Formation Channels of Potential SN Ia Progenitors

delay times & rates of various scenarios

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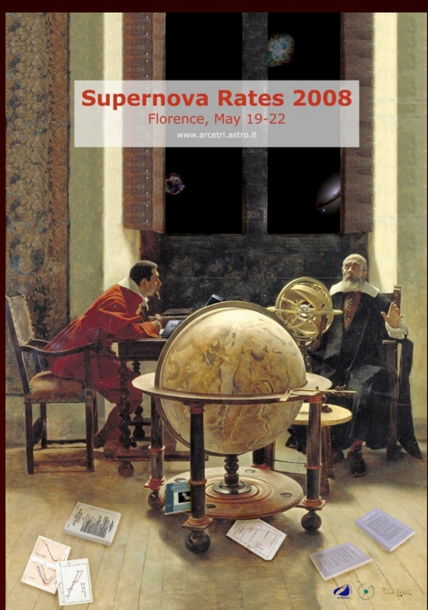


Supernova Rates 2008
Florence, Italy, May 19-22

Binary Evolution:
population synthesis model

- Use ***StarTrack*** population synthesis code (Belczynski et al. 2008) to evolve stellar populations
- Evolve single and binary stars incorporating analytical formulae for stellar evolution and most recent prescriptions for accretion onto WDs (Nomoto et al. 2007)
- Consider: common envelope (CE) evolution, metallicity, binary fraction, IMF, SFR
- Calibration: use Galactic stellar mass (6 x 10^{10} $M_\odot$)
- SNe Ia event criteria:

SN Ia Formation Channels
(Chandrasekhar Mass)

DDS: CO+CO, Co+He, He+He WD-WD merge with $M_{tot} > 1.4\ M_{\odot}$

SDS: CO/He WD + MS/Giant accreting binary (WD reaches $1.4\ M_{\odot}$)

AM CVn: Co/He WD accretes to $1.4\ M_{\odot}$ from He-rich companion (WD or helium star)

CE Merger (SN IIa): WD + core of AGB star merge in a Common Envelope with $M_{tot} > 1.4\ M_{\odot}$ (Livio & Riess 2003)

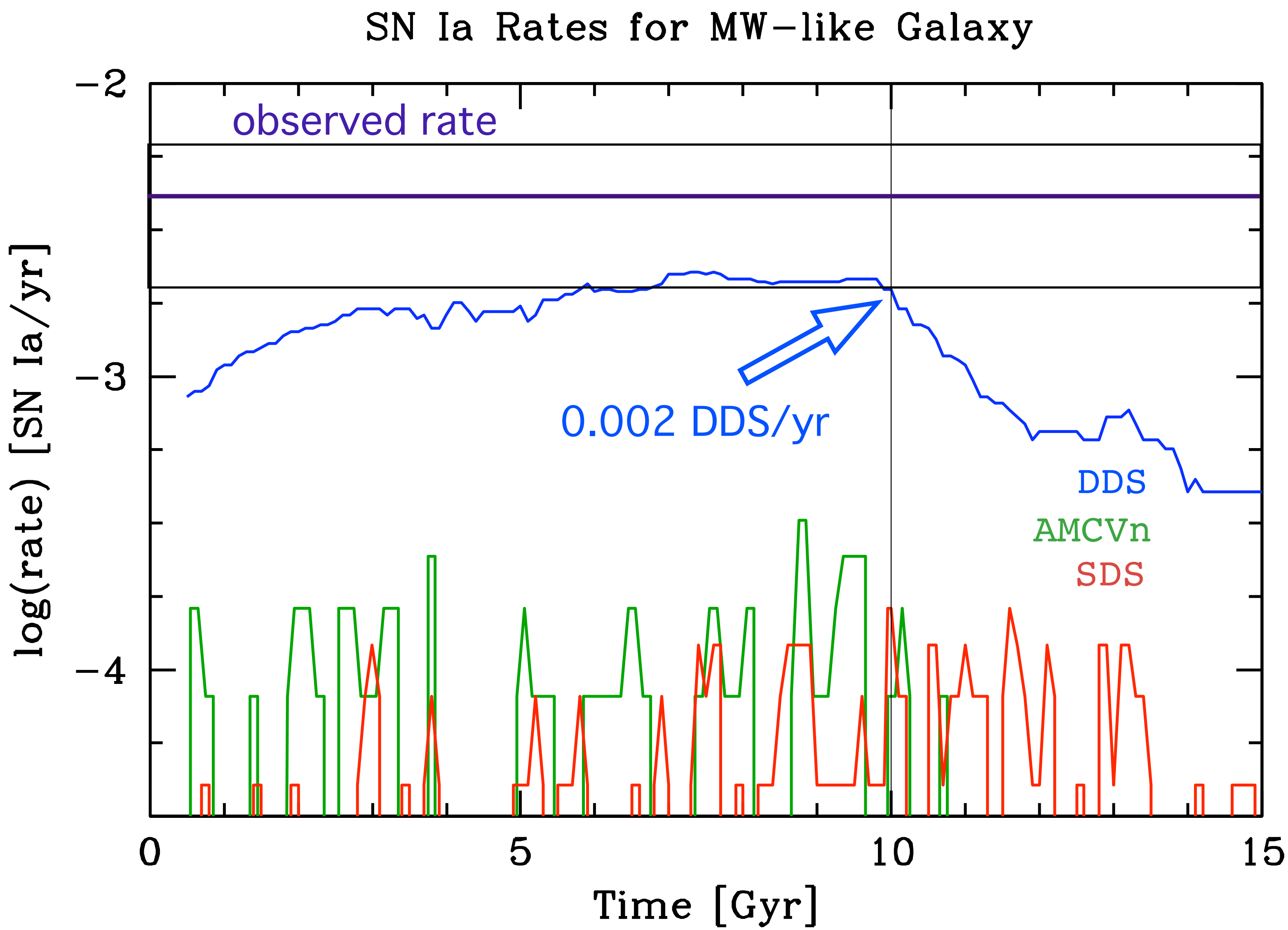
Calibration: SN Rates

two model galaxies

- Two *simple* galaxy models: spiral & elliptical
- Spiral Galaxy: Z=0.02, constant star formation history for 10 Gyr
- Elliptical Galaxy: Z=0.002, starburst at t=0
- Kroupa IMF (0.08 - 150 $M_\odot$)
- Standard CE prescription $\alpha\lambda = 1$ (Webbink 1984)
- Initial q flat; initial separation flat in log, 50% binary fraction

SN Rates

		Elliptical	Spiral
channel	efficiency (per binary)	SNIa/yr @ 10 Gyr Z=0.002,starburst	SNIa/yr @ 10 Gyr Z=0.02, cons.SFR
DDS	0.3 % of binaries	4×10^{-4}	2×10^{-3}
SDS	0.01 % of binaries	$\sim 10^{-5}$	5×10^{-5}
AM CVn	0.01 % of binaries	$\sim 10^{-5}$	8×10^{-5}
Type II + Ib/c	1% + 0.8% of binaries	0	$\sim 10^{-2}$

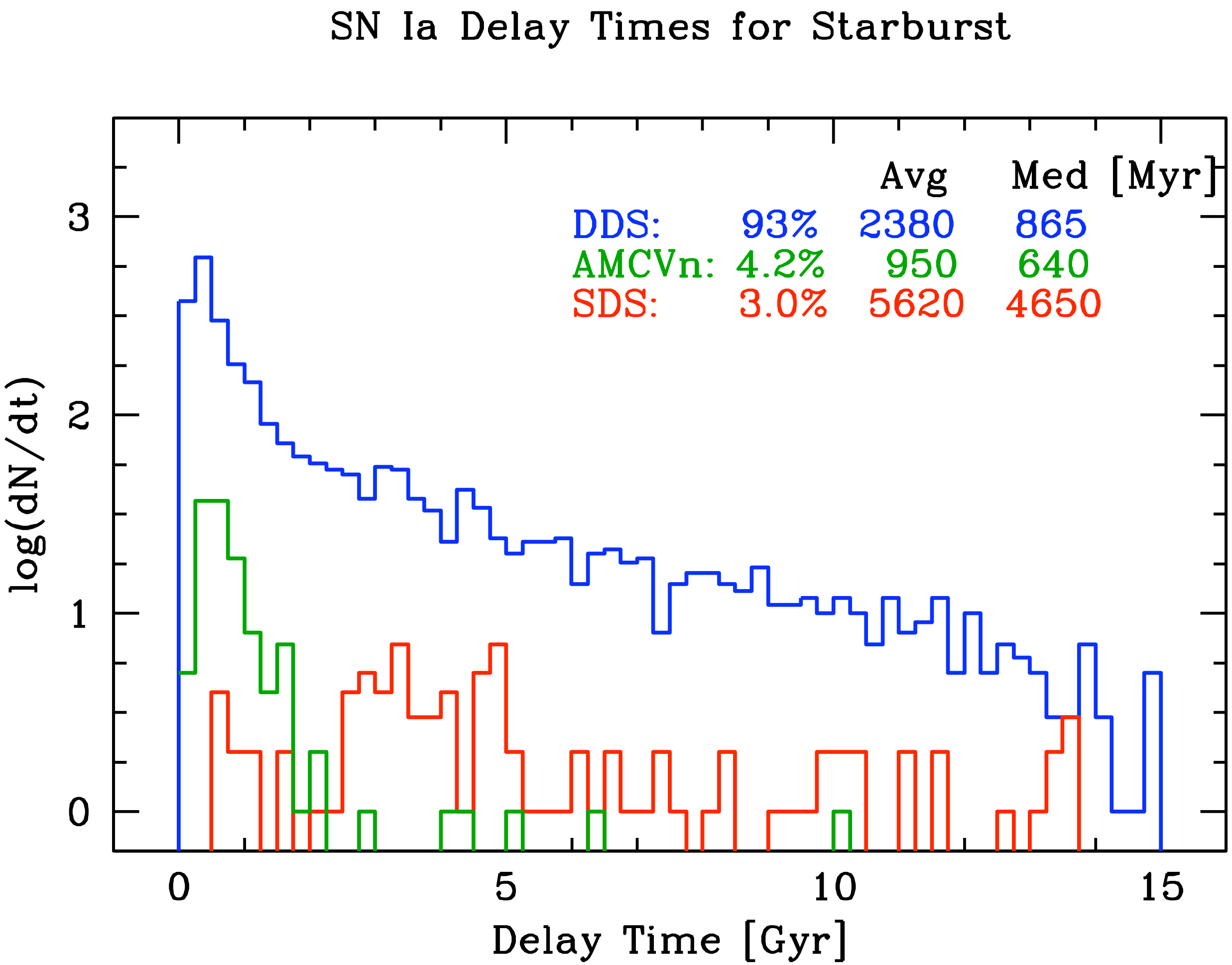


Observed Galactic rate: 0.004 ± 0.002 SNIa/yr (E. Cappellaro)

Model Delay Time Distributions

ZAMS binary formation to SN Ia

Predicted Delay Times From Burst of SF



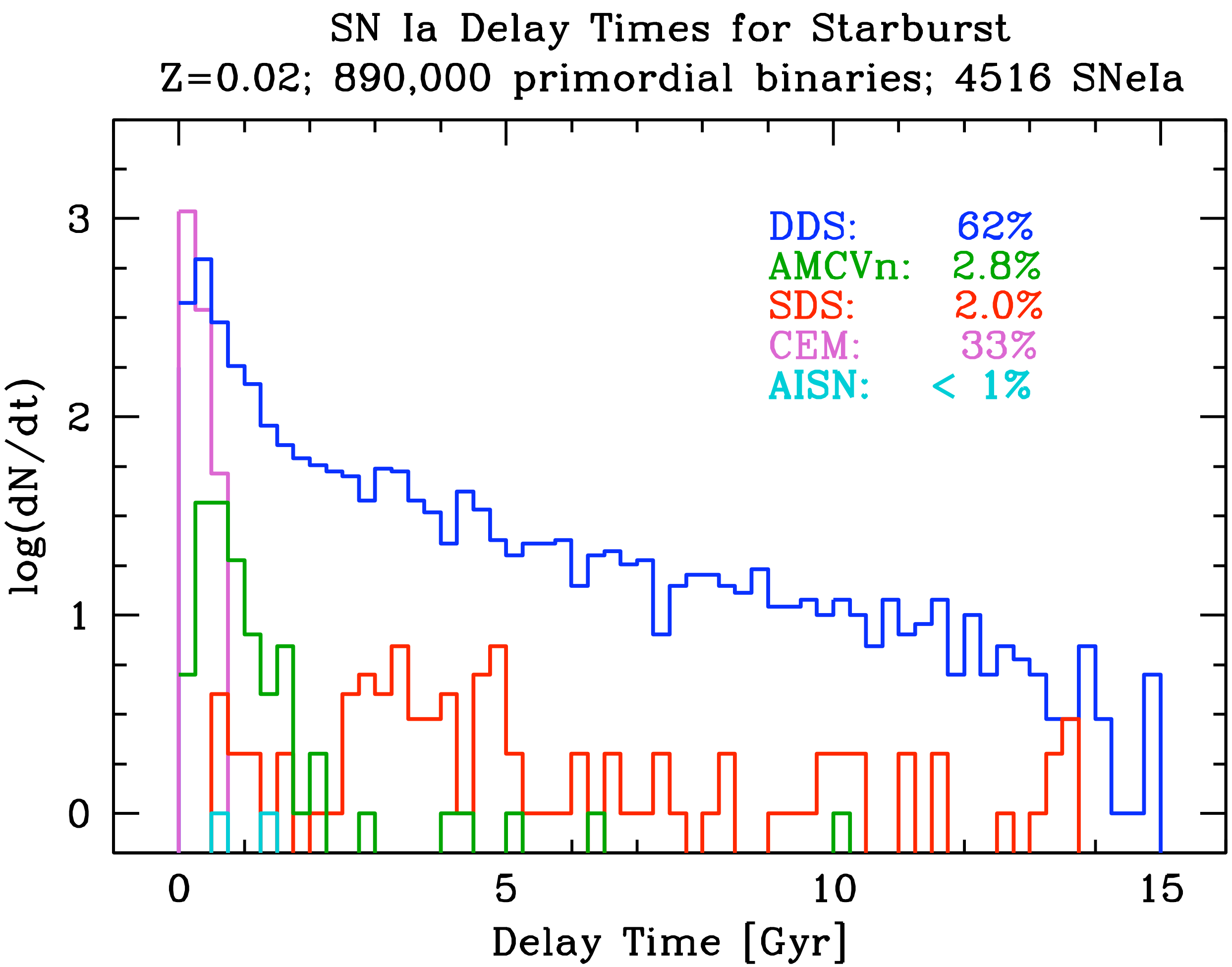
Dominant mechanisms:
DDS: GR timescale
CO-CO only; DT_{min}=50 Myr.
AMCVn: shortest DTD; GR drives
MT rates (small a).
SDS: mostly Giant-WD; MS-WD
have largest overall DT
take long time to accrete enough H.

Summary + Discussion

- The SDS channel appears to contribute very little to SNe Ia in terms of *rates*
- DDS is more than an order of magnitude more common than SDS in our models and is marginally constant with observed rates
- Additionally, the DDS exhibits a wide range of delay times (prompt as well as tardy, and in between)

Predicted Delay Times

(5 scenarios)



CE merger scenario (CEMS): most prompt channel, could explain the few SNe Ia with Hα but is likely too efficient in our models