Gaia and white dwarf + brown dwarf binaries

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Gaia and white dwarfs

Will observe 400 000 white dwarfs (Torres et al., 2005)

But, it will only provide parallax and proper motion for them

From the white dwarf spectra we can get…

- Temperature
- Gravity
- Age
- Luminosity
- Mass
- Radius
- Initial mass of star

We can’t get

- Metallicity - unless we have a Sirius-type binary

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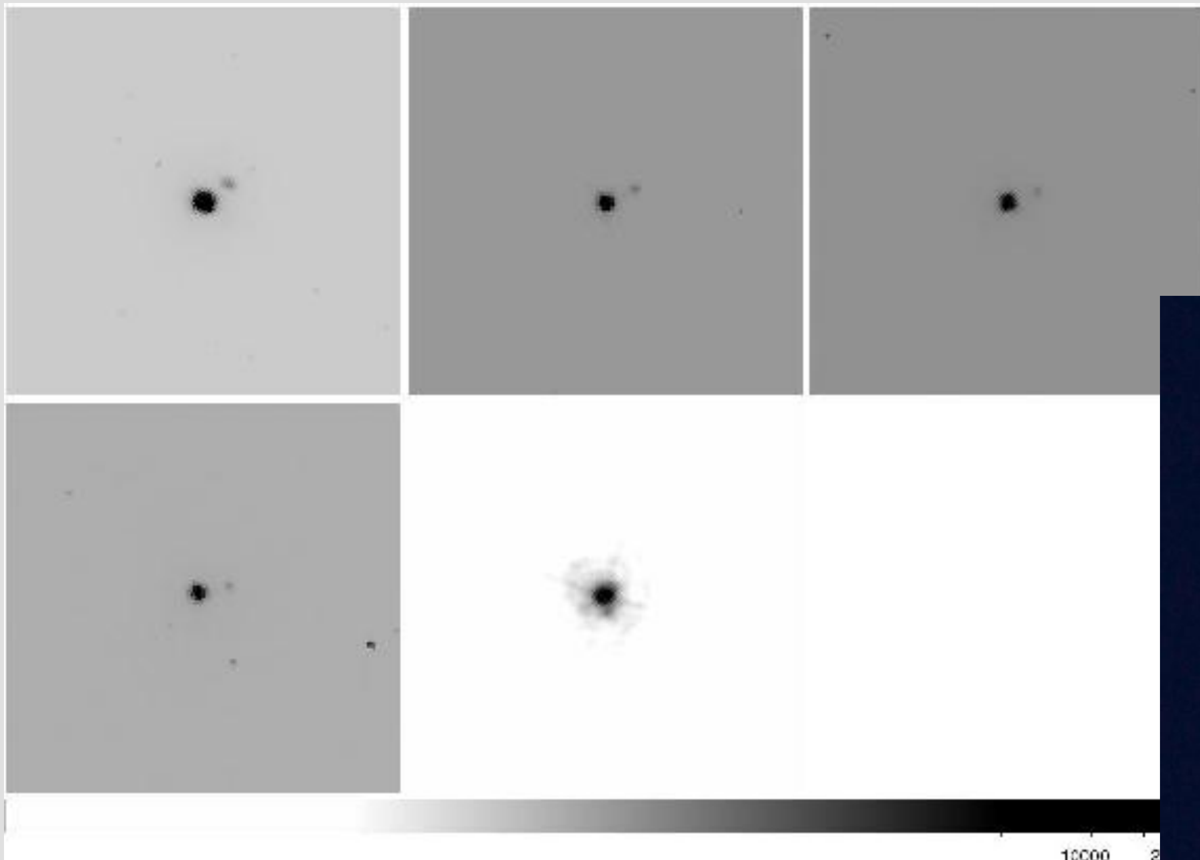
Metallicity



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White dwarf + Brown dwarfs

The systems are rare!

Steele et al., 2011 estimate the unresolved binary fraction to be ≥0.5±0.3%

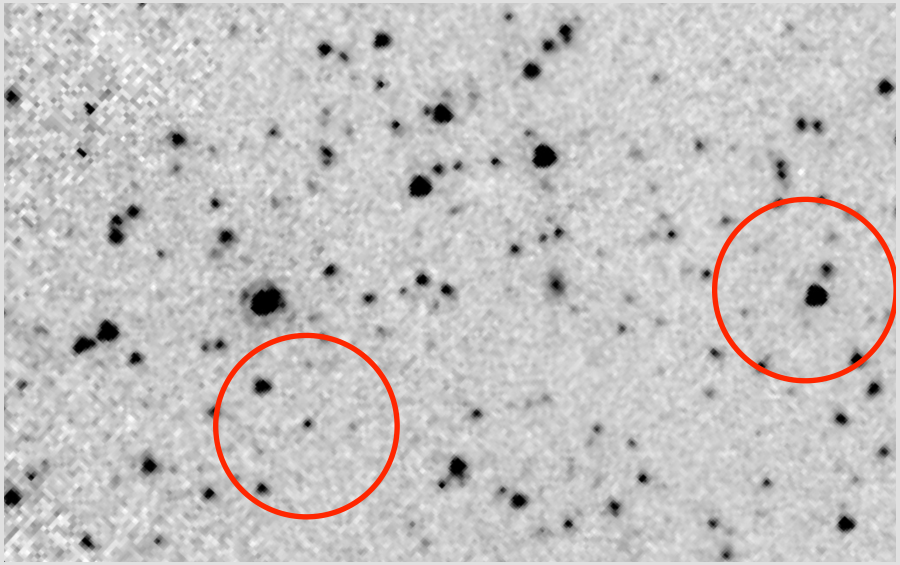
Girven et al., 2011 and Verbeek et al., 2014 estimate it to be 2 %

Gaia will find: 2000-8000 of these!

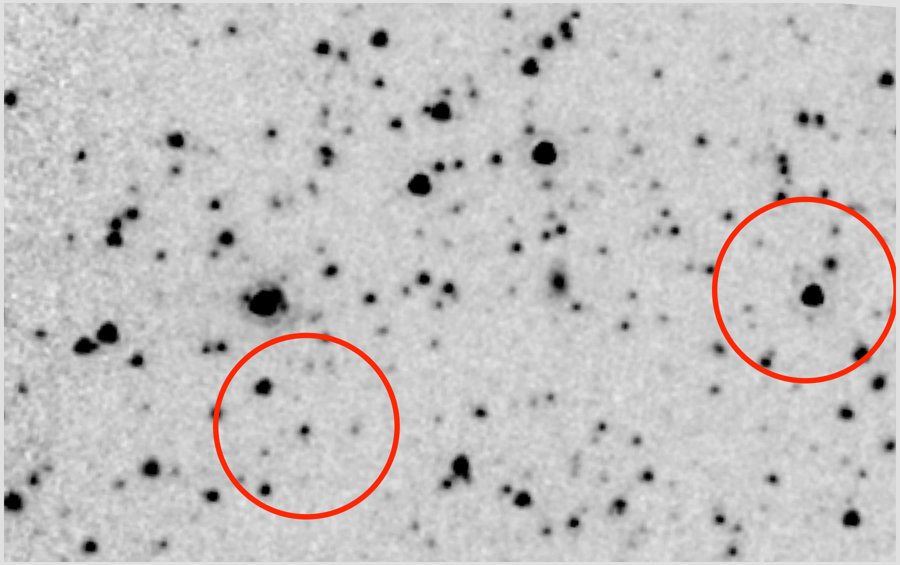
Two main types:

- those discovered via common proper motion (e.g. WD0806-661B, Luhman et al., 2011)
- those discovered through an IR excess (e.g. WD0137-349AB, Maxted et al., 2006)

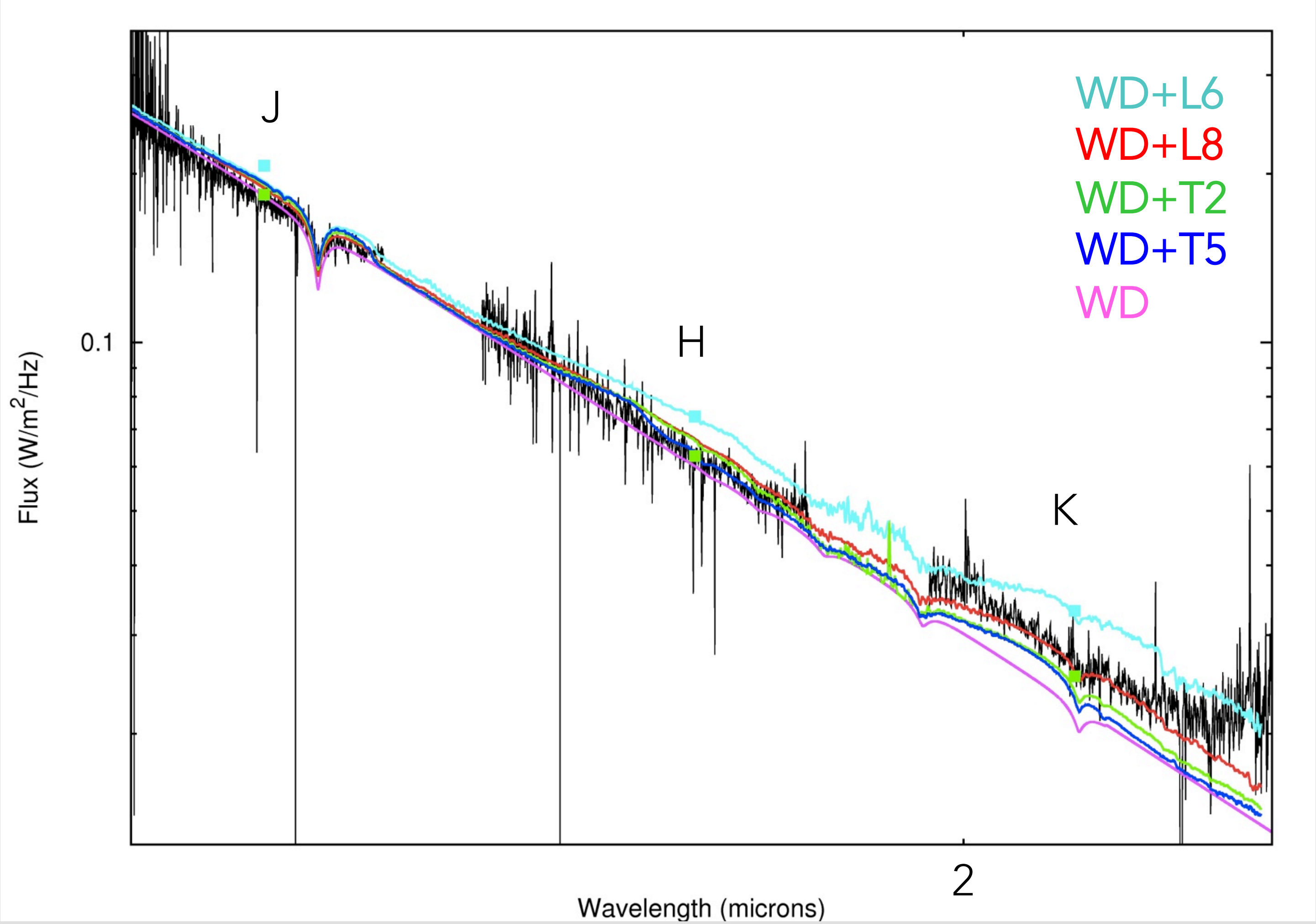
WD0806-661



WD0806-661



WD0137-349



Casewell et al., 2013

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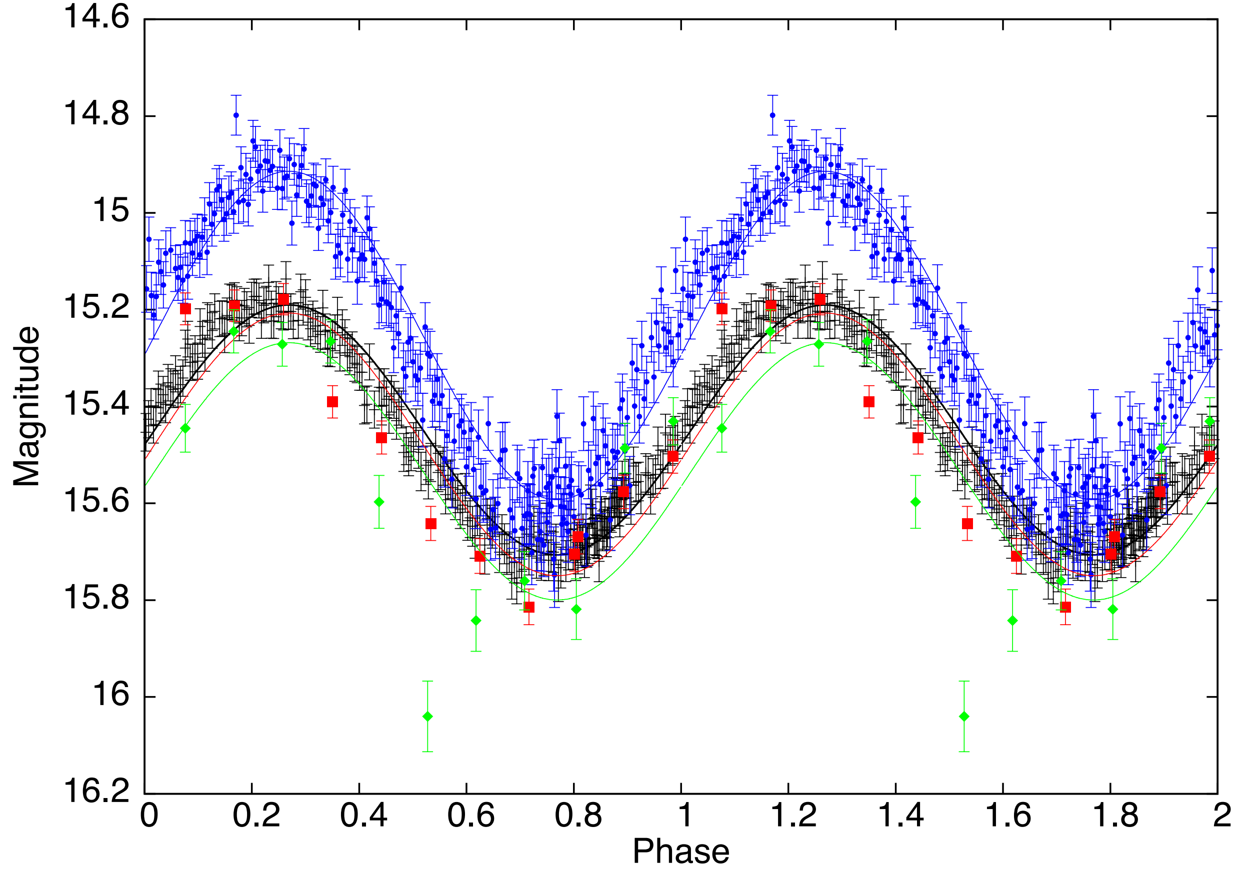
WD0137-349



Casewell et al., 2014 in prep

Measurable WD parameters

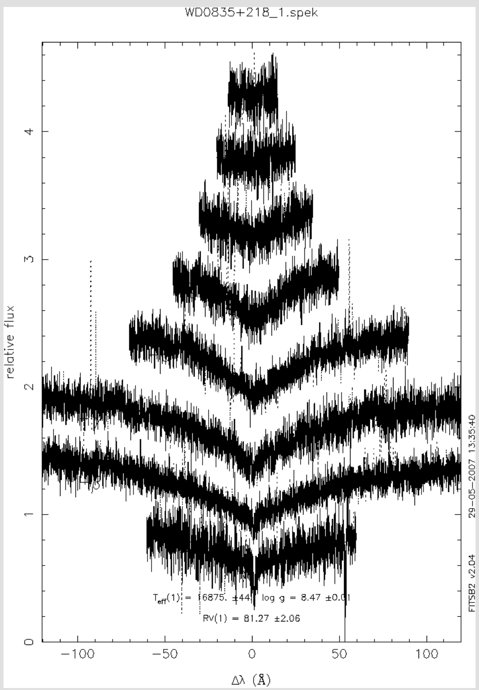
Effective Temperature and log g:

SDSS provides spectra (Kleinman et al.,2013)

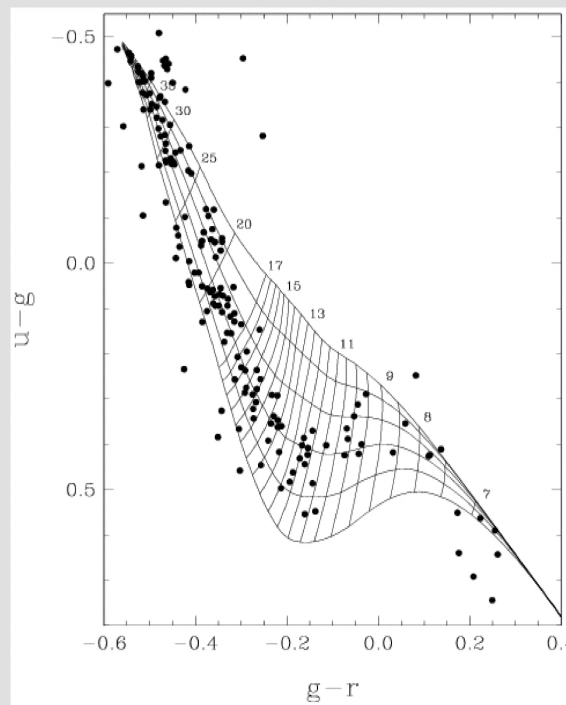
Detlev Koester models or TLUSTY/SYNSPEC models

or

Use synthetic photometry (Holberg & Bergeron 2006)



Casewell et al., 2009



Holberg & Bergeron, 2006

Measurable WD parameters

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From this we can combine with evolutionary models (Wood, Althaus, Bergeron/Fontaine) to get:

Mass, Radius and cooling time

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$$g = \frac{GM}{R^2}$$

$$L = 4\pi R^2 \sigma T^4$$

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More robust with parallax!

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Measurable WD parameters

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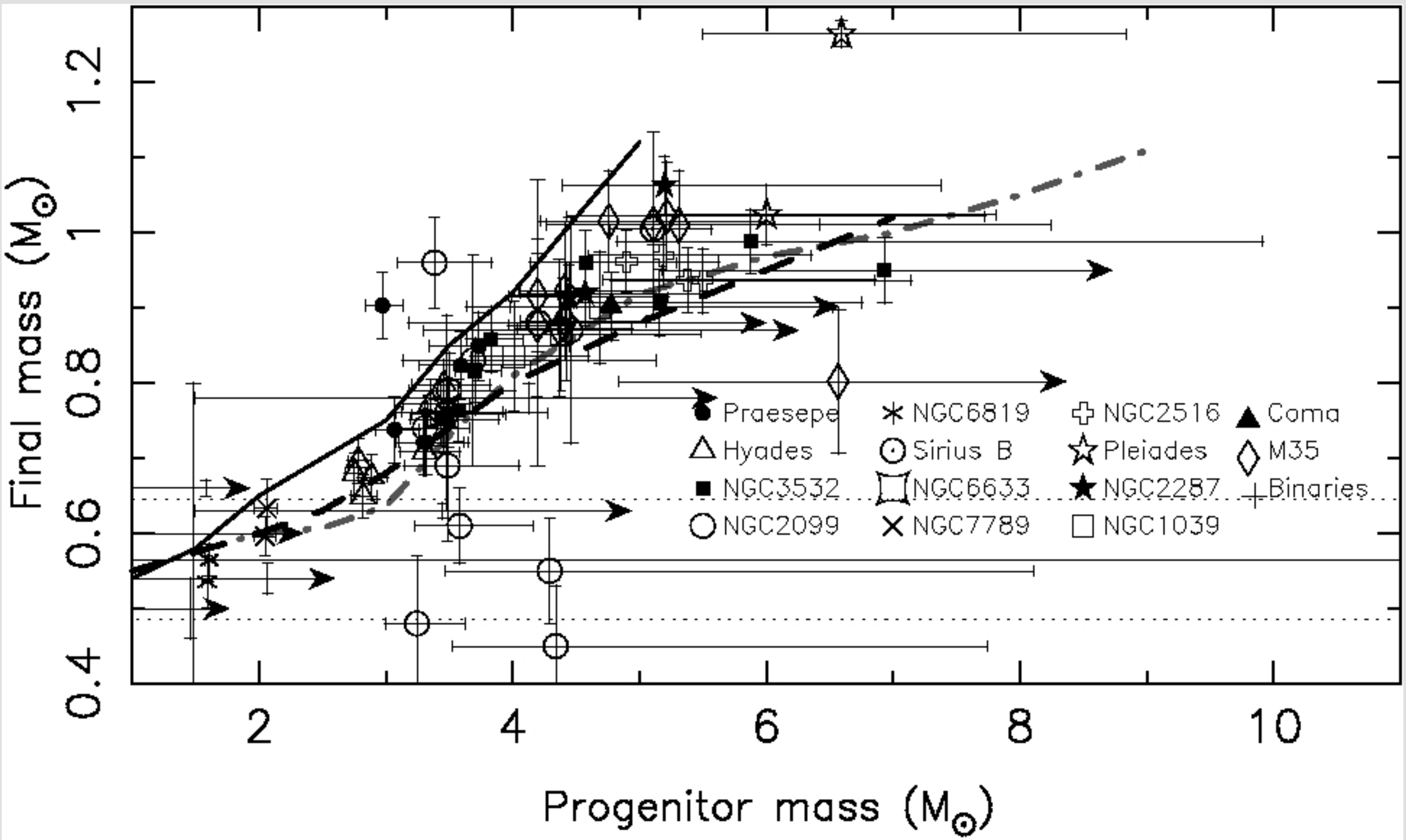
The progenitor mass can then be determined from an initial mass-final mass relation

IFMR



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Stellar models such as those from Girardi et al., can be used to determine the main sequence lifetime

Caveats:

- The IFMR is only based on DA white dwarfs

    Most WDs that are used are in solar metallicity clusters

    The low mass and high mass ends are not well constrained

- We don't know the metallicity of the WD (unless in a Sirius-type binary)

    Have to assume solar metallicity when using stellar models

- WDs are old (ish). Even hot WDs have spend significant time on the MS

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