THE ORIGIN OF LOW-MASS WHITE DWARFS

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ESO

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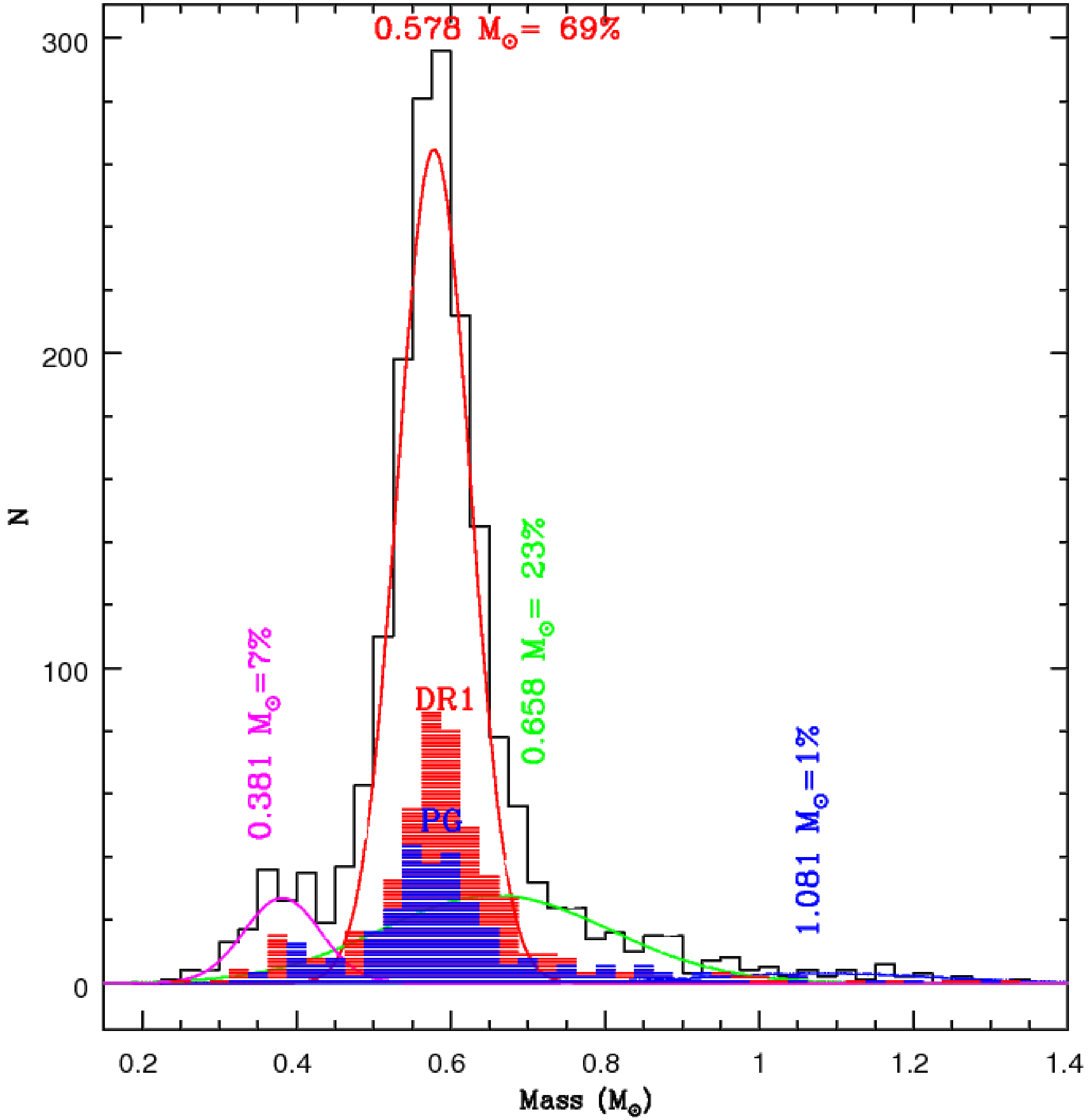
Introduction: the peak at ~0.4 Msun

Kepler et al. (2007)

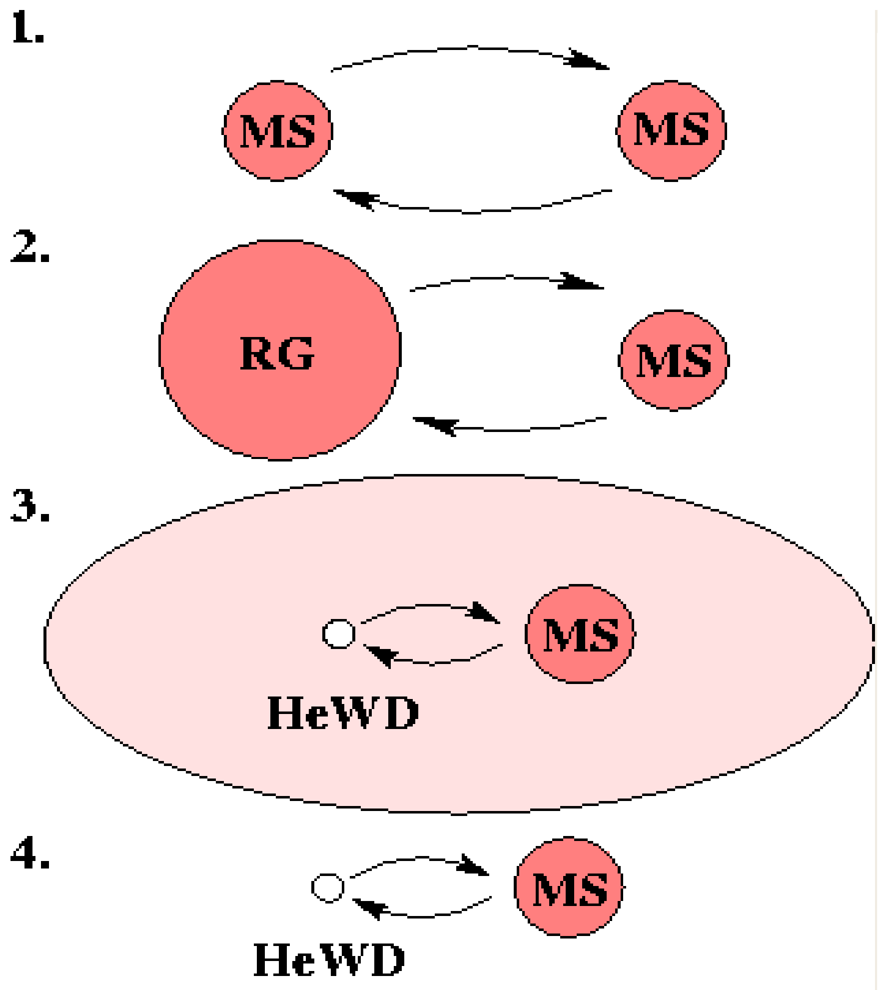
Liebert et al. (2005)

Bragaglia et al. (1995)

Bergeron et al. (1992)



Introduction: PCEBs and wide WDMS binaries



Introduction: theory vs. observations

~50% of all apparently single low-mass WDs are in binaries (e.g. DDs or unseen companions, Marsh et al. 1995, Sigurdson et al. 2003, Maxted et al. 2002, Schreiber & Gansicke 2003)

~50% appear not to have companions (e.g. Maxted et al. 2000, Napiwotzi et al. 2007, Kilic et al. 2010)

Lack of a sufficiently large sample of PCEBs

The PCEB sample

> 2200 WDMS binaries from SDSS (Rebassa-Mansergas et al. 2010, Nebot Gomez-Moran et al. in prep, Rebassa-Mansergas et al. in prep.)

Follow-up observations (RVs)

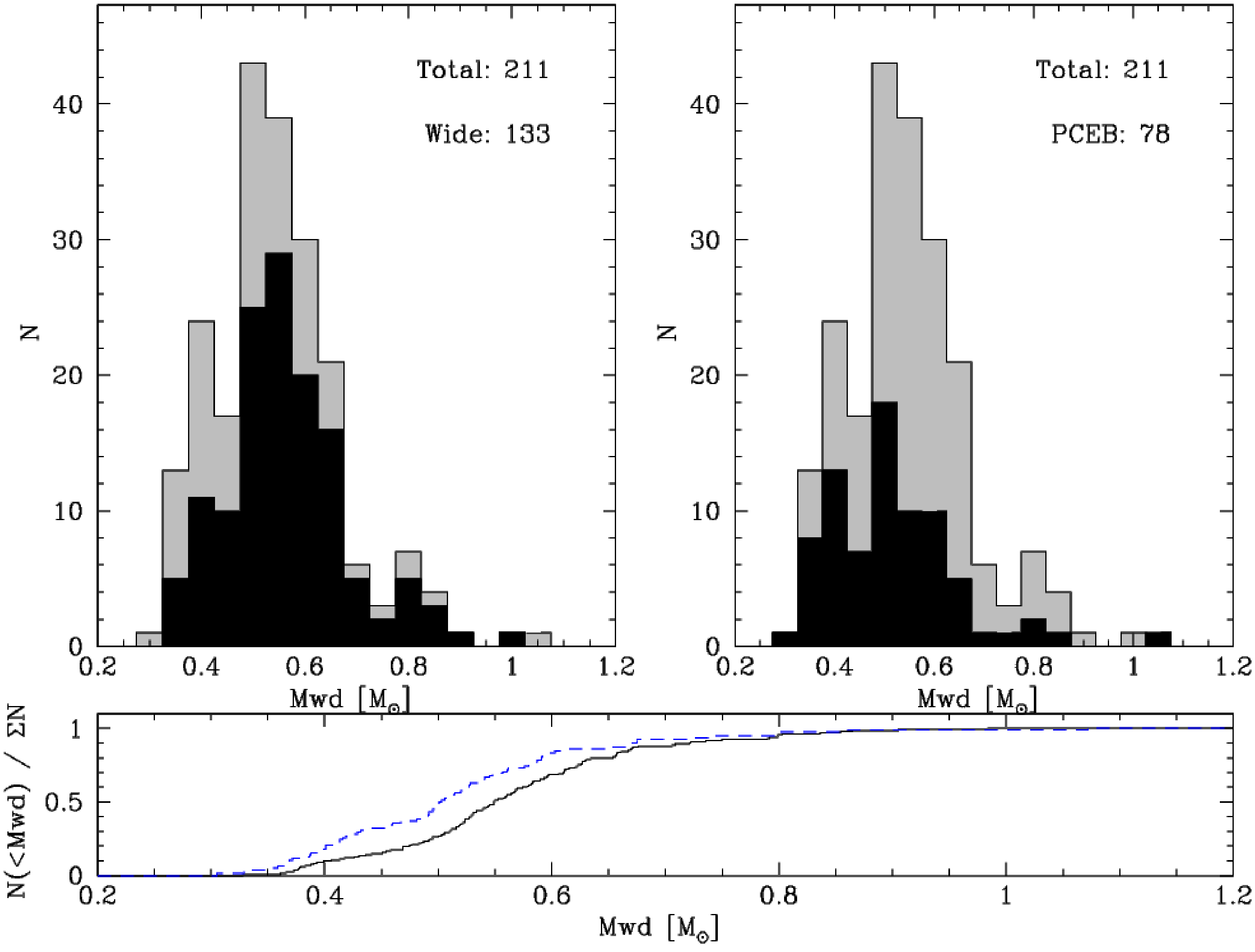
670 WDMS (Rebassa-Mansergas et al. 2007, 2008, Schreiber et al. 2008, 2010)

DA WDs with Teff > 12000

mass error < 0.1 Msun

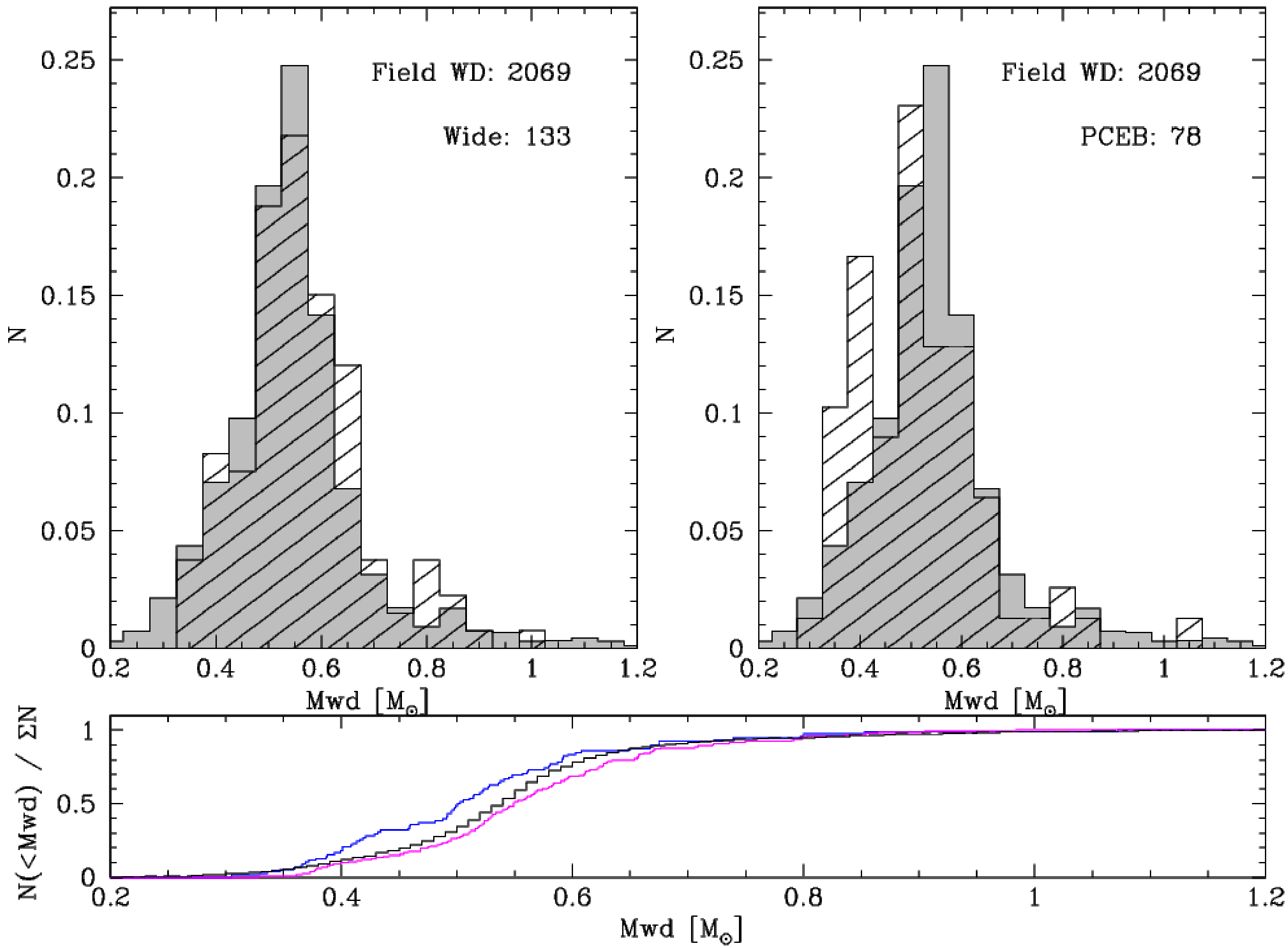
78 PCEBs and 133 wide WDMS binaries (211 WDMS in toal)

The mass distributions



Statistically independent with 99.63% confidence

The mass distributions



Field WDs vs. Wide WDMS : 8.2%
Field WDs vs. PCEBs : 0.8%

The mass distributions

Mass distributions of PCEBs and wide WDMS differ significantly

Mass distributions in field WDs and wide WDMS are similar

However......

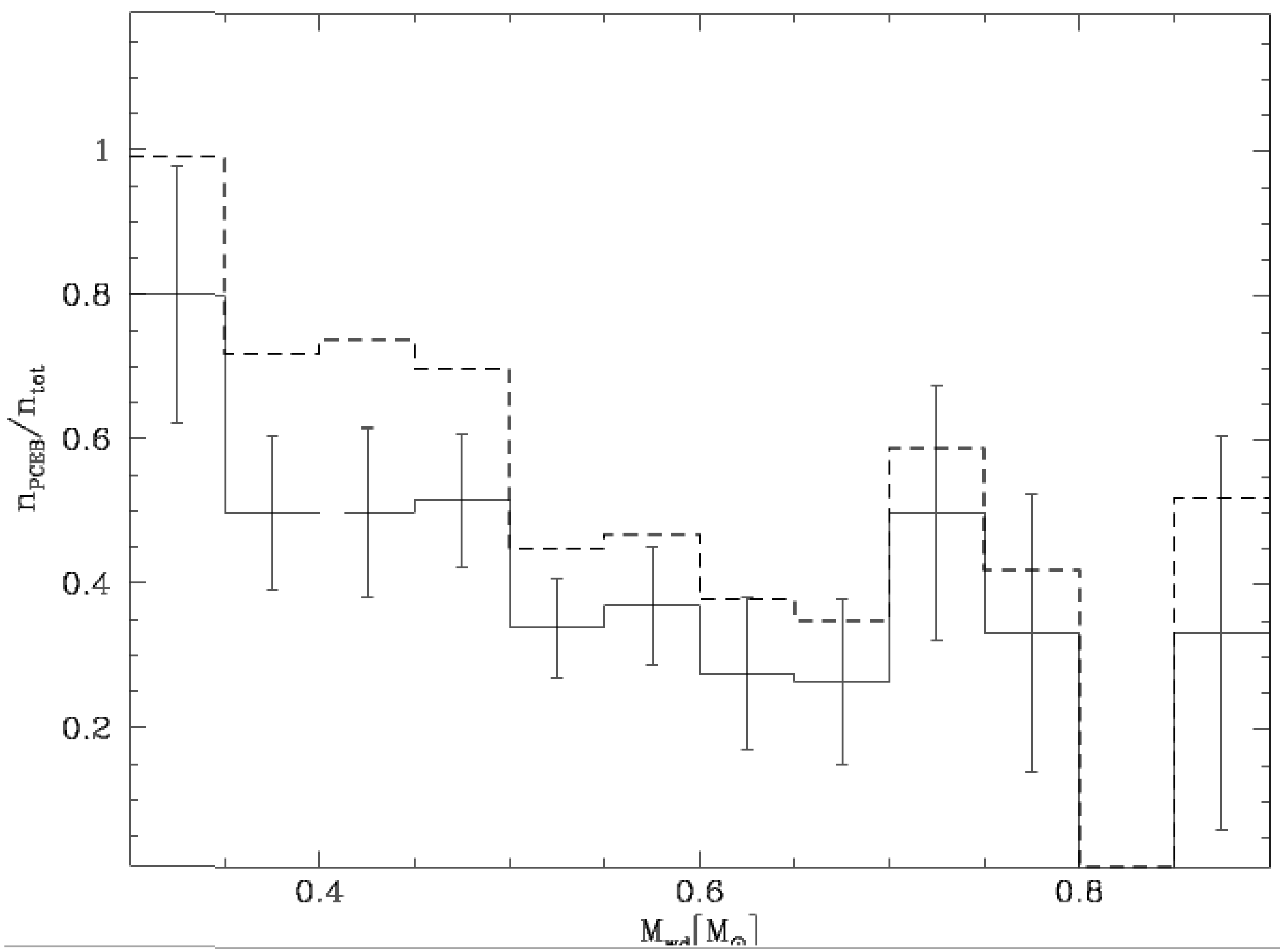
We have to take into account observational biases

Close binary fractions

Monte Carlo simulations → PCEB detection probability ~0.7

Close binary fractions

Monte Carlo simulations ⟶ PCEB detection probability ~0.7



Close binary fractions

Monte Carlo simulations → PCEB detection probability ~0.7

Bayesian statistcis → P(D|M2) / P(D|M1) in function of f_a

The origin of low-mass WDs

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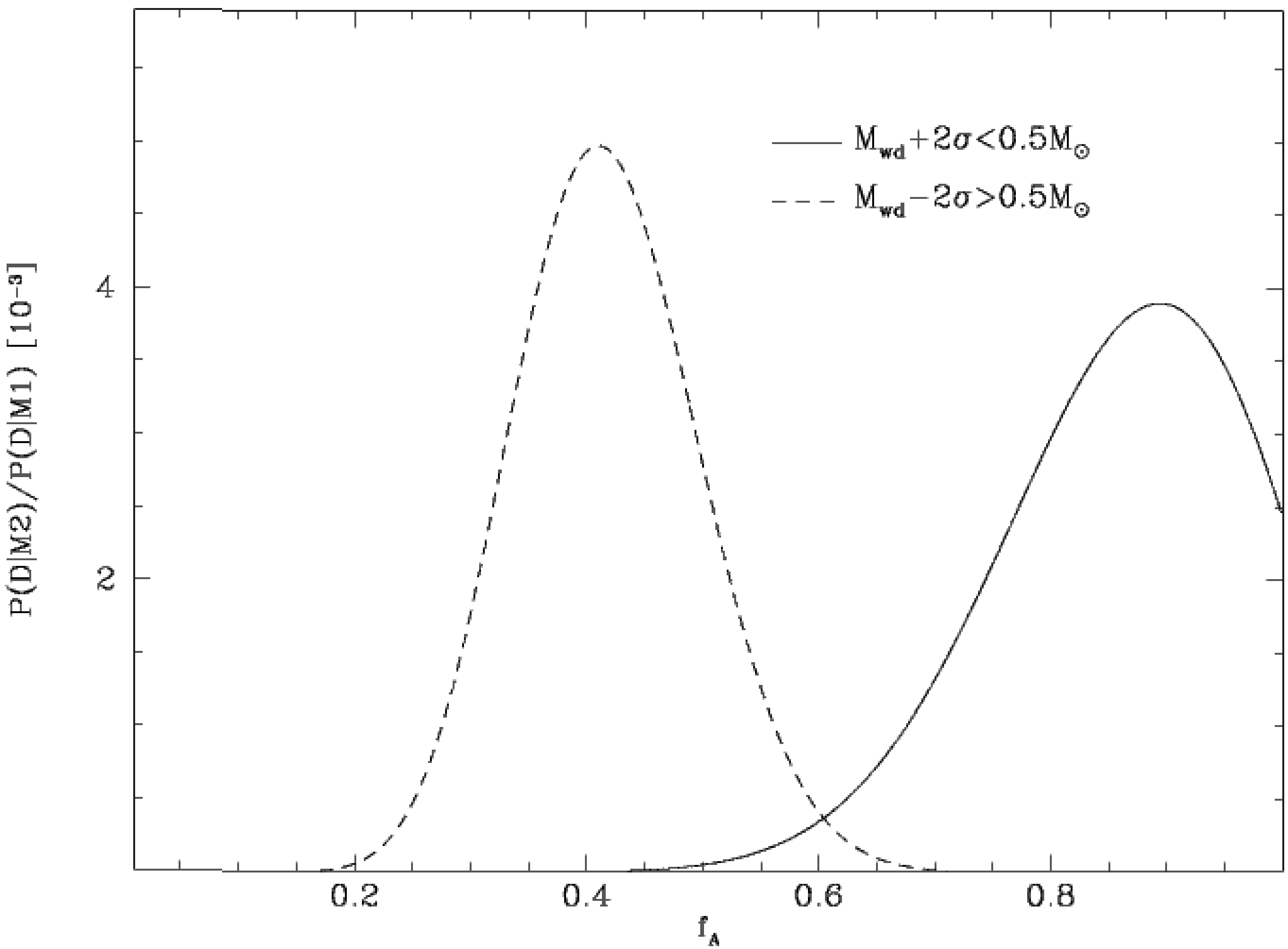

The origin of low-mass WDs

~89% of all low-mass (M < 0.5 Msun) WDs are formed in binaries

~41% of all high-mass (M > 0.5 Msun) WDs are formed in binaries

↓

~9% of all wide WDMS contain low-mass WDs

~10% of all apparently single WDs are of low-mass

Conclusions

WD mass distriutions of PCEBs and wide WDMS are significantly different

WD mass distributions of wide WDMS and field WDs are similar

The large majority (~89%) of low-mass WDs are formed in binaries

~9% of the wide WDMS seem to contain low-mass WDs

The evolution of compact binaries

Valparaiso - Vina del Mar - Santiago de Chile

6-11 March 2011

Sessions:

Different classes of compact binaries
Formation of close binaries
Stellar population synthesis
Common envelope phase
Post common envelope phase
Contact phase
Graveyard or Boom?

SOC:

Jarrod Hurley, Australia
Andrew King, UK
Ulrich Kolb, UK
Mario Livio, USA
Felix Mirabel, France
Linda Schmidtobreick, ESO
Matthias Schreiber, Chile

LOC:

María Eugenia Gómez, ESO
Paulina Jirón, ESO
Elena Mason, ESO
Kieran O'Brien, UCSB
Retha Pretorius, ESO
Alberto Rebassa, U. de Valparaíso
Linda Schmidtobreick (chair), ESO
Matthias Schreiber (chair), U. de Valparaíso
Claus Tappert, U. de Valparaíso
Maja Vuckovic, ESO
Mónica Zorotovic, ESO-PUC

Web page: www.eso.org/sci/meetings/Binary_Evolution2011/
Conference email: binary-evolution-2011@eso.org

The origin of low-mass WDs in wide binaries

~9% of all wide WDMS contain low-mass WDs

~10% of all apparently single WDs are of low-mass

- → ~50% (~5%) contain an unseen companion
- → ~50% (~5%) seem to be single

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Triple systems formed by a DD + M dwarf?

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- Merging of two very low-mass WDs (Han et al. 2002)
- Severe mass-loss on the giant branch (Kilic et al. 2007)
- Envelope ejection due to nearby planets (Nelemans & Tauris 1998)
- SN explotions that blow away the envelope of the companion (Justham et al. 2009)

$$P(D|M2)/P(D|M1) = (fa^{Na} \times \Pi qi) / \Pi pi$$

$$qi = fa[1 - ei]$$

$$Pi = 1 - ei$$

We have 89% of LMWDs formed in PCEBs, 41% in HMWDs
Our sample is 211 WDMS, 73 LMWDs and 137 HMWDs. So:

73   LMWDs – 89% of PCEBs = 8
137 HMWDs – 41% of PCEBs = 81

8 + 81 = 88

Then 8/88 = ~9% of all wide WDMS contain LMWDs
         81/88 = ~91% of all wide WDMS contain HMWDs