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# constraining the prompt Ia delay time directly

# The Two-Component Ia Rate



$$SNR_{Ia}(t) = AM_*(t) + B\dot{M}_*(t)$$

Mannucci *et al.* (2005)

Scannapieco & Bildsten (2005)

Sullivan *et al.* (2006)

# The Two-Component Ia Rate



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↑  
Delayed

↑  
Prompt

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- Assumes instantaneous prompt component
- Neglects necessary delay time for white dwarf formation

# The Two-Component Ia Rate

$$SNR_{Ia}(t) = AM_*(t) + B\dot{M}_*(t - \tau)$$

↑  
Delayed

↑  
Prompt

↑  
Prompt  
Delay

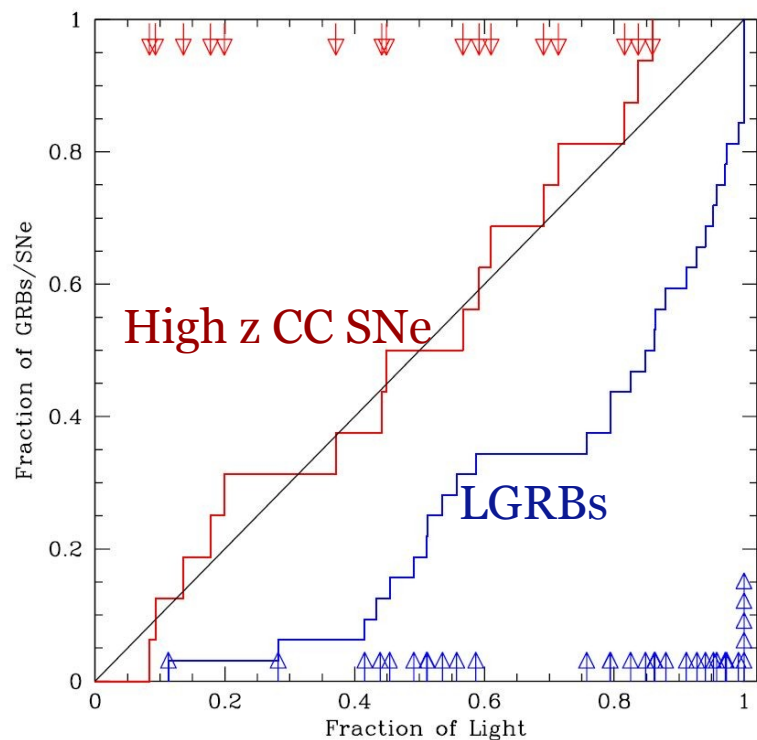
- Assumes instantaneous prompt component ( $< 500\text{Myrs}$ )
- Neglects necessary delay time for white dwarf formation

# Using Spatial Distributions

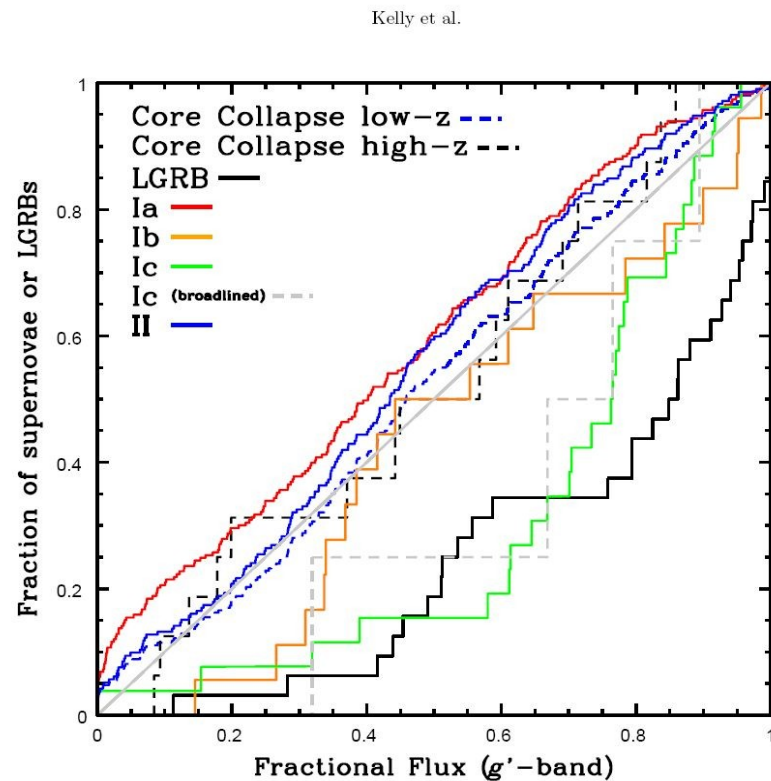


- Fruchter *et al.* (2006)
  - Used host region brightness around a transient as a corollary of “environment”
    - ✦ Rank ordered host pixels by brightness
    - ✦ Cumulative plot of fractional pixel brightnesses for each transient
  - Applied to LGRBs and high-*z* CC SNe

# Using Spatial Distributions

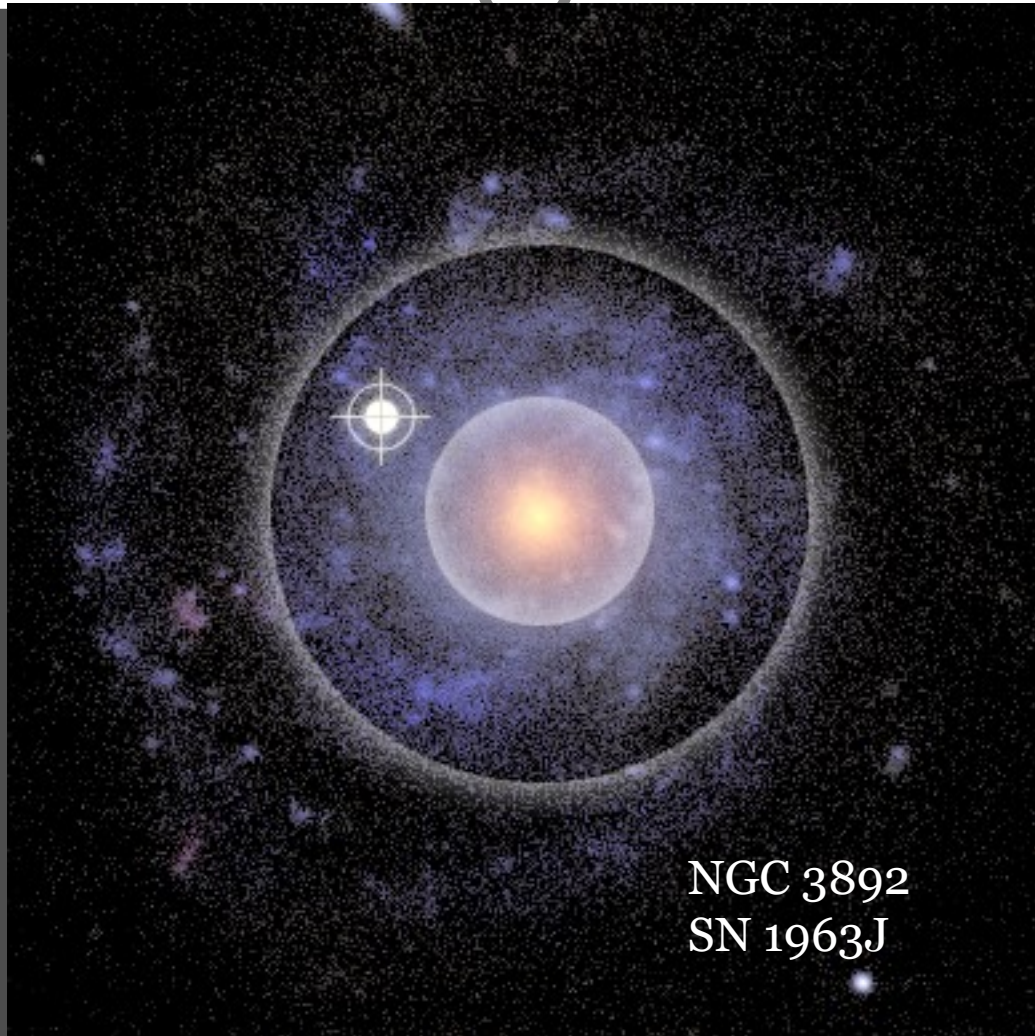


Fruchter *et al.* (2006)



Kelly, Kirshner, & Pahre (2008)

# The Doughnut Method



NGC 3892  
SN 1963J

Raskin *et al.* (2009)

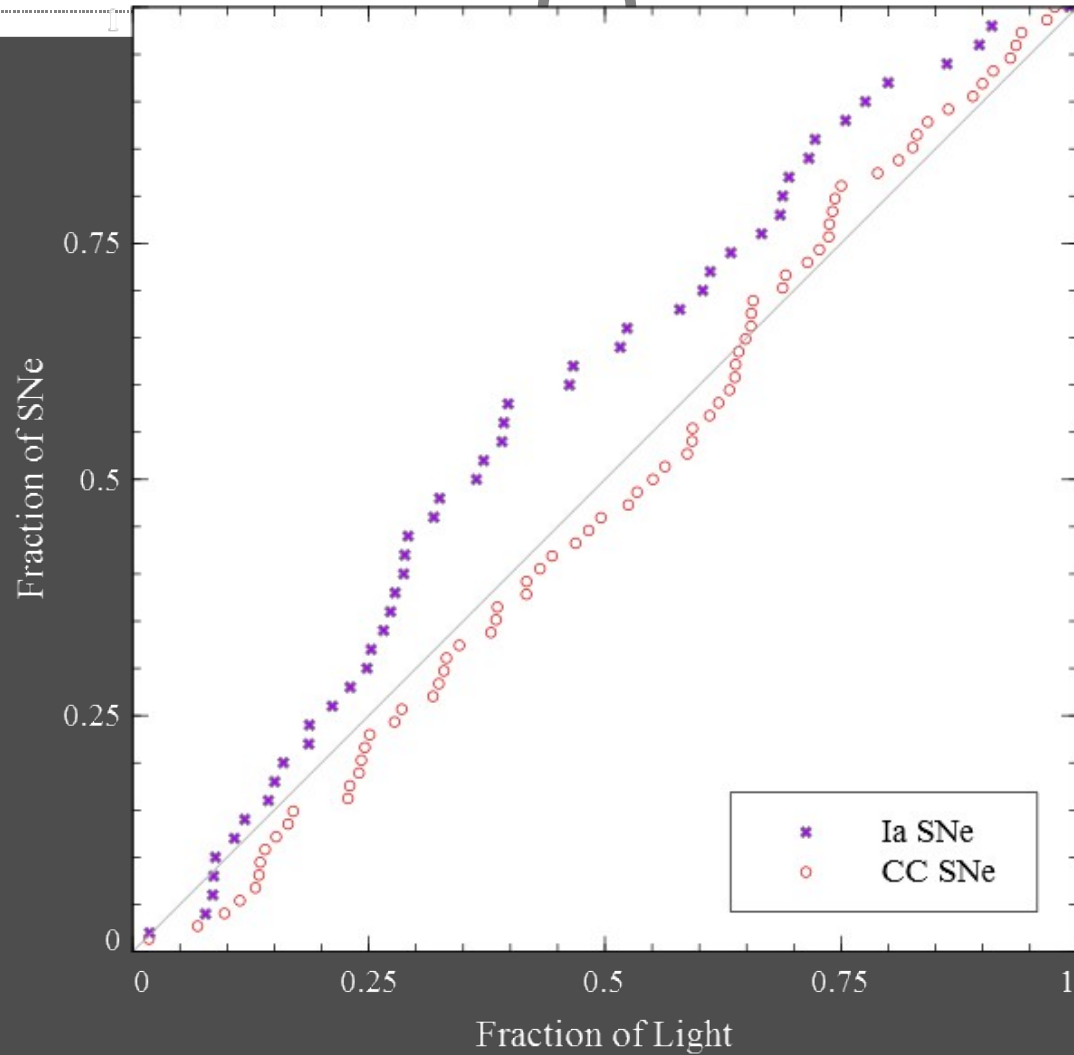


# Host Sample



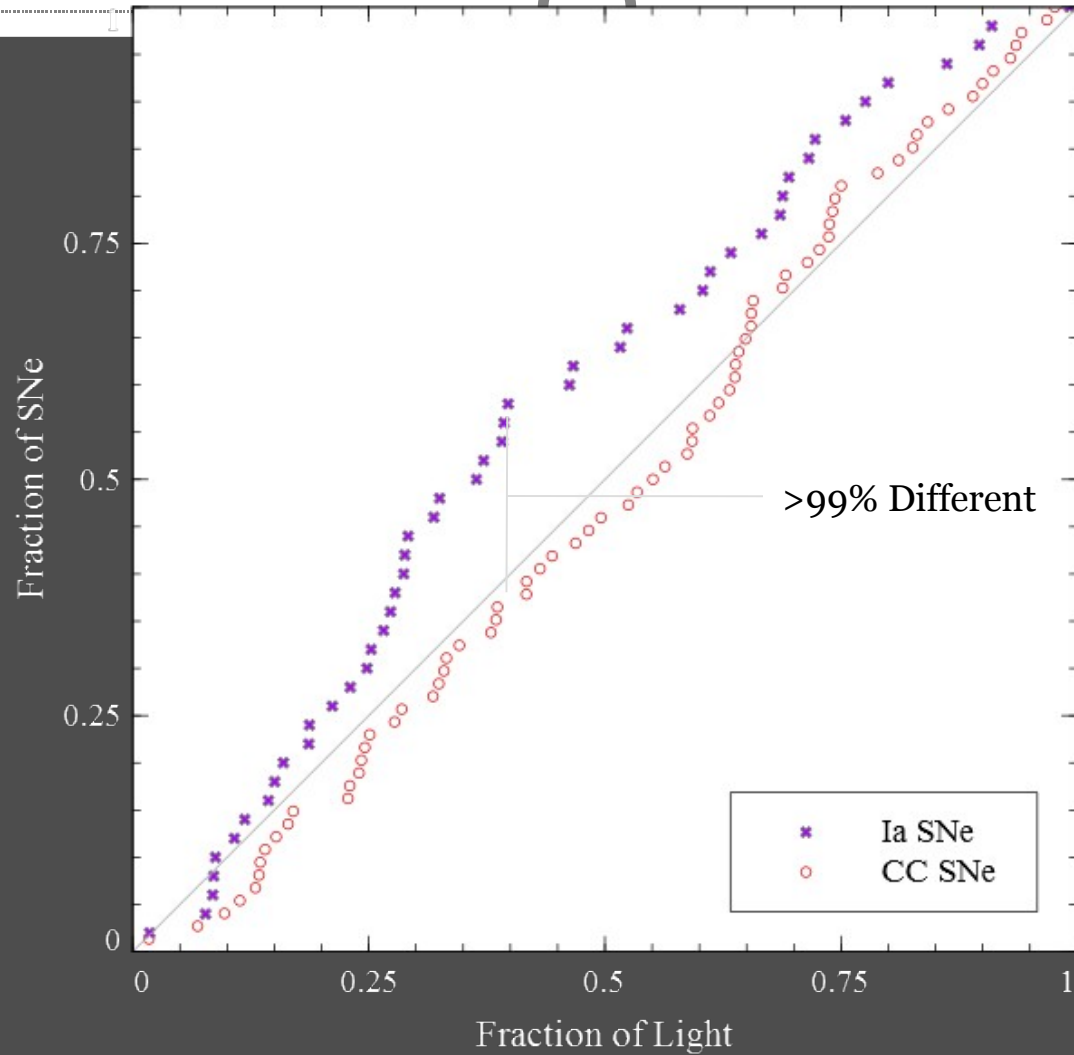
- Padova-Asiago SN catalog
  - Cut on SDSS image availability
  - Spiral hosts
  - Low inclination  $i < 60^\circ$
  - 50 usable  $g'$  images for SNeIa
  - $\sim 75$  usable  $g'$  images for CCSNe (control sample)
  - $z < 0.07$
- $0.5 r_0$  doughnut width

# Results



Raskin *et al.* (2009)

# Results



Raskin *et al.* (2009)

# Analytical Model



B-band Spiral



K-band Spiral

Raskin *et al.* (2008)

- Convolution Integral

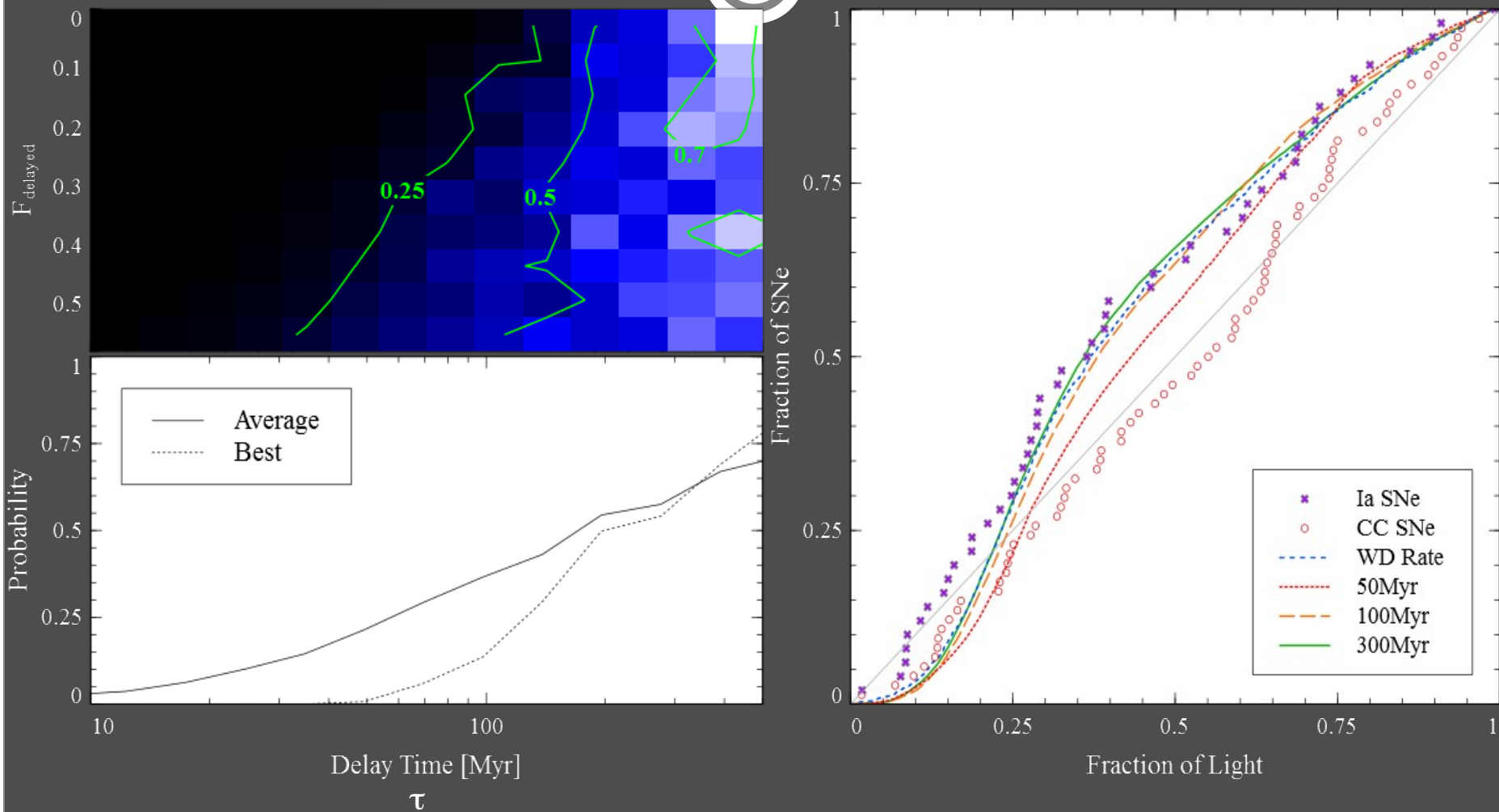
$$\Sigma_\nu(r, \theta, t) = \int_0^t L_\nu(t - t') \dot{\Sigma}(r, \theta, t') dt'$$

- Bruzual & Charlot (2003) for  $L_\nu$
- Dirac-delta function for SF $_\infty$

$$\dot{\Sigma}(r, \theta, t) = \phi(r) \sum_{n=0}^{\infty} \delta(\theta - n\pi - \Omega_p t)$$

- SNIa map has two free parameters:  $\tau$  &  $F_{\text{delayed}}$

# Model Results

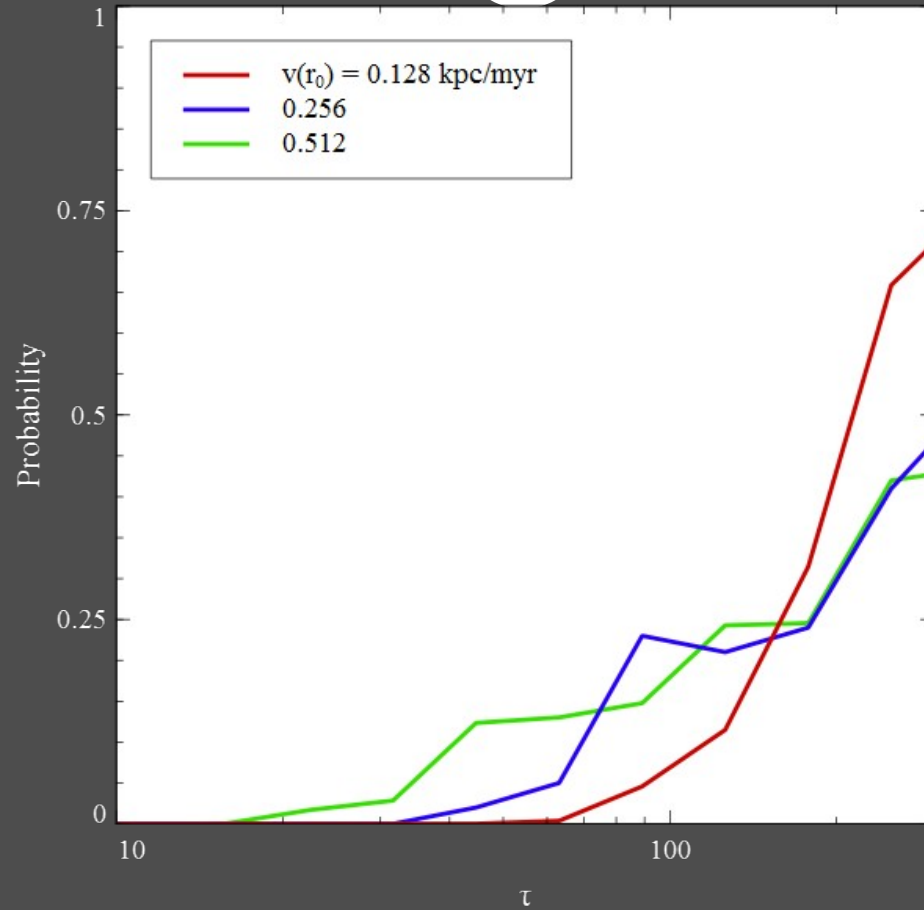


# Conclusions



- Prompt delay is long
  - ~200-500 Myr
    - ✦ Companion stars are  $\sim 3 M_{\odot}$  or white dwarfs in double-degenerate binaries
  - Does not rule out a fraction of prompt SNeIa with shorter delay times

# Fitness Tests



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