Massive Stars as Progenitors of SNe & GRBs

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Outline

- Supernovae as function of initial mass
- Supernovae as function of metallicity
- Supernovae as function of rotation

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- Supernovae as function of initial mass
- Supernovae as function of metallicity
- Supernovae as function of rotation
- NOT: Supernovae as function of magnetic fields
- NOT: Supernovae from binaries

Supernovae as function of mass

$Z = Z_\odot$, no rotation

- e^--capture supernovae
- cc-supernovae: NS (Meynet)
- cc: BH; supernovae? (Podsiadlowski)
- NO $e^\pm$-supernovae (mass loss)

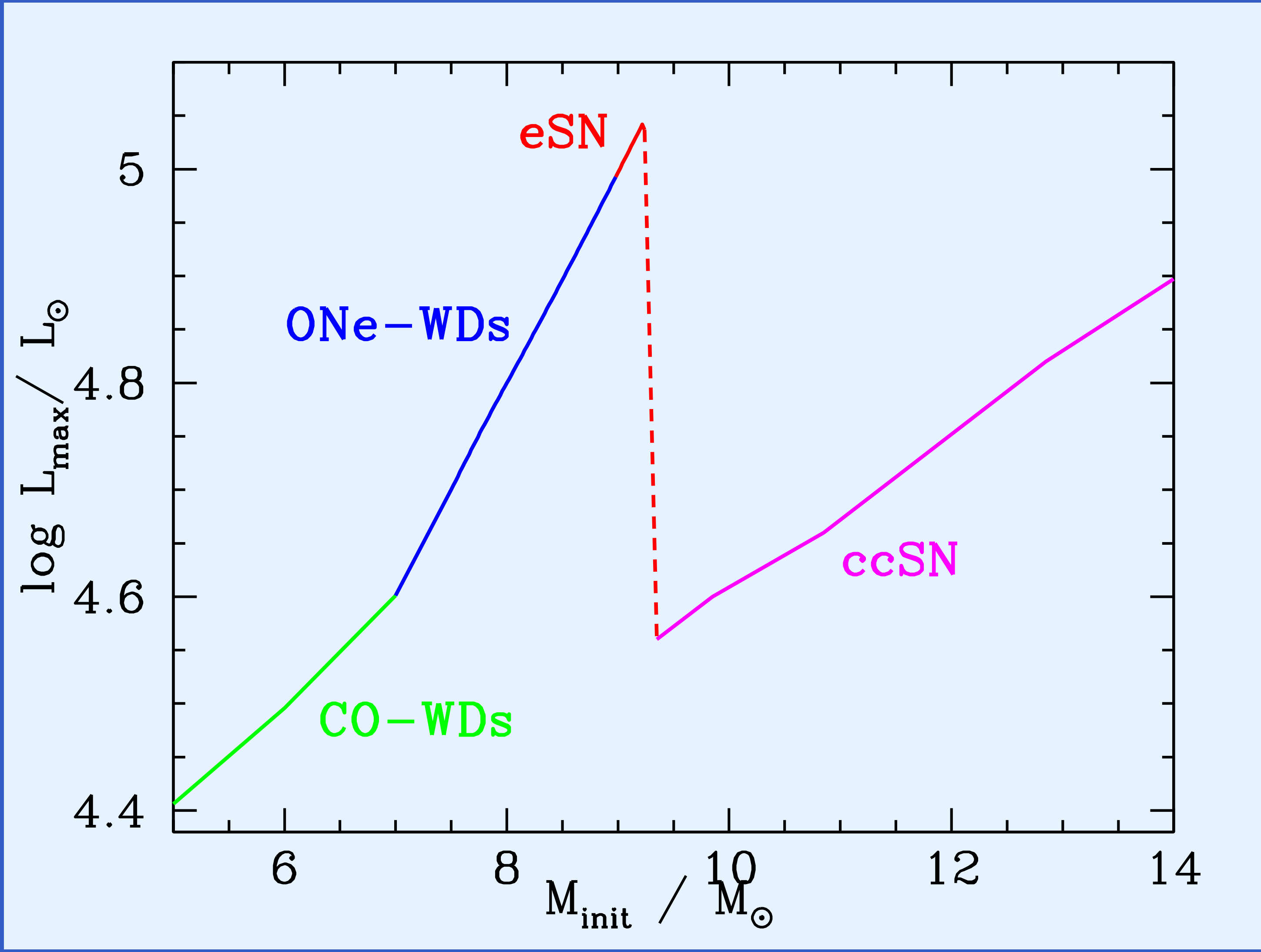
e^--capture supernovae

Nomoto 1987

($Z = Z_\odot$, no rotation)

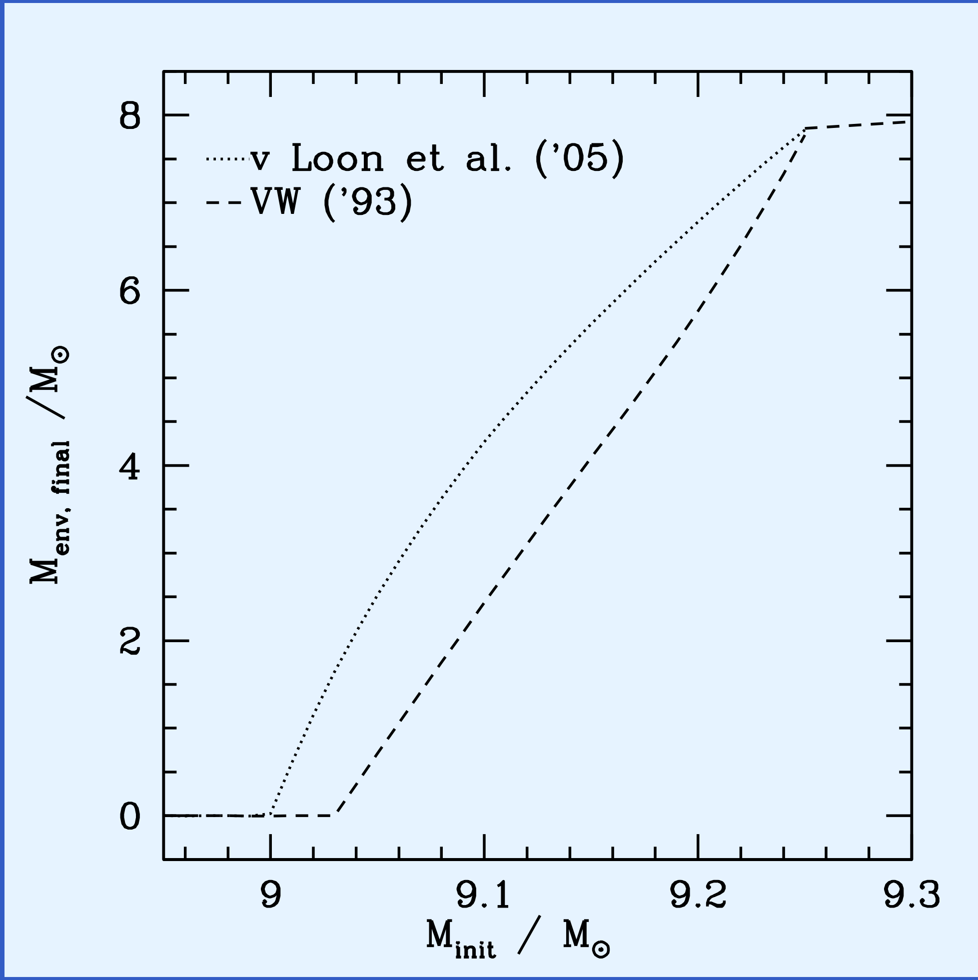
- small mass range (Poelarends)
  much larger in binaries; Podsiadlowski
- low SN energy? low nickel/metals (Janka)
- low kick (Podsiadlowski)
- potentially large range of envelope masses: $0.2 \ldots 8\,\mathrm{M}_\odot$
  $\rightarrow$ slow $\ldots$ fast ejecta

Pre-WD, Pre-SN luminosities



Poelarends et al. 2008

Final envelope masses



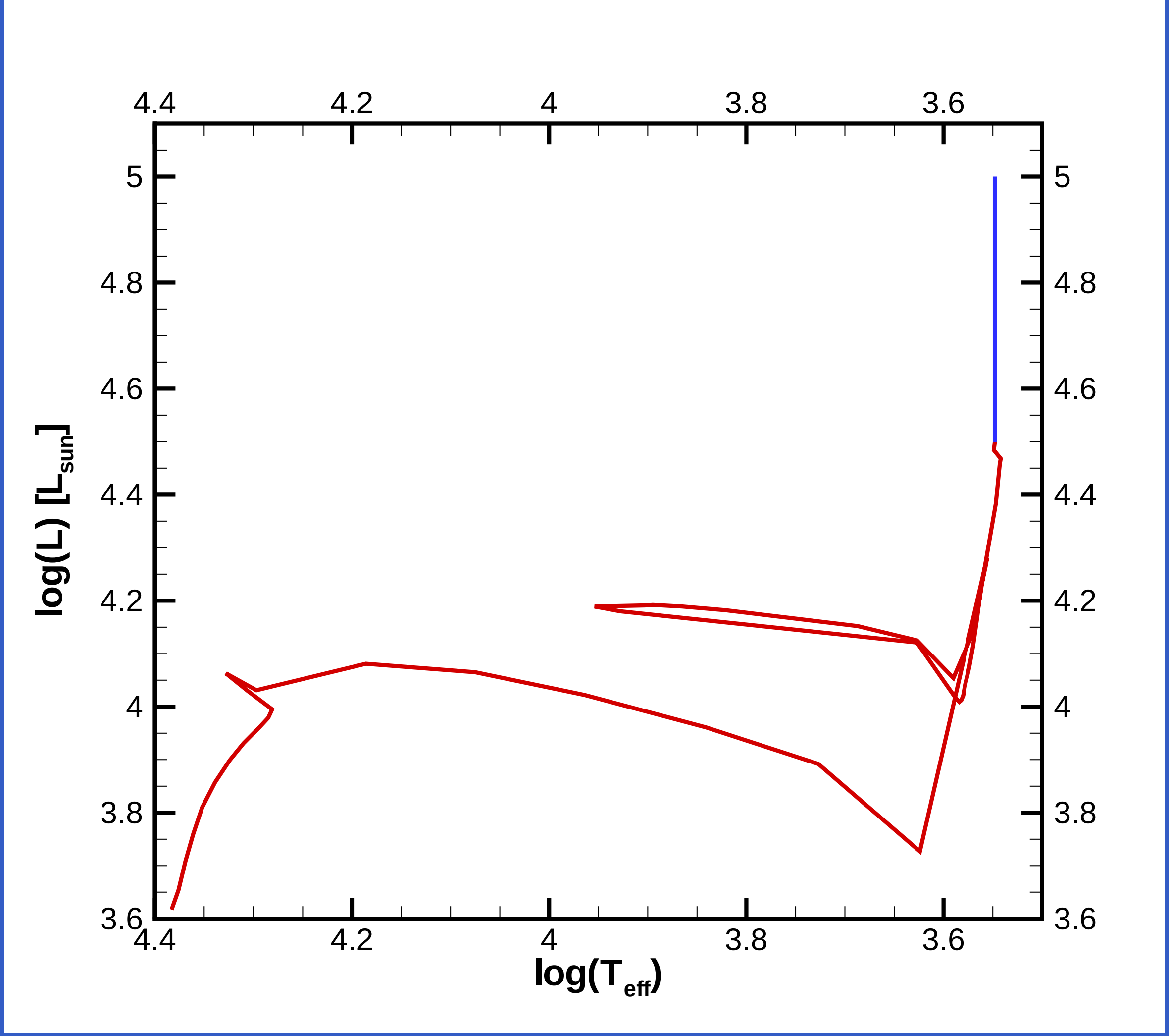
Poelarends et al. 2008

eSN range $Z = Z_\odot$

	$\lambda =$ parameterized			$\lambda = 0$		
	$M_{\rm low}/\,{\rm M}_\odot$	$M_{\rm high}/\,{\rm M}_\odot$	% EC	$M_{\rm low}/\,{\rm M}_\odot$	$M_{\rm high}/\,{\rm M}_\odot$	% EC
Reimers	8.67	9.25	8.4	7.86	9.25	19.7
VW93	9.03	9.25	3.2	8.82	9.25	6.2
van Loon	9.00	9.25	3.6	8.76	9.25	7.1

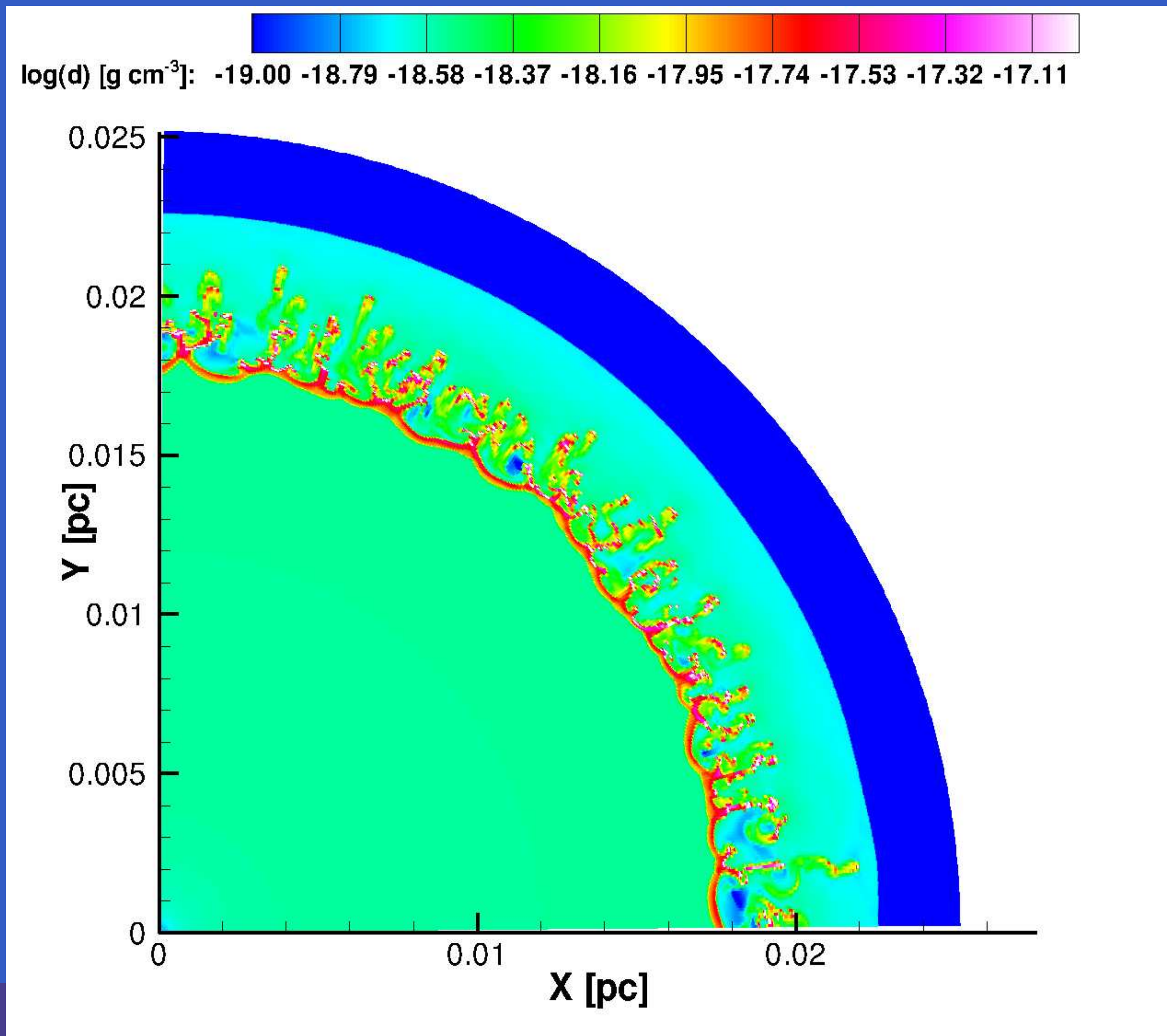
Poelarends et al. 2008

e^--capture supernovae: pre-SN HR-d

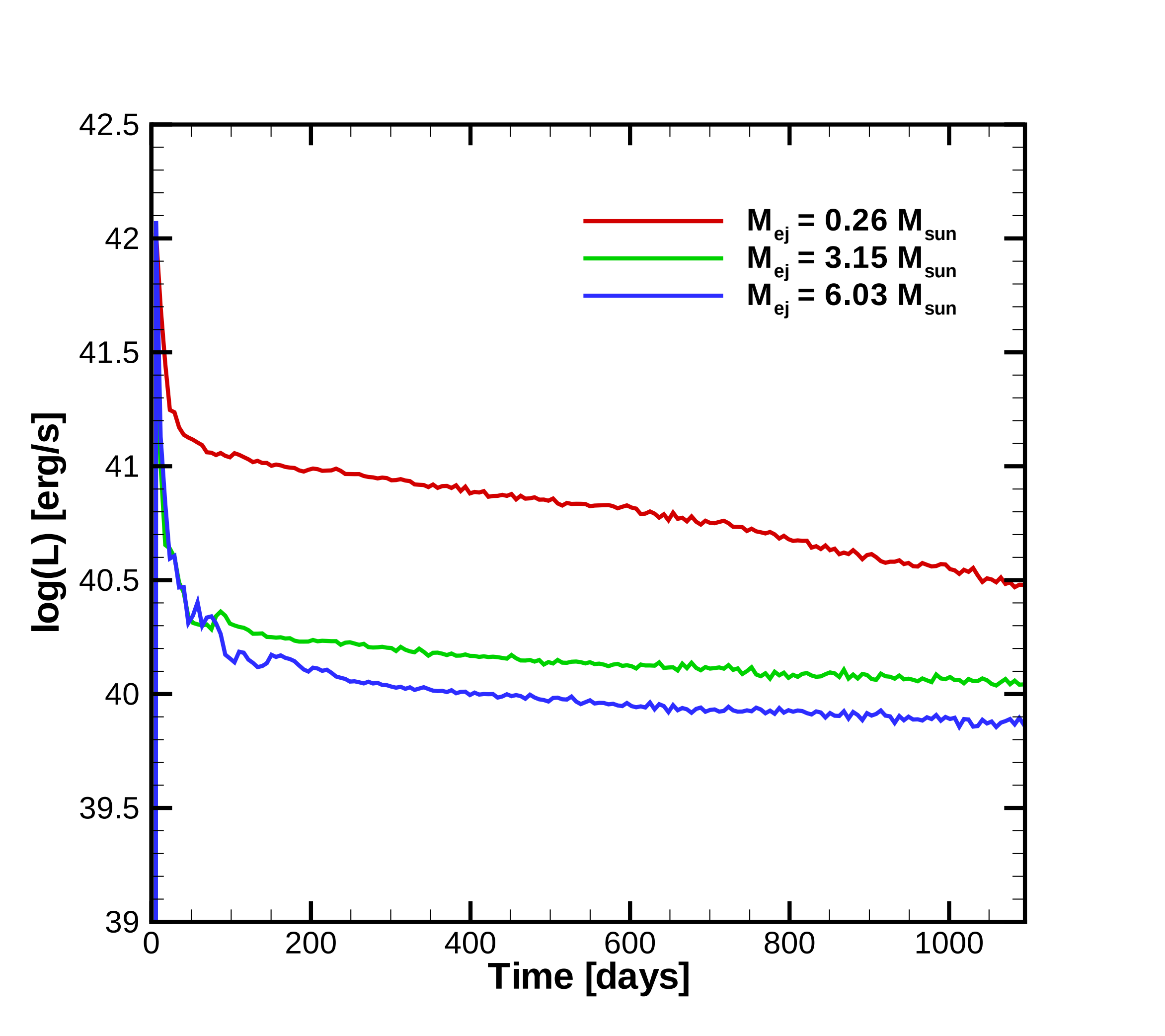


Poelarends et al. 2008

e^--capture supernovae: 2D model

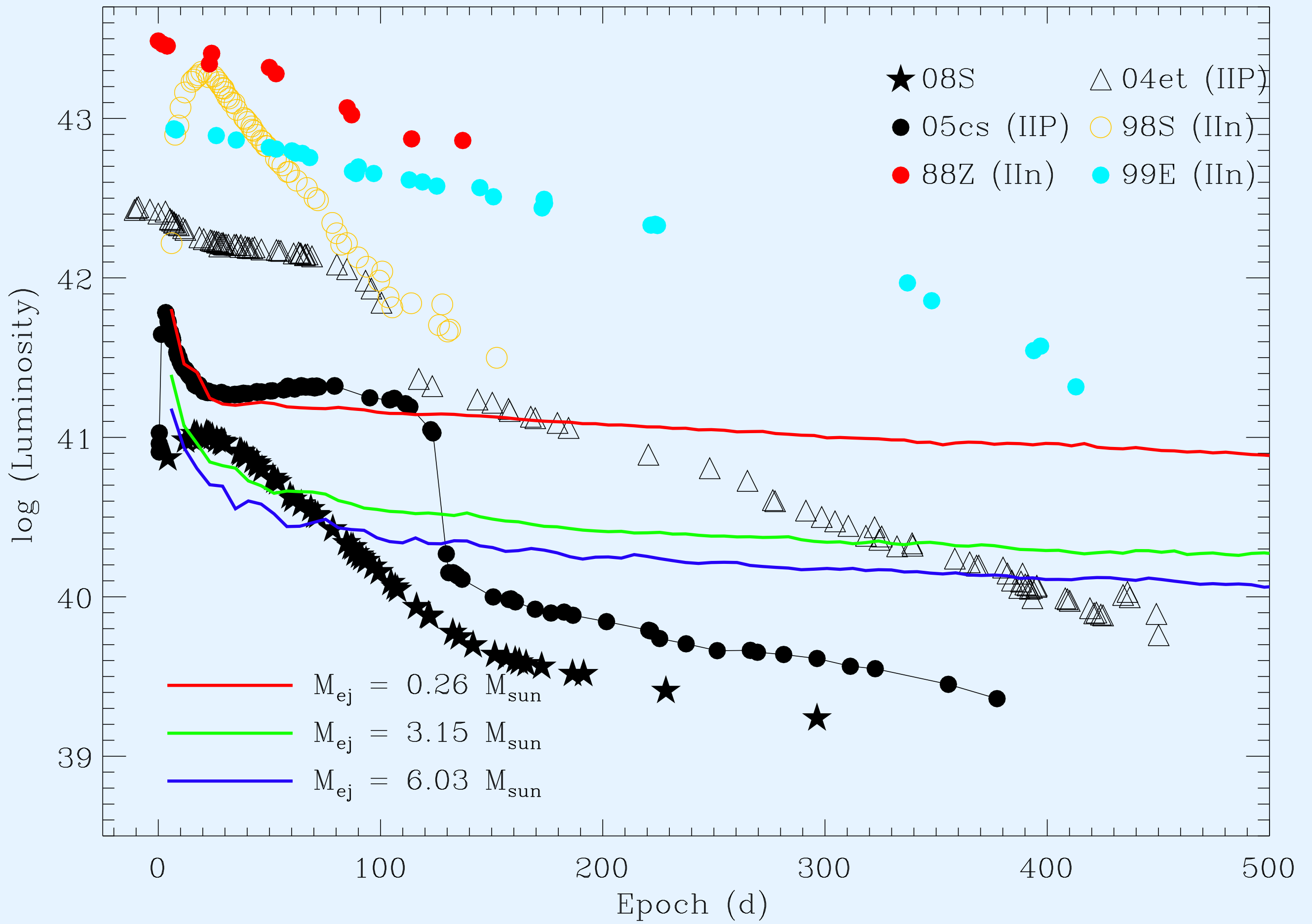


e⁻-capture supernovae: light curves



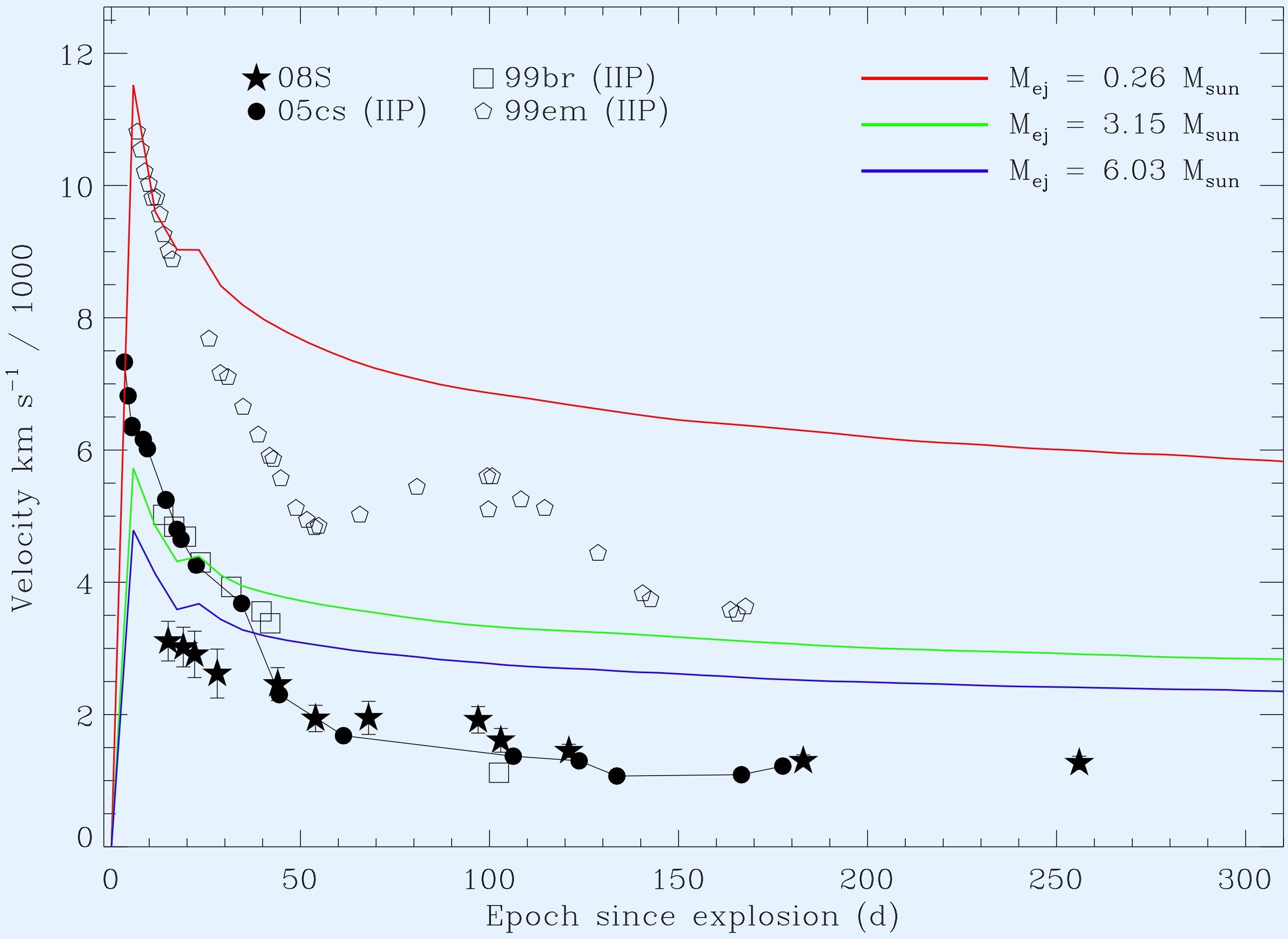
van Veelen et al., in prep.

e⁻-capture supernovae: light curves



van Veelen et al., in prep.

e^--capture supernovae: velocities



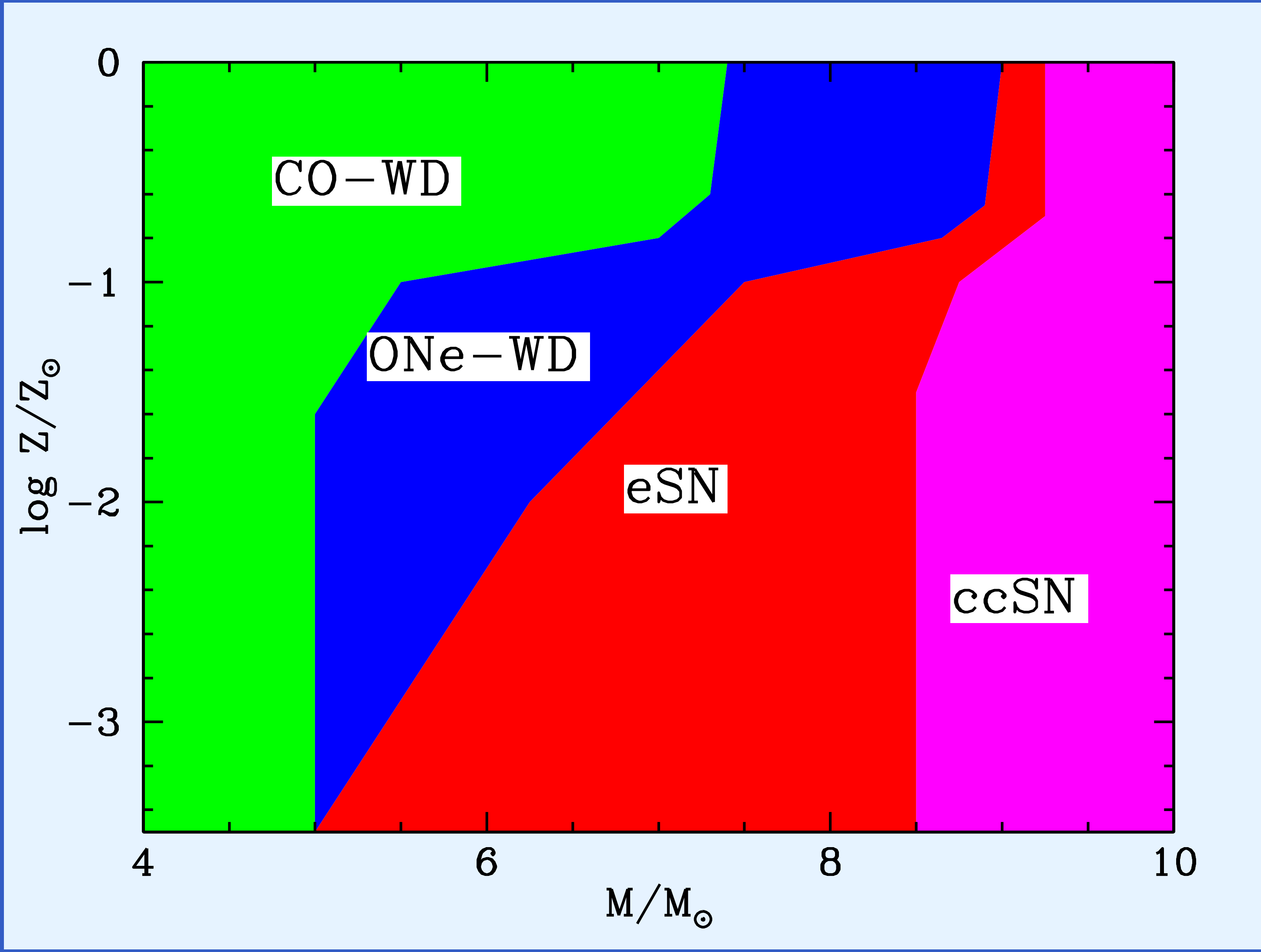
van Veelen et al., in prep.

Supernovae as function of mass

(small Z, no rotation)

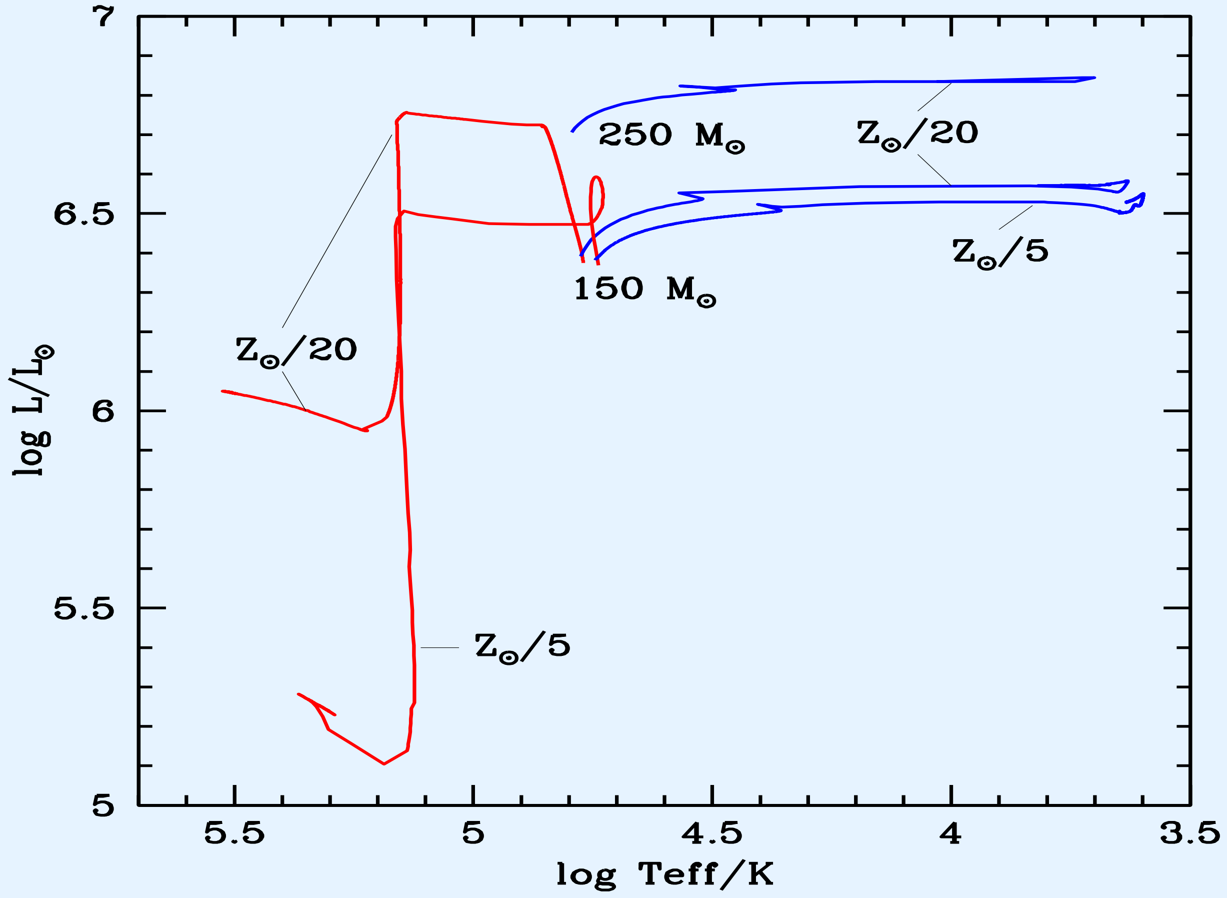
- e^--capture supernovae
- cc-supernovae: fewer/no SNe Ib/c
- $e^\pm$-supernovae? YES

WD-SN transition regime as $f(Z)$



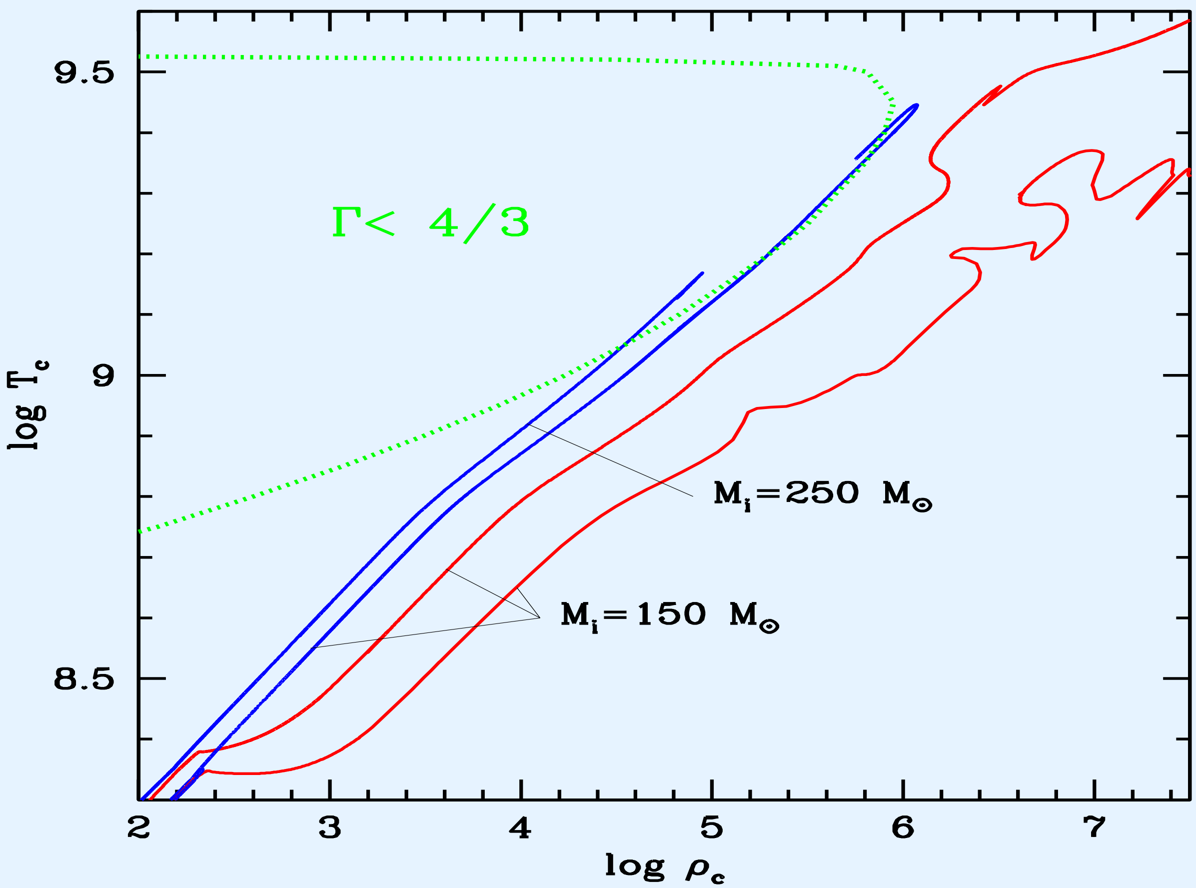
Poelarends 2008

$e^{\pm}$-pair creation



Langer et al. 2007

$T_c - \rho_c$-plane



Langer et al. 2007

Local $e^{\pm}$-SN rate

best mass loss rate (Vink & de Koter):
PCSNe from $Z < Z_{\odot}/3$

$$\longrightarrow \frac{\#SNe(Z<Z_{\odot}/3)}{\#SNe} \simeq \frac{1}{10}$$ (Langer & Norman 2006)

also: $\frac{\#stars>150\,\mathrm{M}_{\odot}}{\#stars 10...150\,\mathrm{M}_{\odot}} \simeq \frac{1}{100}$??

$\Rightarrow$ 1 PCSN / 1000 SNe

Supernovae as function of rotation

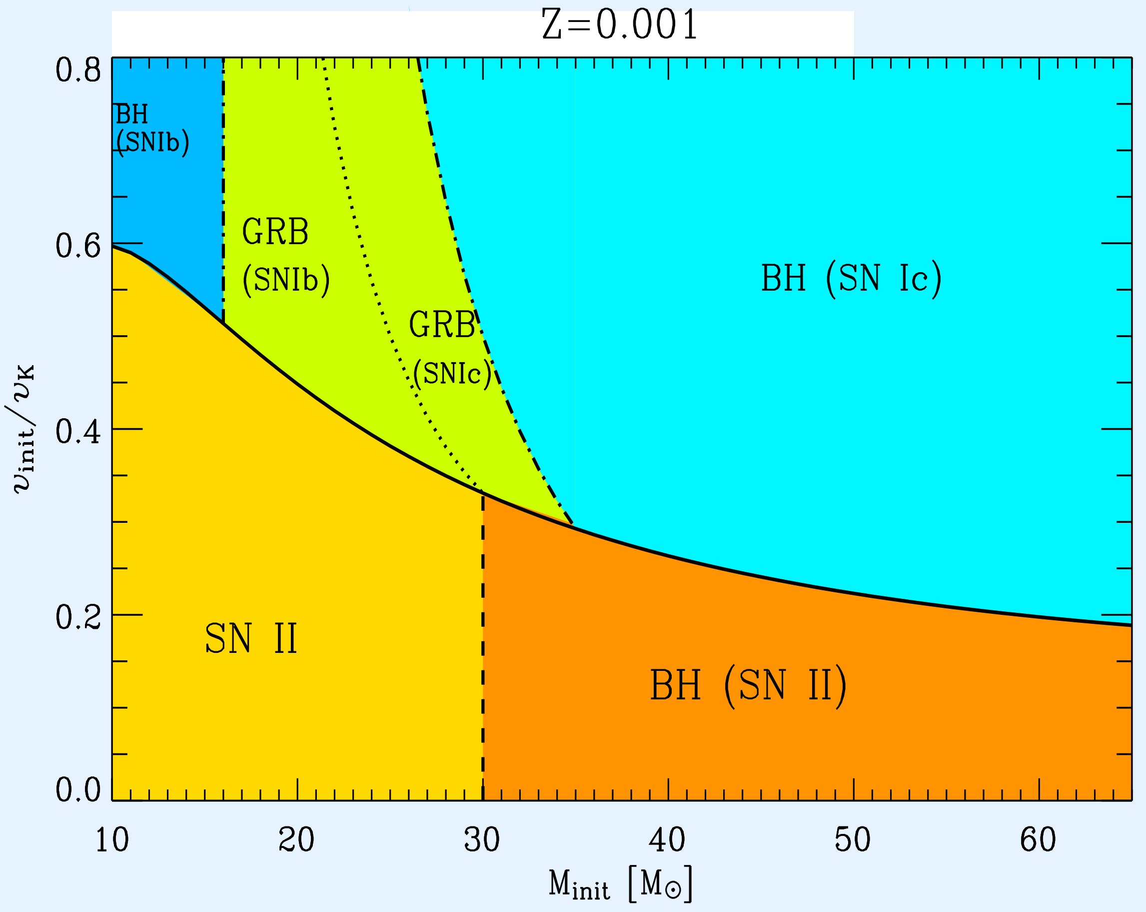
favoured at small Z: weaker winds

- chemically homogeneous evolution (Yoon)
  long GRBs

favoured in binaries:

- Cantiello et al. 2007:
  mass transfer $\rightarrow$ spin-up $\rightarrow$ hom. evolution
- de Mink (poster):
  fastest rotators: all in binaries?

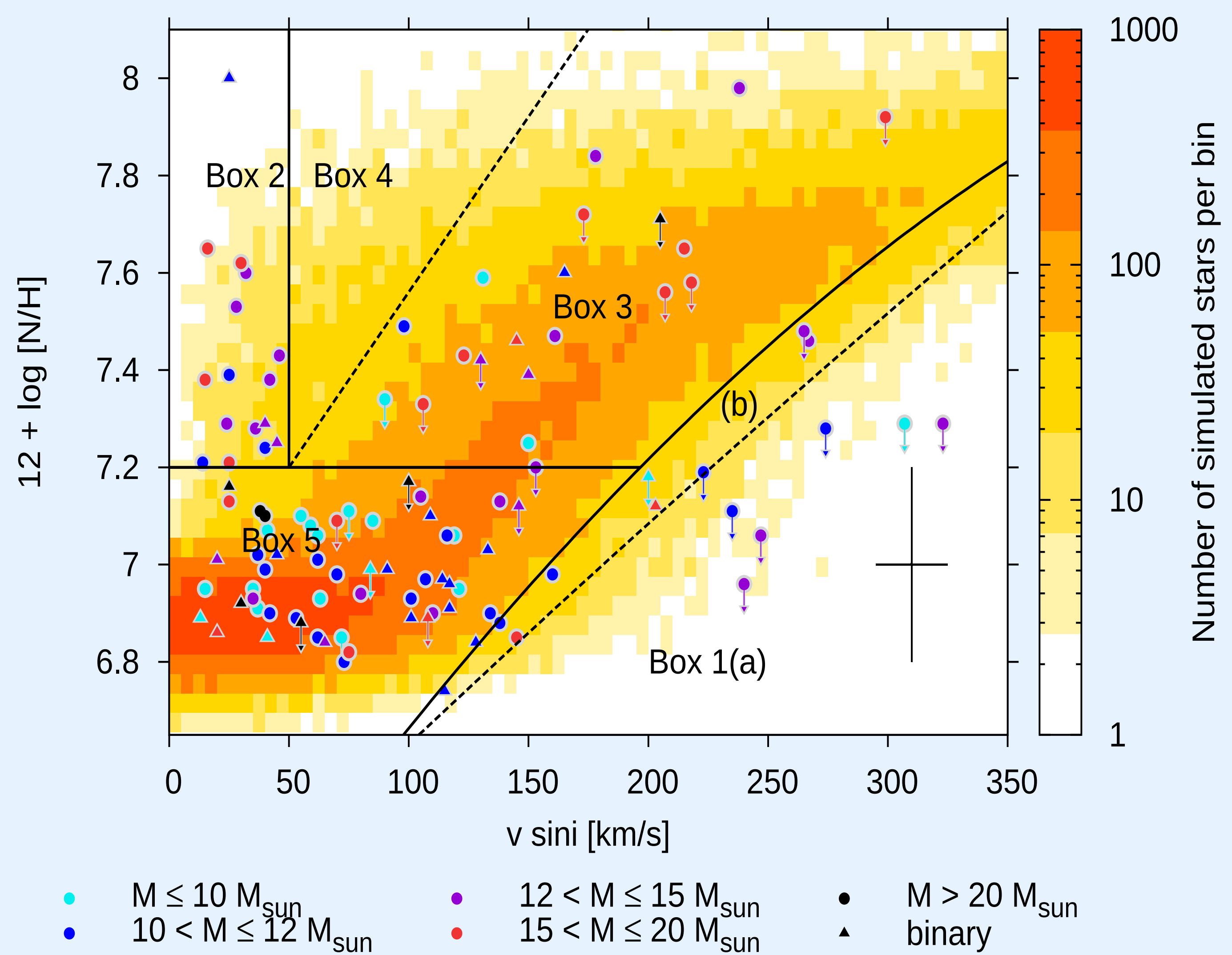
GRB progenitors



Yoon et al. 2006

VLT-FLAMES Survey of Massive Stars

PI: Smartt



Brott et al., in prep.

Conclusions

- find (more) e^--capture supernovae
  very long lasting, low velocities
- find (more) $e^\pm$-supernovae
  SN2008bi (Gal-Yam), progenitors, low Z
- rotation effects: strongest at low Z
  lGRBs
- beware of “magnetic supernovae”
  15% ?