The White Dwarf Initial-Final Mass Relation

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The relation between a star's ZAMS mass and its white dwarf (WD) remnant mass is the initial-final mass relation (IFMR)

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B. Balick, V. Icke, G. Mellemea, & NASA

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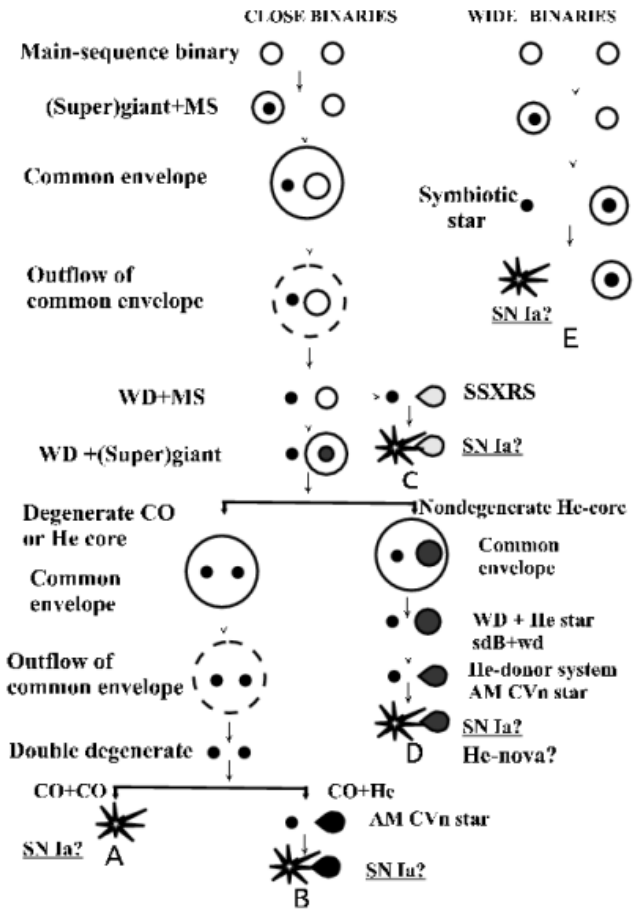
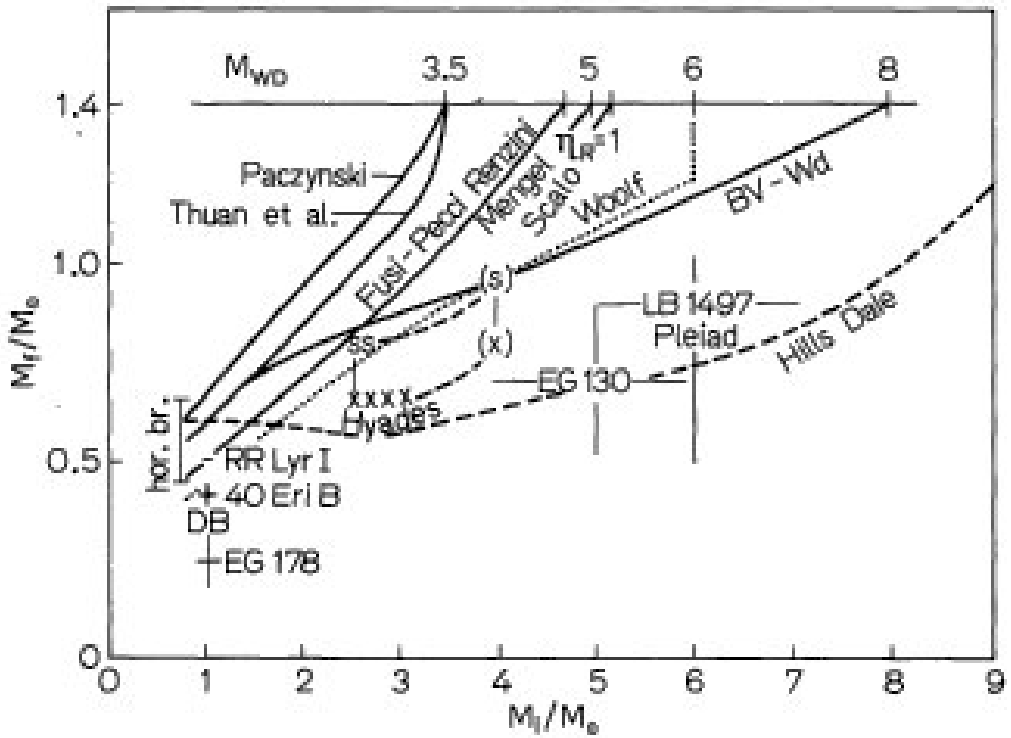
The IFMR is one key ingredient of Type Ia progenitor population synthesis calculations.



Yungelson (2004)

Given widely disparate theoretical IFMRs, a precise empirical IFMR is needed.



Weidemann (1977)

Many questions about the IFMR remain.

- Is the IFMR single-valued?
- Is there significant internal scatter?
- What is the effect of metallicity on the IFMR?
- What is the maximum mass WD produced by single star evolution?
- What is the maximum mass of WD progenitors?

Open star clusters are the best way to construct an empirical IFMR.

Observed WD $T_{\rm eff}$ and log g

↓ *WD evolutionary models*

WD mass and cooling age

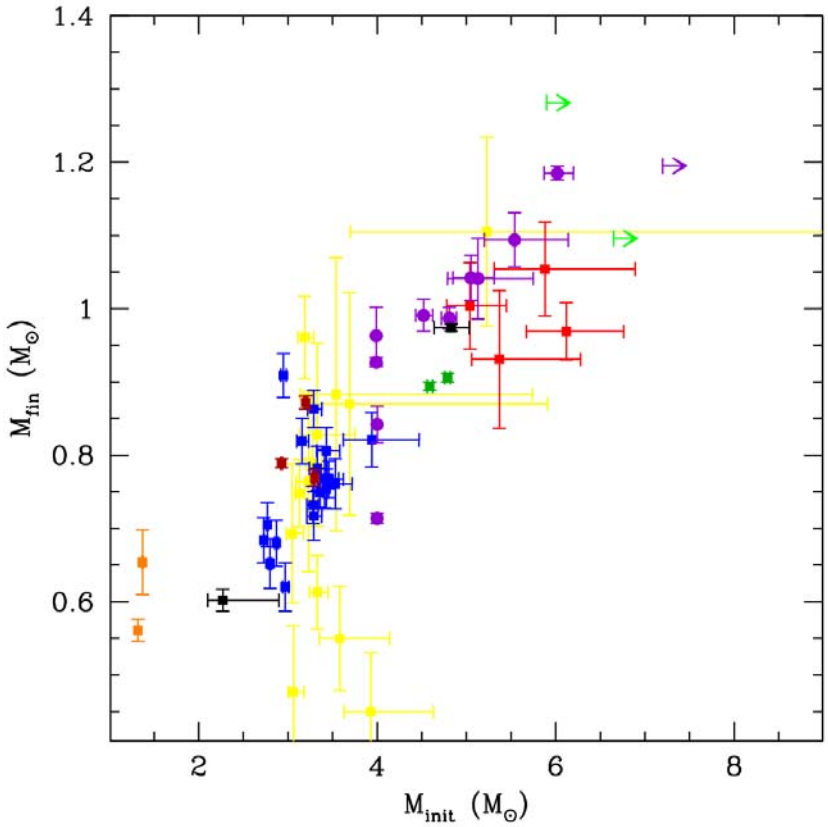
↓ *Subtract from cluster age*

Progenitor star lifetime

↓ *Stellar evolutionary models*

Progenitor mass

The current empirical IFMR has data from 11 star clusters and binary star systems.



M67

Procyon B

Hyades/Praesepe

M37

NGC 6633

M34

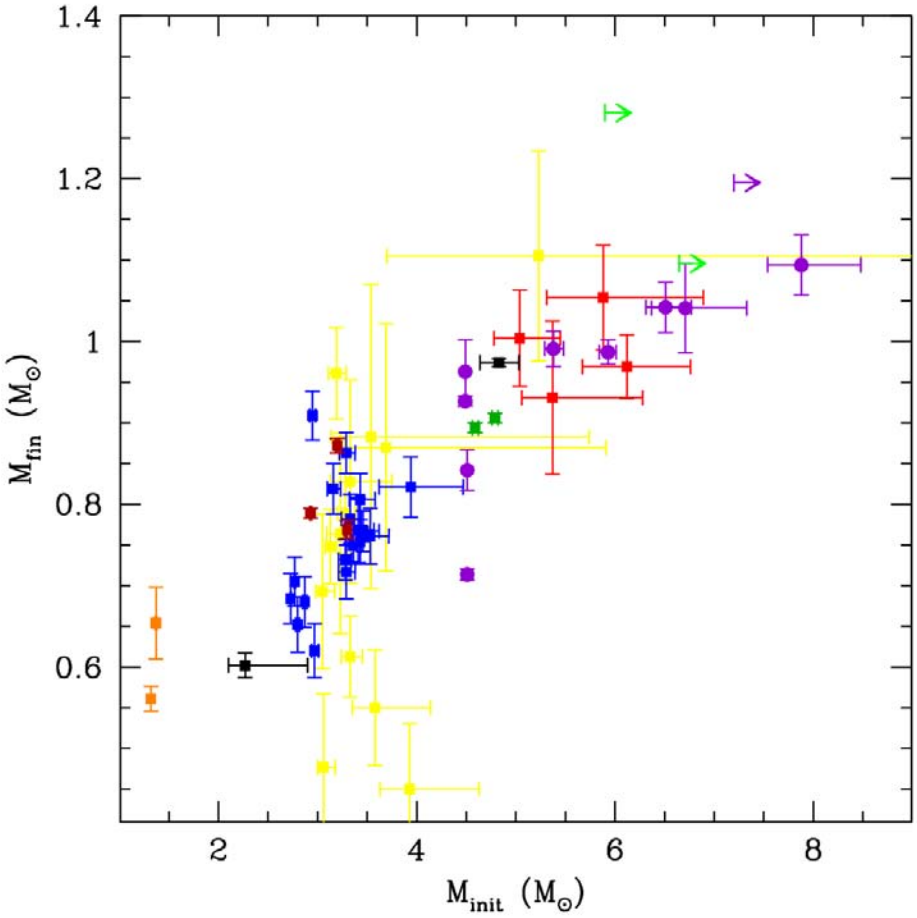
Sirius B

M35

NGC 2516

Pleiades

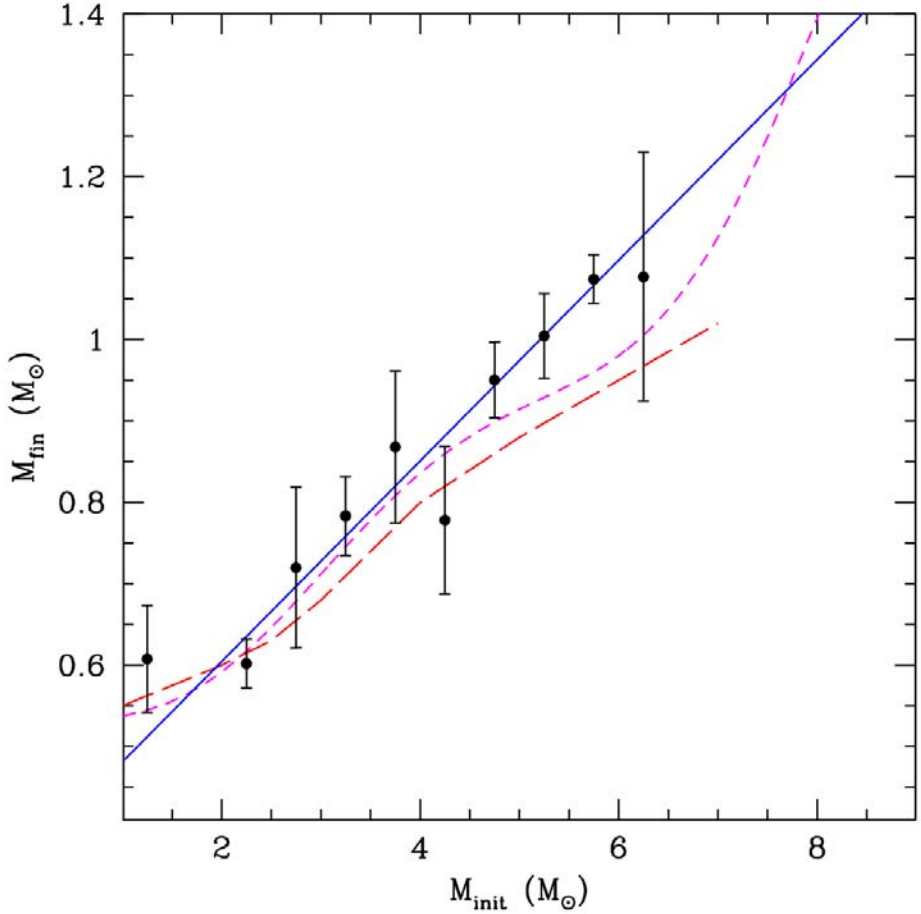
The largest uncertainty remains star cluster ages.



M35:

Age=150 Myr

Binning by mass shows the IFMR is nearly linear.



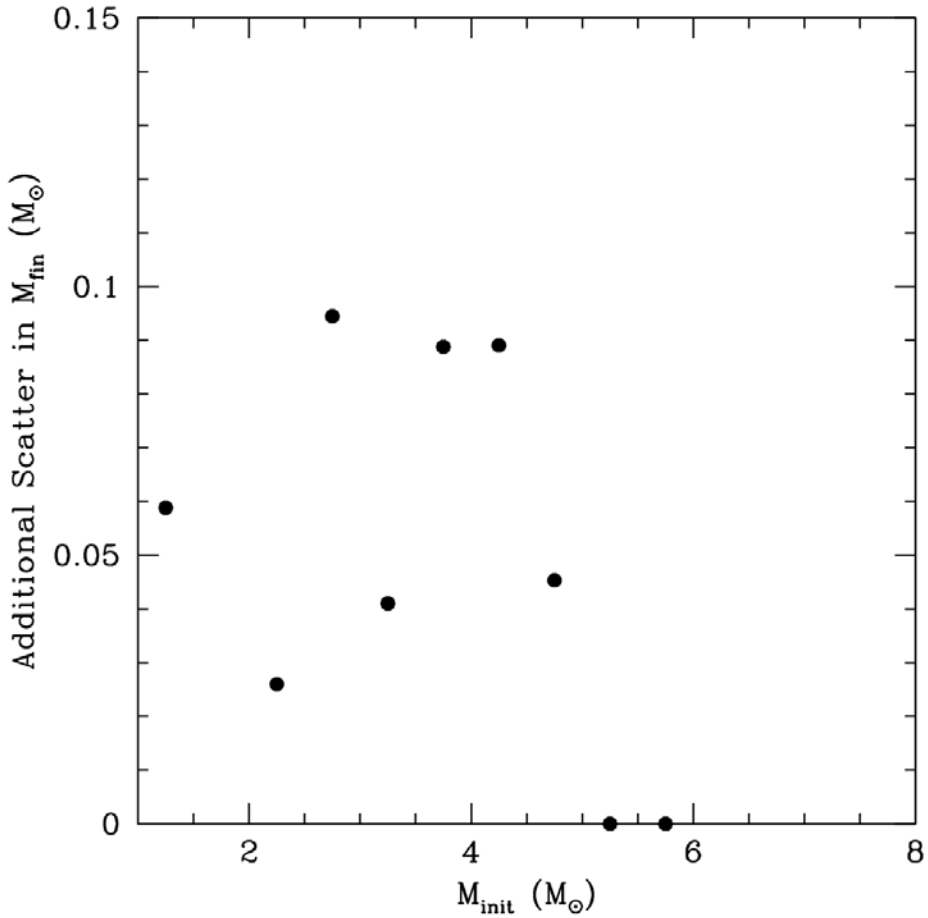
Weidemann (2000)

Ferrario et al. (2005)

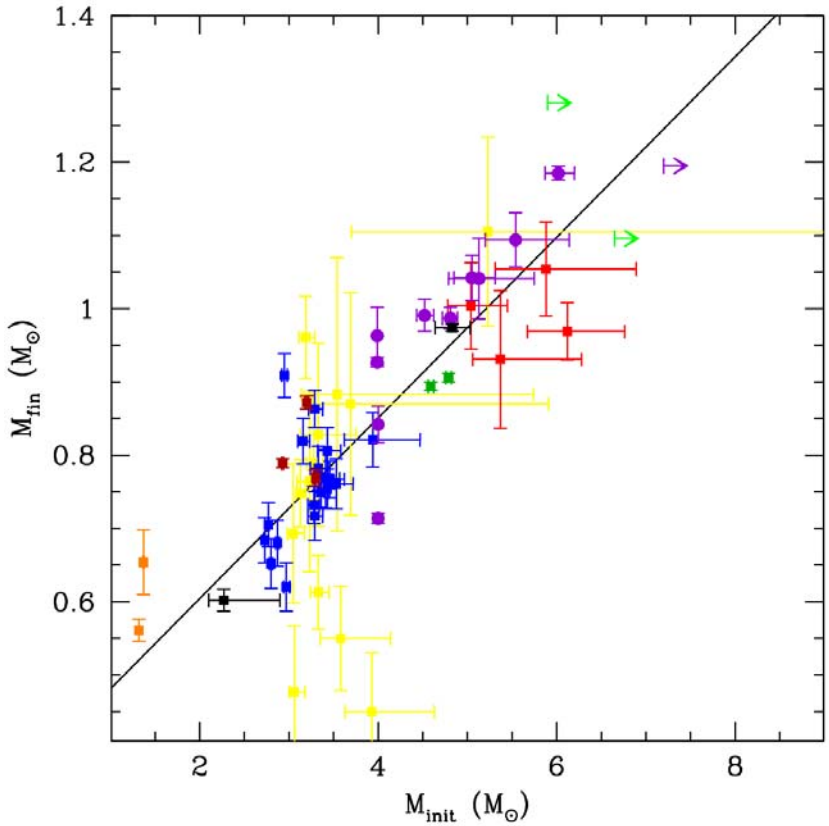
Current linear fit:

$$M_f = 0.358 + 0.123 M_i$$

If there is intrinsic scatter in the IFMR, it is $\leq 0.1 M_{\odot}$



Larger samples and more accurate measurements are needed to search for metallicity dependence.



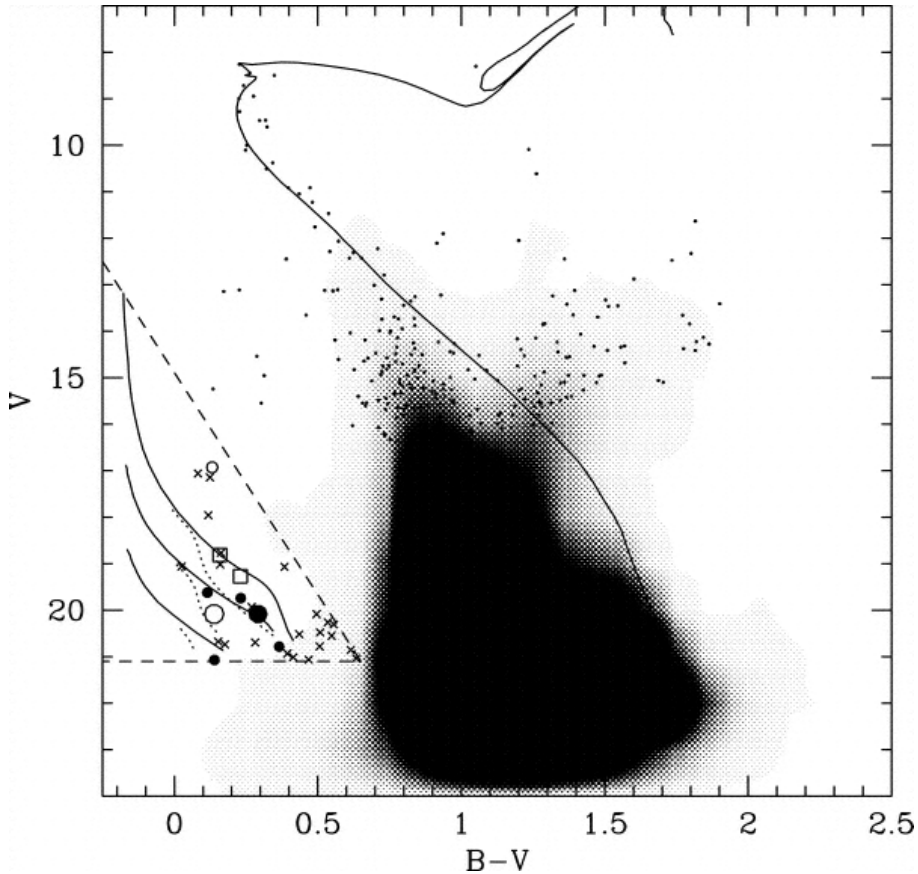
NGC 2516: [Fe/H]=+0.01

M35: [Fe/H]=-0.21

Praesepe: [Fe/H]=+0.13

NGC 6633: [Fe/H]=-0.1

An aside: We have *two* super-M_{ch} WD-WD binary candidates in the open cluster NGC 6633



Williams & Bolte (2007)

Conclusions

- Open cluster white dwarfs are ideal for studying the initial-final mass relation
- The current empirical IFMR is nearly linear, with M_f=0.358+0.123M_i
- Uncertain cluster ages is the dominant source of systematic error in the IFMR.
- Intrinsic scatter is less than ~0.1$M_\odot$
- Any metallicity effects are masked by cluster age uncertainties