radio-power (Della Valle et al., 2005)



Strong two channel model

Bimodal distribution of DTD: 50% prompt (age<10^8yr) + 50% tardy

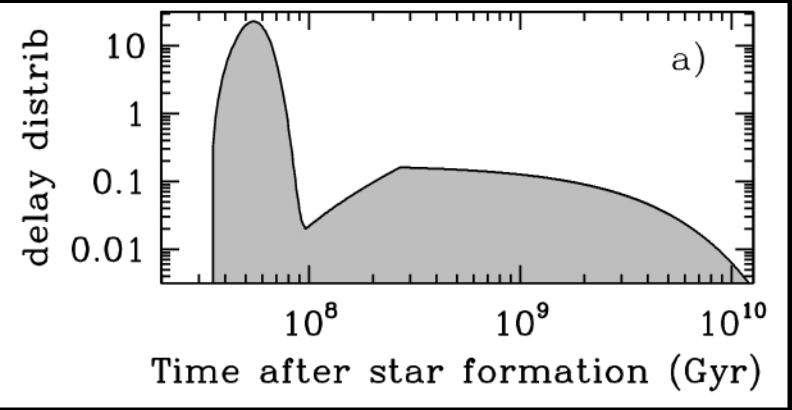




evolving ratio

Mannucci, Della Valle & Panagia 2006

Strong two channel model



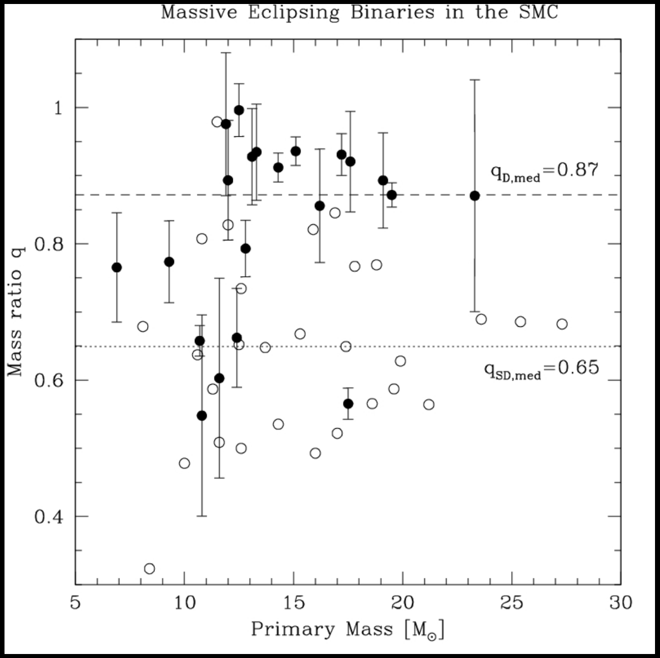
1. two different progenitors or channels are more likely (but not requested: binary system parameter)
2. stronger expected spread of observed properties
3. many SNe in Ell are “prompt”
4. “prompt” and “tardy” SNe in every galaxy
5. it is based on 21 SNe (13 RL + 8 RQ) and galaxy models
6. but…

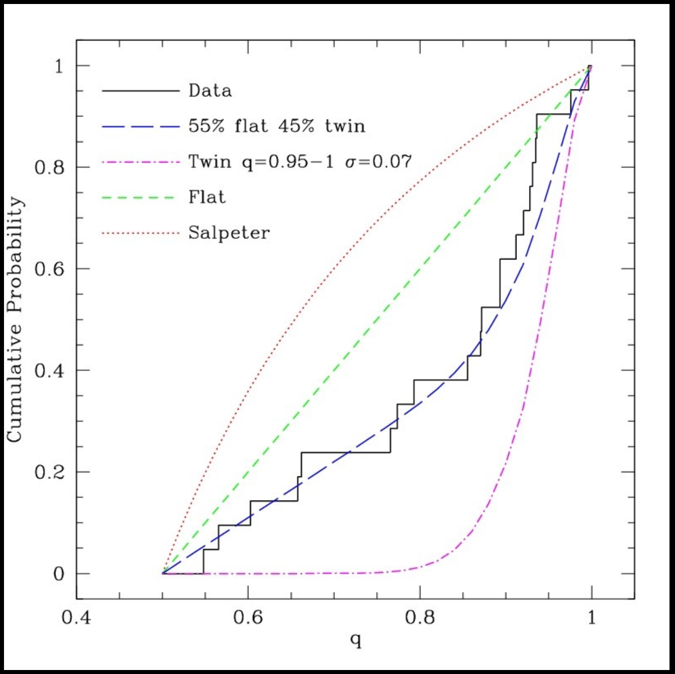
Two Components – 1

Mass ratio in binary systems in SMC

Pinsonneault & Stanek (2006)

- 45% "twins" ($M_2 \sim M_1$)
- 55% "flat" distribution of q=M2/M1





Halbwachs et al. (2003): twins at lower masses (0.5-1.7 M☉), the fraction of twins decreases with separation

Two Components – 2

SN remnants in the LMC

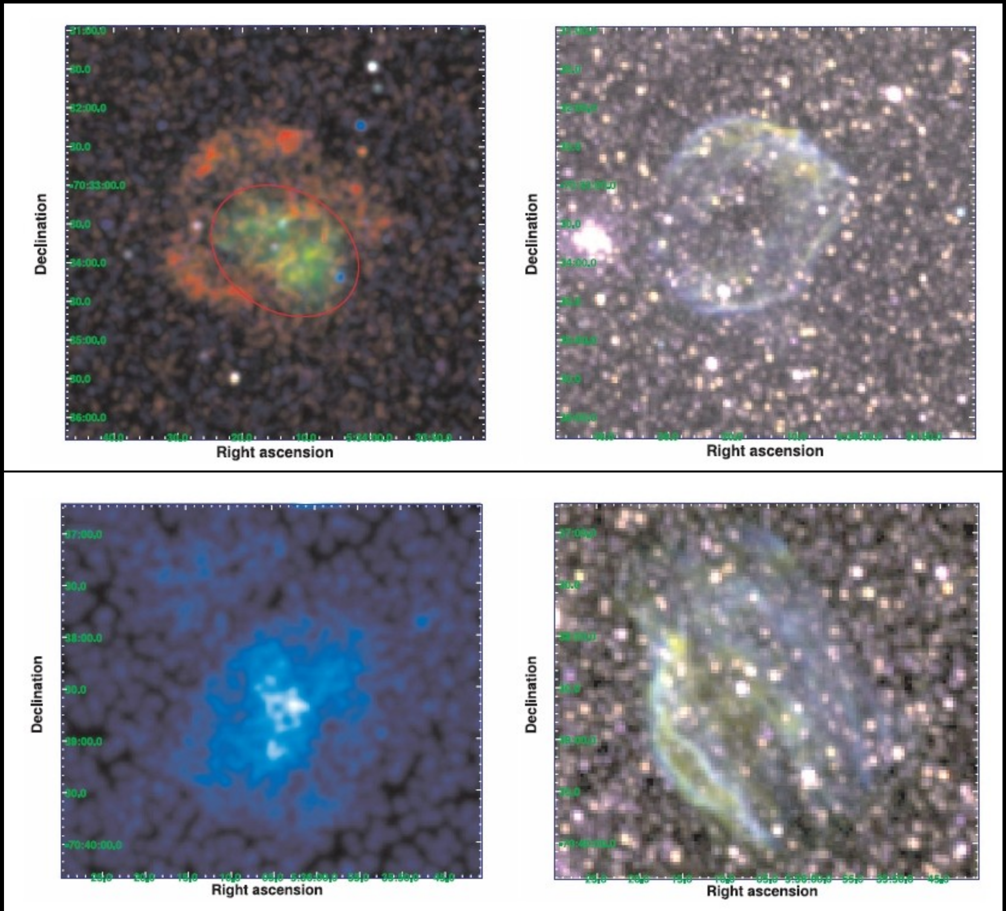
Borkowski et al 2006

12 SNR with Fe in LMC

- DEM L238
- DEM L249
- DEM L316A
- SNR0509-67.5
- SNR0519-69.0
- DEM L71
- SNR0548-70.4
- SNR0534-69.9
- DEM S128
- IKT 5
- IKT 25
- SNR0454-67.2

prompt?

3 show dense CSM

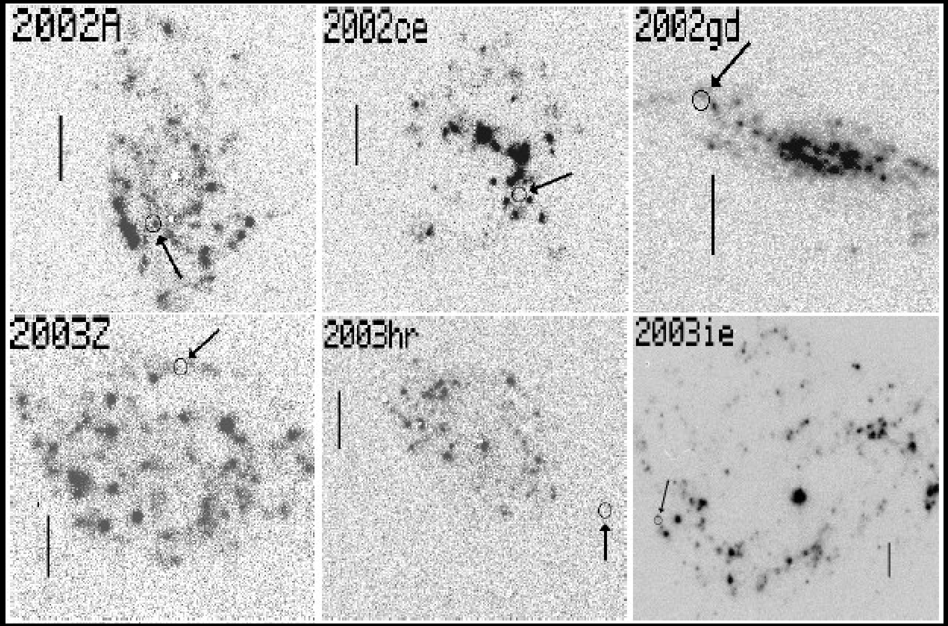


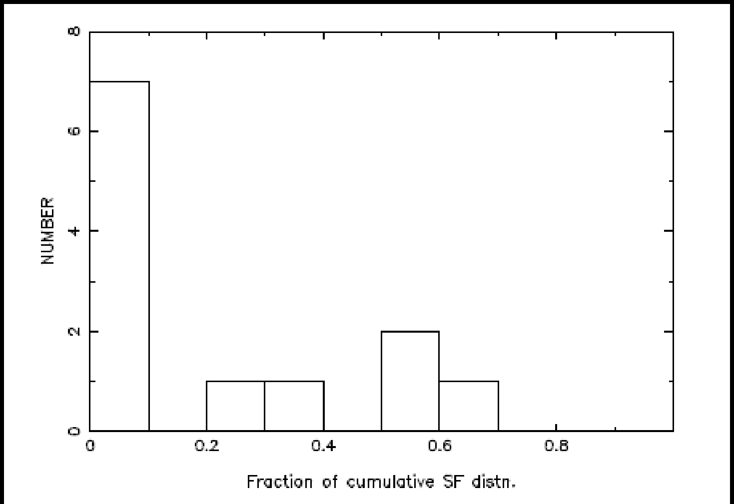
Turatto's talk: a few SNIa with strong interaction with CSM

Two Components – 3

Association SNIa – Hα

James & Anderson (2006)





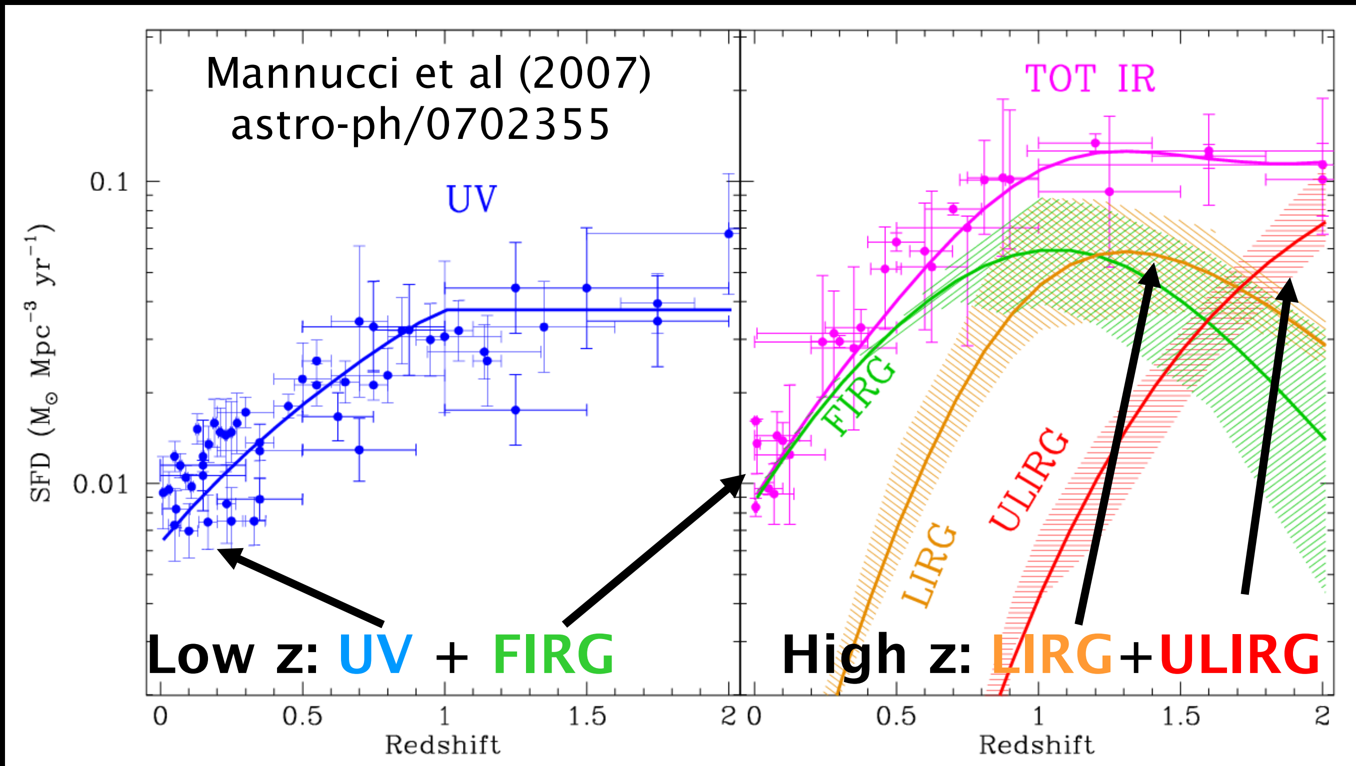
Two Components – 4

Traces (~1%) of star formation activity in Ell

Diagnostic	Authors	Fraction of “active” ETG
Far UV colors	Schawinski et al. (2006)	30%
Faint emission lines	Sarzi et al. (2005)	75%
Tidal tails	Van Dokkum et al. (2005)	50%
Dust features	Colbert et al. (2001)	75%

increasing number of observations supporting or consistent with the strong model

Evolution of the rates



Le Floch+ 2005
Perez-Gonzalez+ 05
Daddi+ 05
Chary+ 07

Liang+ 04
Marcillac+ 06
Choi+ 06

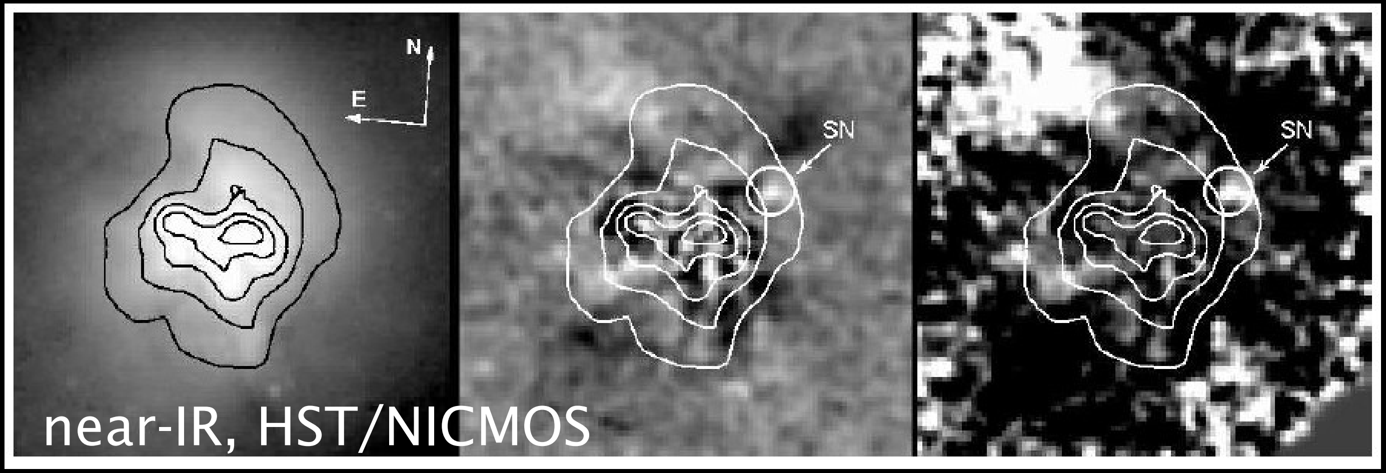
Cosmic SFR: UV

IR
- FIRG: low lumin, low SFR, low extinc.
- LIRG: $L>10^{11}L_\odot$, high extinc.
- ULIRG: $L>10^{12}L_\odot$, very high extinc.

Evolution of the rates

Most SNe in starburst galaxies (LIRG and ULIRG) cannot be detected by optical and near-IR searches

ARP220:
Expected: 3-4 SNe/year (many tens of SNe)
Detected: at most, 1 possible SN (Cresci et al., 2007)



Near-IR monitoring of starburst (LIRG):

1. more SNe than in the optical
2. A_V>20-30
3. only ~20% of the expected SNe

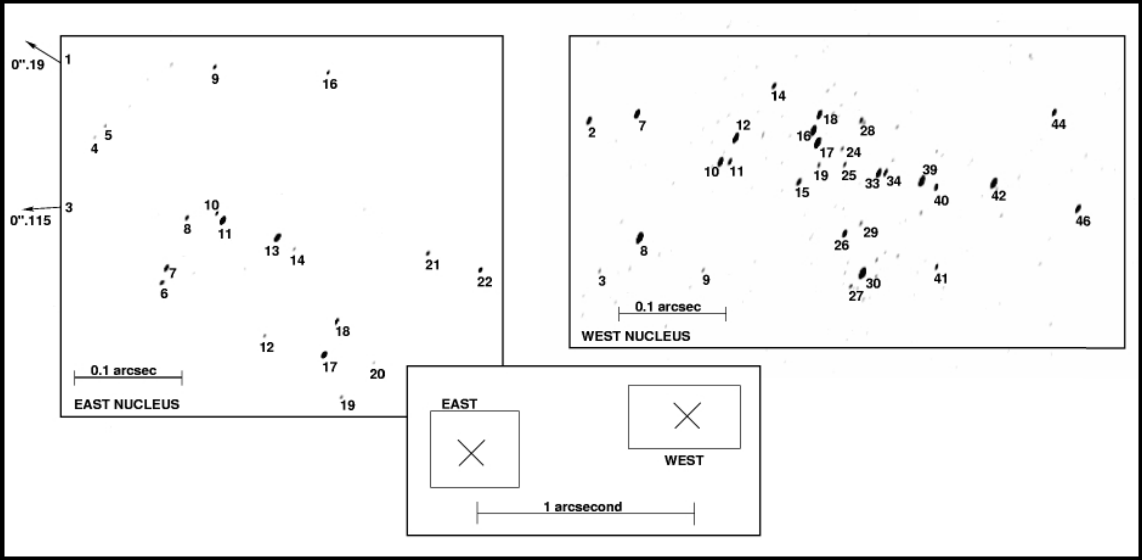
Maiolino et al. 2002
Mannucci et al., 2003
Mattila et al., 2004
Cresci et al., 2007

Evolution of the rates

Most SNe in starburst galaxies (LIRG and ULIRG) cannot be detected by optical and near-IR searches

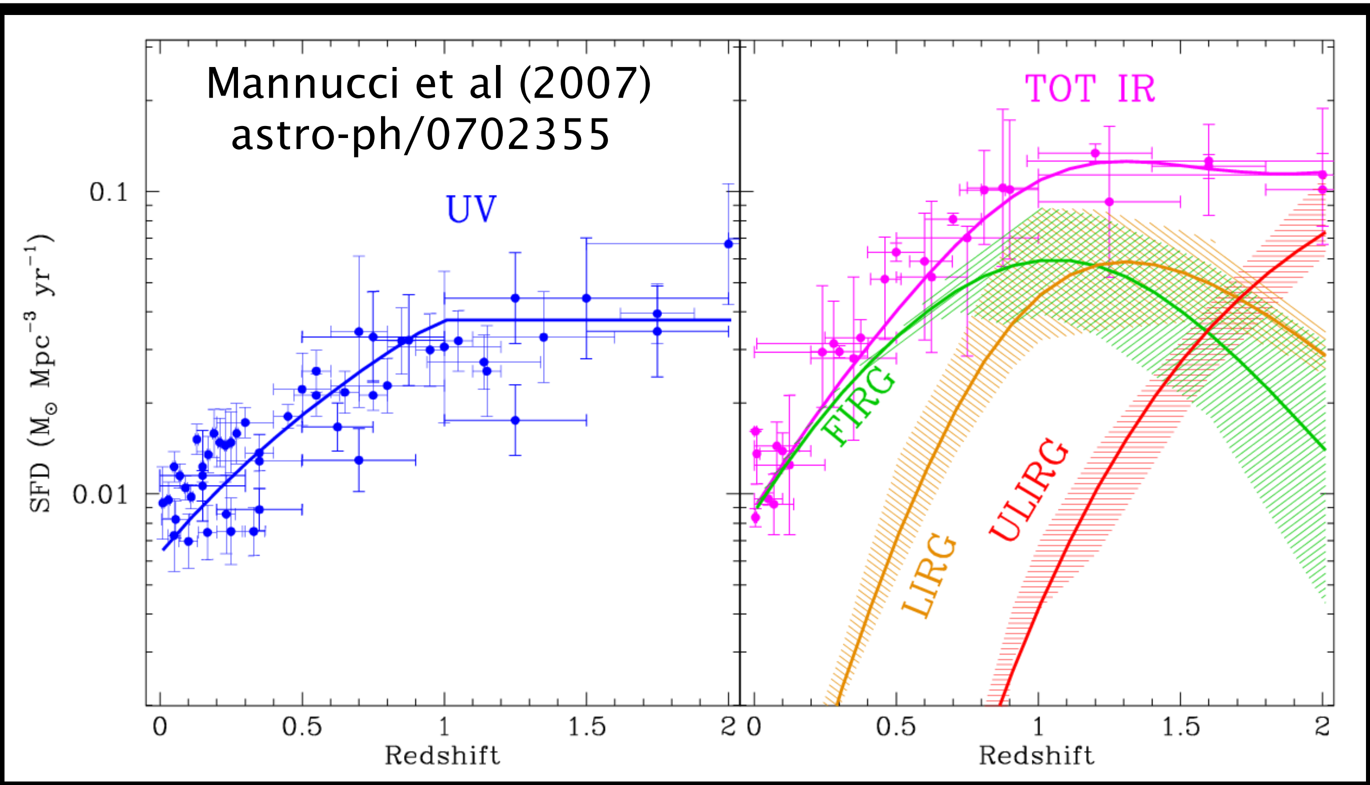
ARP220: Detection by very deep interferometric radio observations

Smith et al (2004)
Lonsdale et al. (2006)



Current (and future) large searches: optical or near-IR
What can we expect?

Evolution of the rates

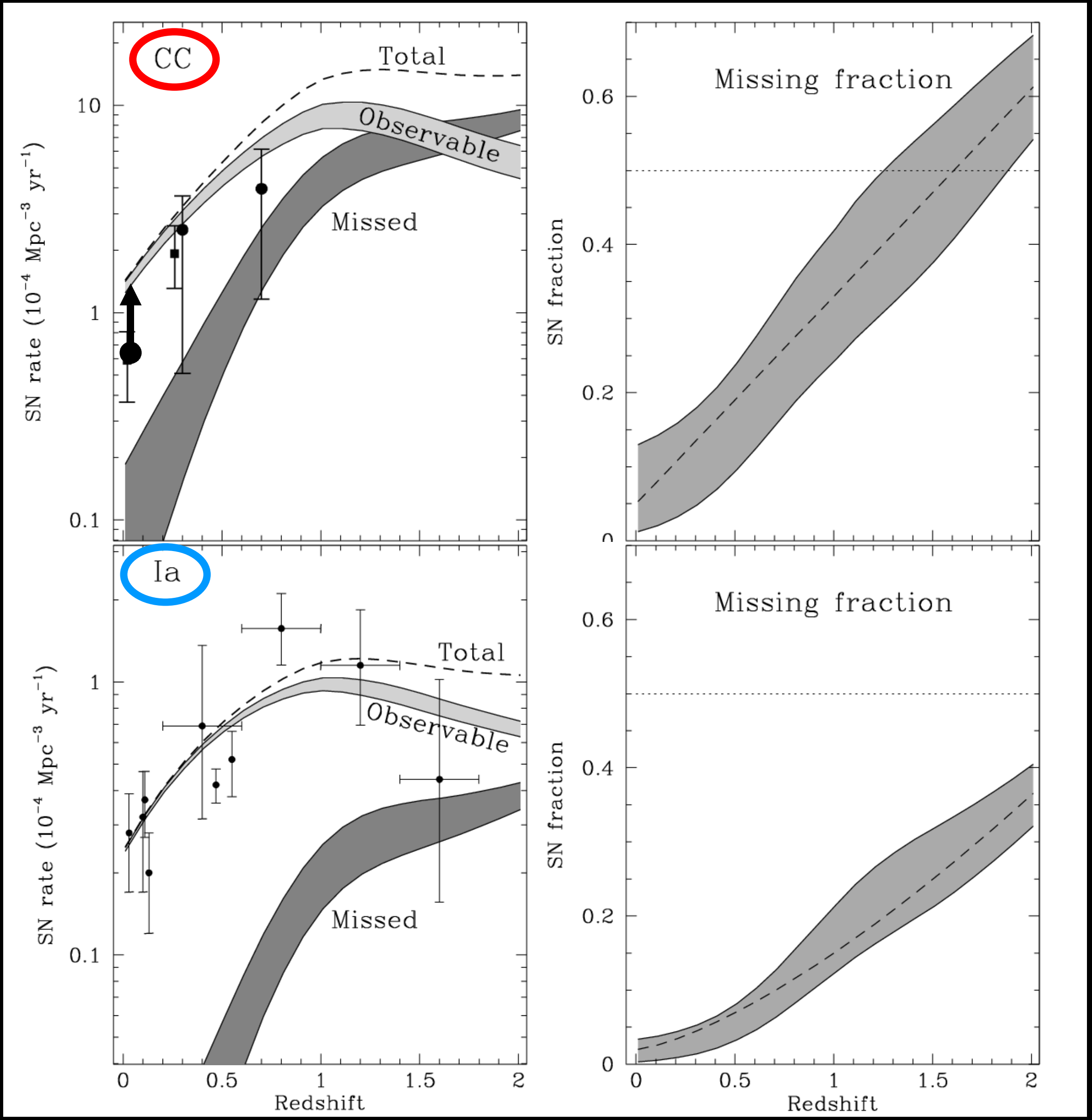


Detectable CC SNe:

Cosmic SFR:

- UV → 100%
- IR:
  - FIRG → 80 – 100%
  - LIRG → 0 – 40%
  - ULIRG → 0 – 10%

Evolution of the rates



Mannucci et al (2007)
astro-ph/0702355

Conclusions

1. The weak model is very robust
2. The strong model is getting stronger
3. Do not use the A+B parameterization
4. There are prompt SNe in Ellipticals

6. Dust effect on rates increases with redshift
    1. missing CC: 10% @ z=0 2/3 @ z=2
    2. missing Ia: 3% 1/3