The Type Ia Supernova Rate

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ApJL, 2005, 629, 85

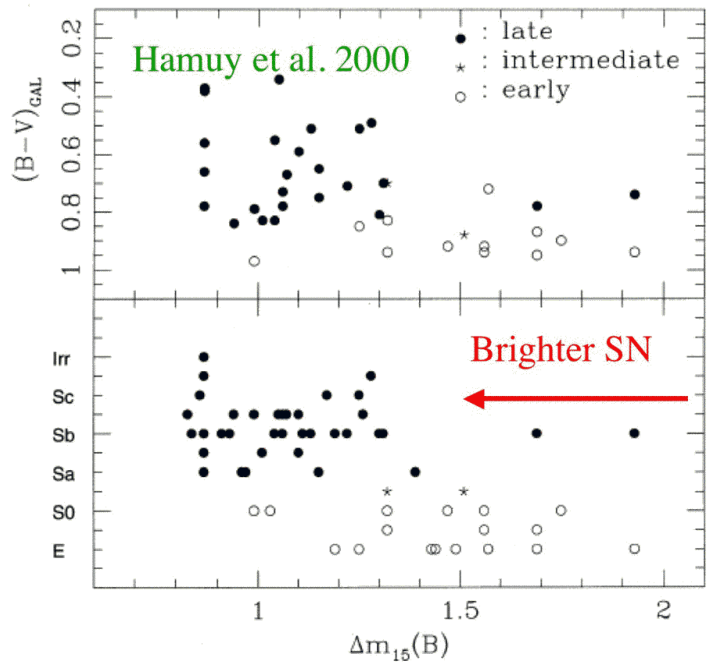
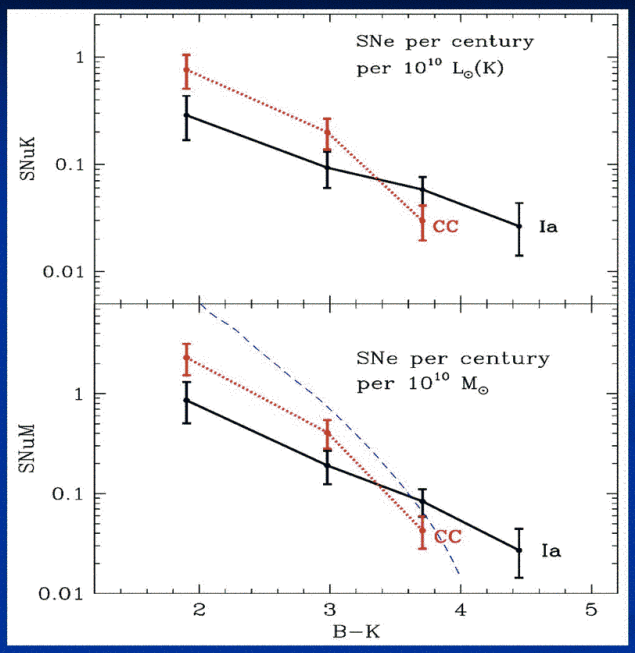


FIG. 1.—$B-V$ color (*top*) and morphological type (*bottom*) of the SN host galaxy vs. decline rate of the SN.

- Brightest Ia's occur only in star forming galaxies
- Faintest Ias only occur in old populations of stars

Ia Rate Per Unit Stellar Mass



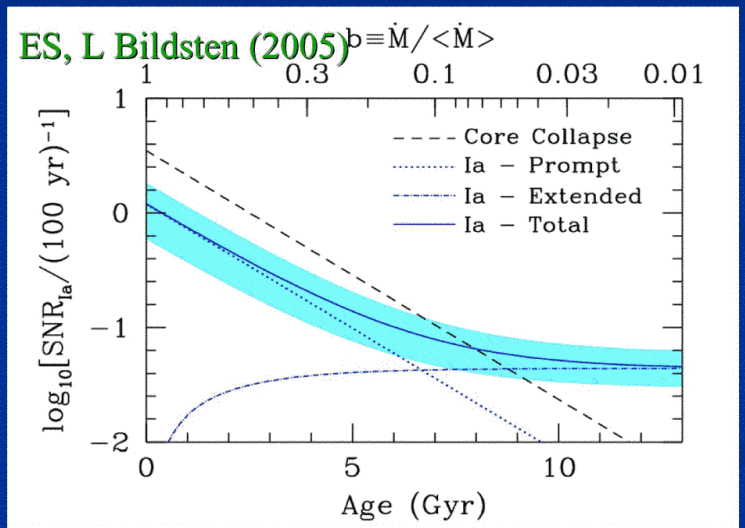
- 2MASS K magnitudes were used to determine the stellar mass
- previous work was in using B, rather than K, to measure the rate
- Data can be "fit" with a simple law of one term that depends on the mass and another that is 40% of the core collapse rate (type II)

F. Mannucci M. Della Valle, N. Panagia, E. Cappellaro, G. Cresci, R. Maiolino, A. Petrosian, M. Turatto (2005)

Two Component Fit

$$\text{Ia rate} = \#\times SFR + \#\times Mass$$

ES, L Bildsten (2005)



Prompt dominate if b < 0.1

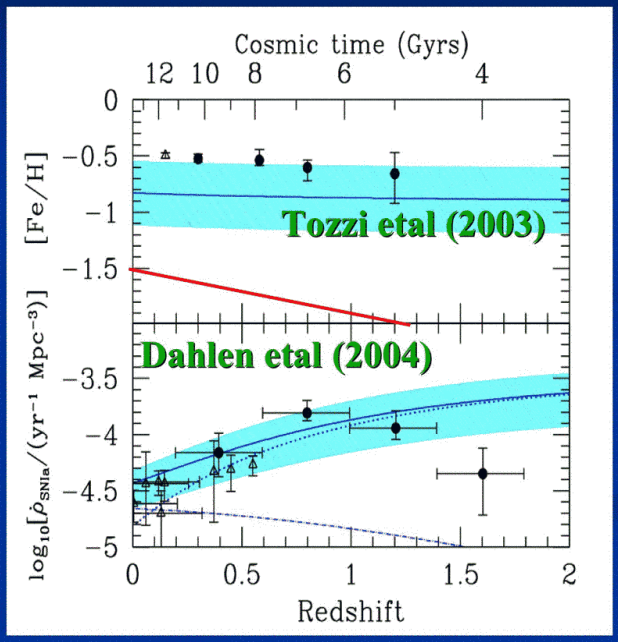
Prompt ALWAYS dominate integral (Metals)

SFR(t)= $M_{gas}(t)/\tau$ τ = 2 Gyrs

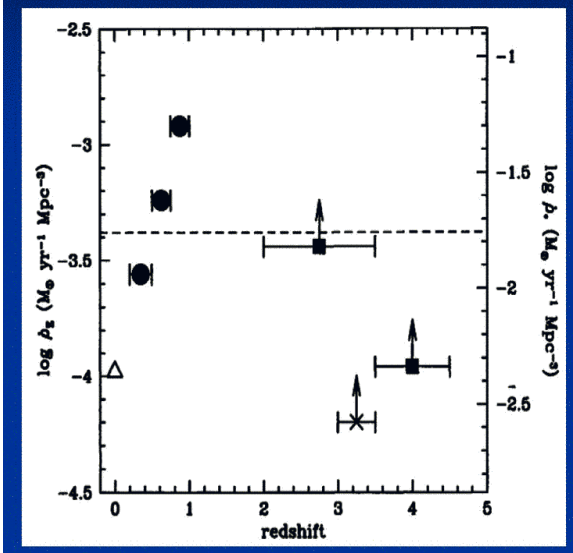
Enrichment & Counts

Gets high level of [Fe/H] in clusters (see Renzini 2003) As well as constancy with z

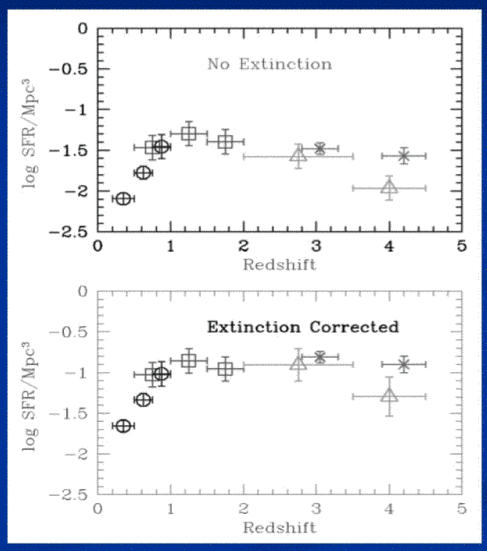
Predicts z>= 1.5 rate will be revised upwards



The cosmic star formation rate

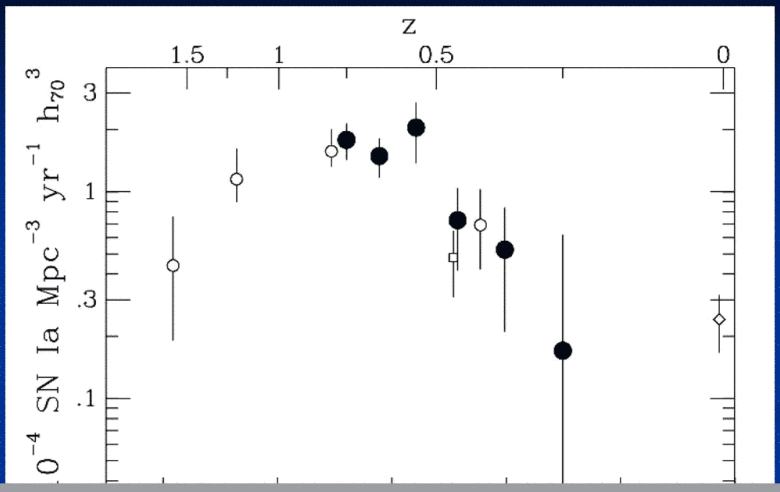


Madau et al (1996)



Steidel et al (1999)

Barris & Tonry (astro-ph/0509655)

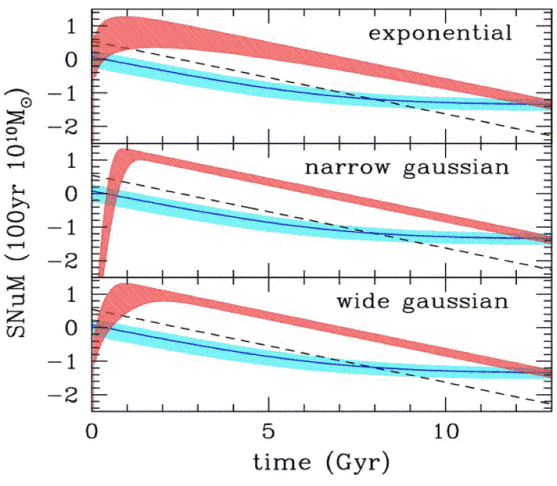


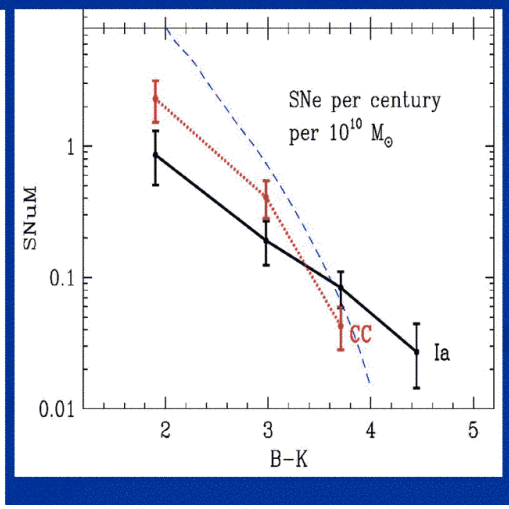
The next measurement of the SFR at higher redshift is at $z \approx 3$ ($t \approx 2.2$ Gyr), which corresponds to $z \approx 2$ after a shift of $t = 1$ Gyr. This measurement of $0.18^{+0.03}_{-0.03}$ $M_\odot$ Mpc^{-3} yr^{-1} h_{70} would predict a Type Ia SNR of 3.0±1.3 x 10^{-4} SNIa Mpc^{-3} yr^{-1} h_{70}^3 using SFR/SNR = 580±240 h_{70}^{-2} $M_\odot$/SNIa. This strongly conflicts with the trend suggested by the $z = 1.6$ ACS SNR measurement of 0.44 x 10^{-4} SNIa Mpc^{-3} yr^{-1} h_{70}^3. However, it agrees well with the predicted range of 1-3.5 x 10^{-4} SNIa Mpc^{-3} yr^{-1} h_{70}^3 given by Scannapieco & Bildsten 2005 (astro-ph/0507456).

Standard single-component "Fits"

delay function

$$\mathrm{SNR_{Ia}(t)} = \int \Delta t \, \mathrm{SFR}(t - \Delta t)\Phi(\Delta t)$$





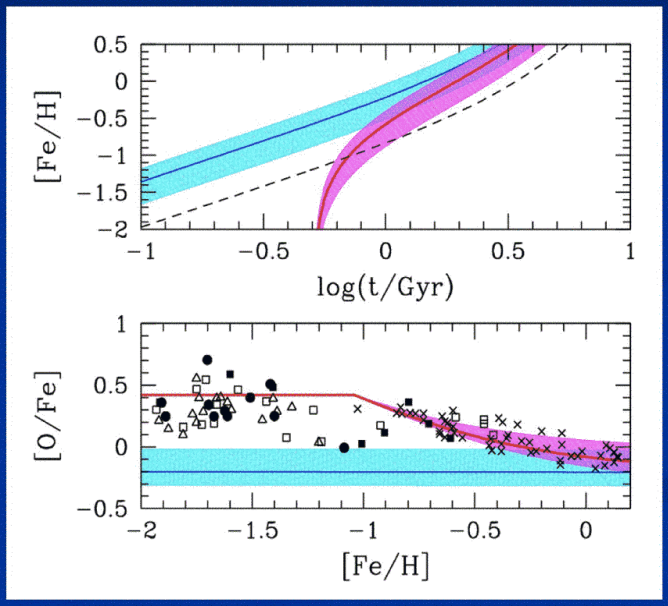
Halo Stars

$SFR(t)=M_{gas}(t)/\tau$

τ = 2 Gyrs

Short delay of ~1/2 Gyr

Scales with HALO SFR



Conclusions

- Single-component models for Ia rates do not fit the local data
- A simple 2 component model (SFR, Stellar Mass) works well
- Cluster iron enrichment seems not to be a problem
- Measurements at z>=1.5 are a strong test of this model
- Observations constraining Ia's on small time scales (spiral arms, correlation with radio jets, etc.) are important for calibrating "prompt delay"