Merger Rate of Low Mass White Dwarf Binaries

Dr. Warren R. Brown

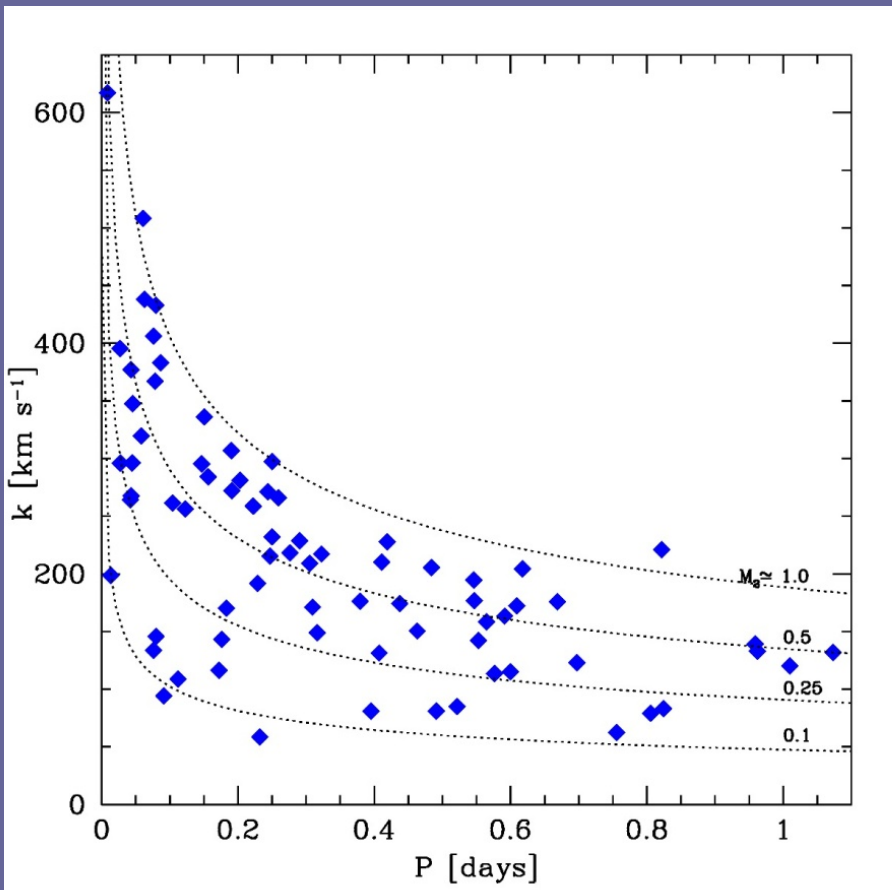
Smithsonian Institution

Center for Astrophysics

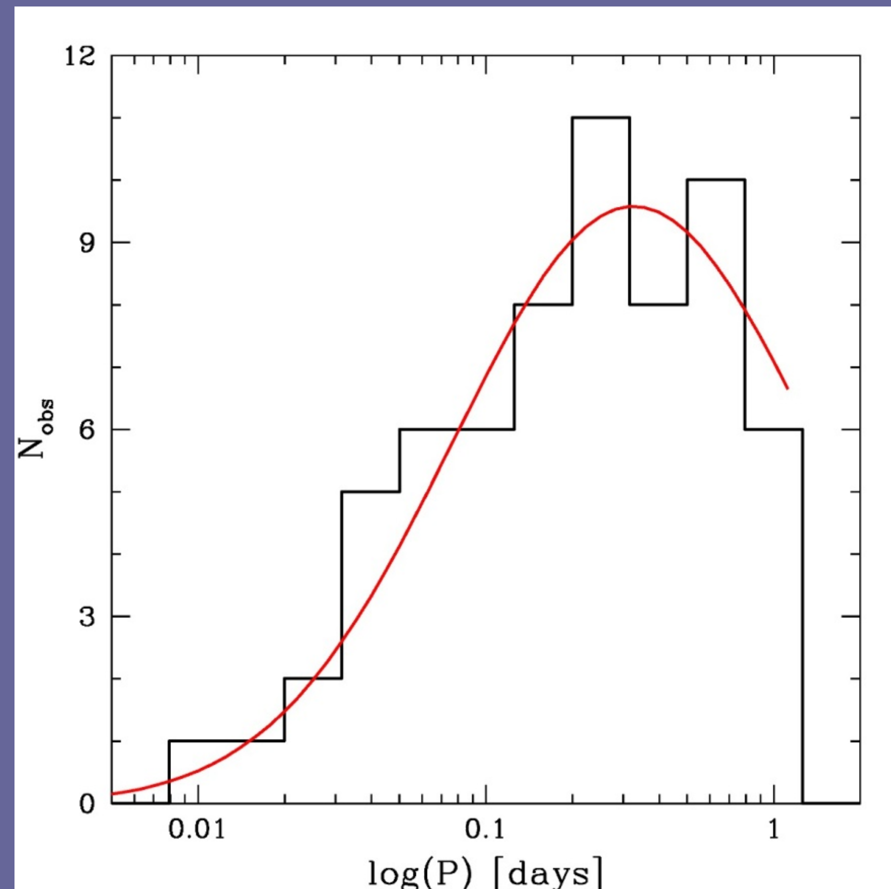
Collaborators: Mukremin Kilic, Alex Gianninas, JJ Hermes

MMT Telescope

75 White Dwarf Binaries P<1 day



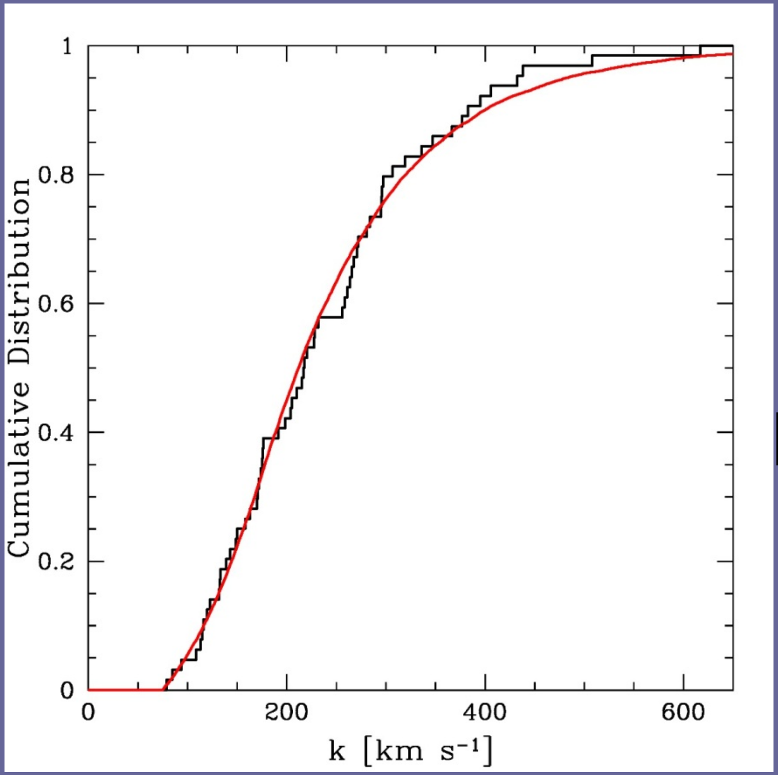
Observed Sample



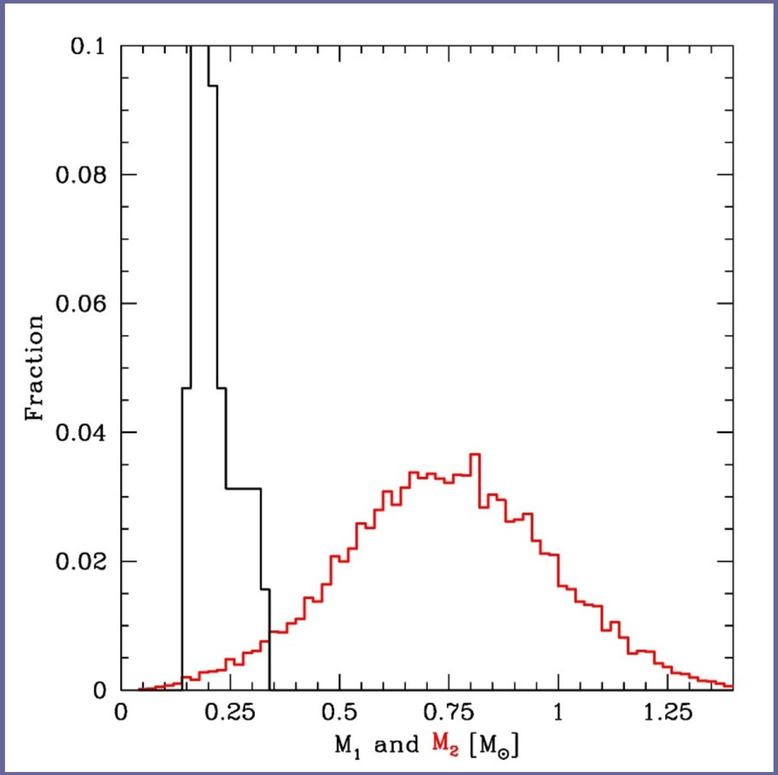
→ lognormal distribution of P

Brown et al 2015

Massive WD companions



Brown et al 2015

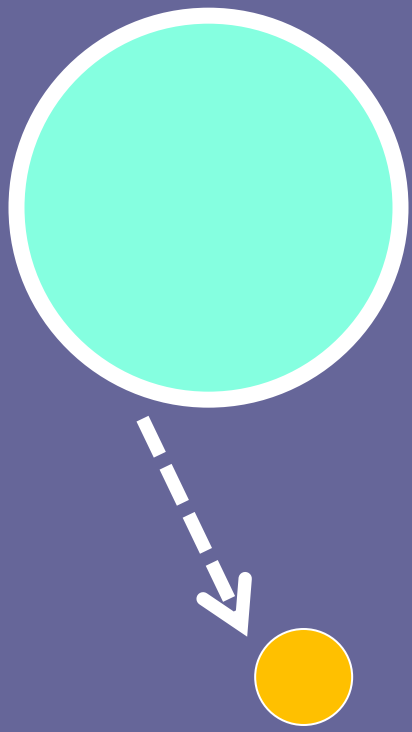


Normal distribution of M_2
(see also Andrews et al 2014)

- mean = 0.74 Msun
- mergers → 1 Msun
- but mass ratio M_1/M_2 extreme

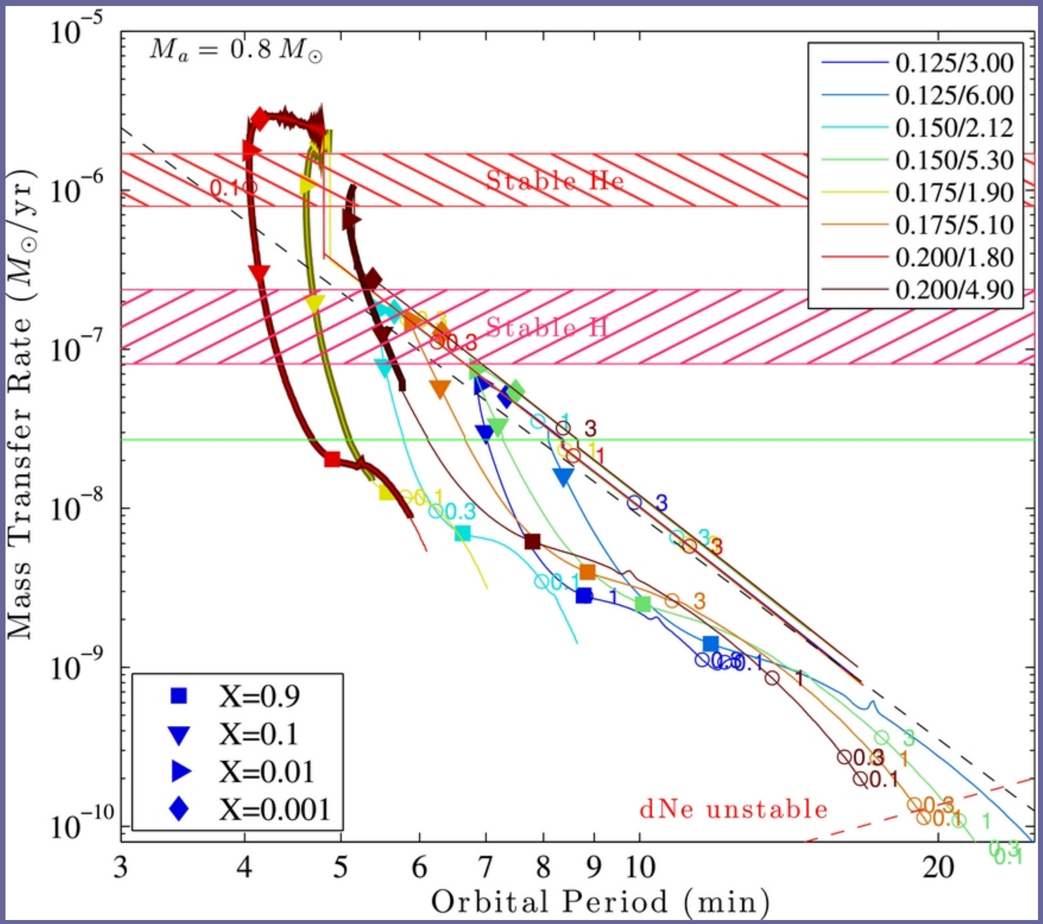
What Happens Next

1. Merge 2. Explode 3. Long-lived stable mass transfer binary



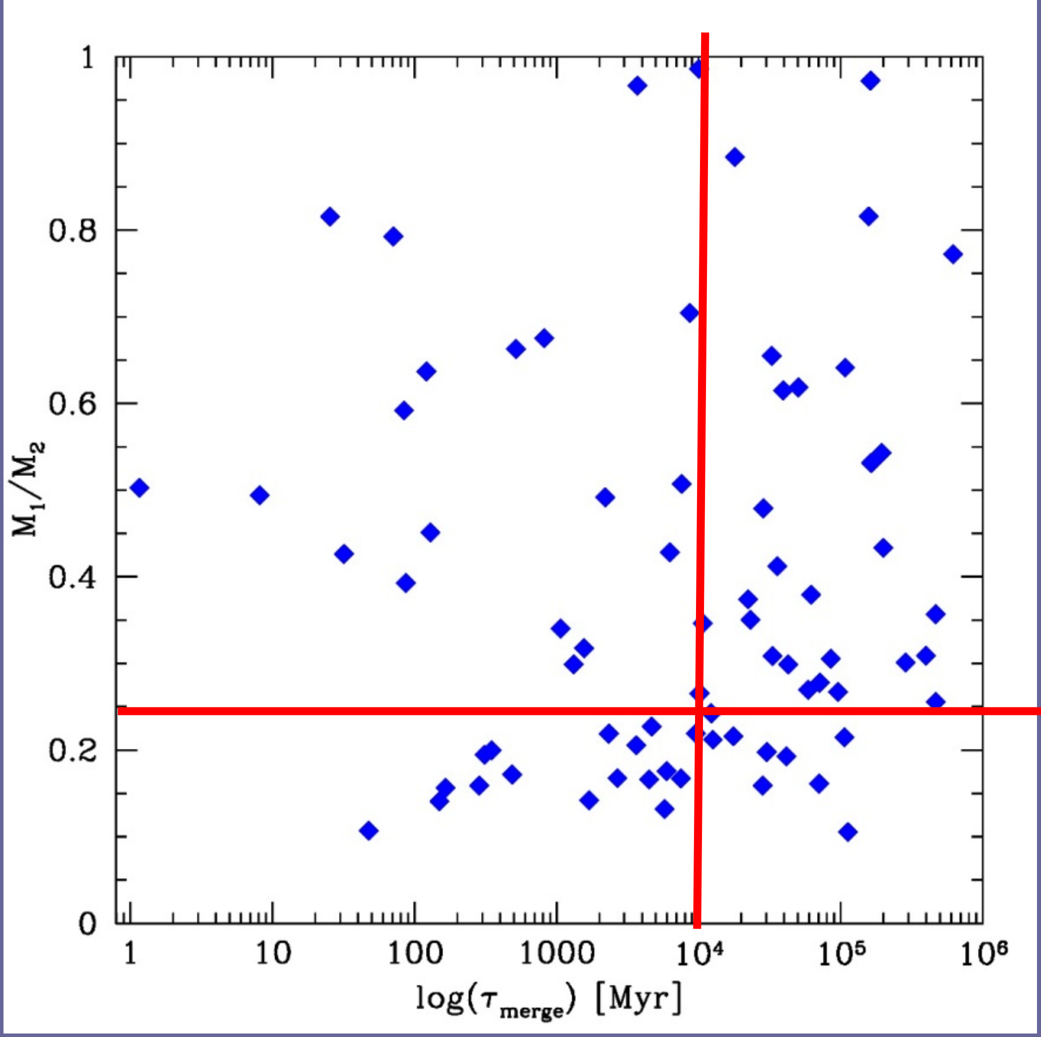
He WD
M ≈ 0.2 Msun
R ≈ 0.04 Rsun
DONOR

C/O WD
M ≈ 0.8 Msun
R ≈ 0.01 Rsun
ACCRETOR



Kaplan et al 2012

Possible Outcomes



Brown et al 2015

~50% have τ < 10 Gyr

q > 0.25 = merge

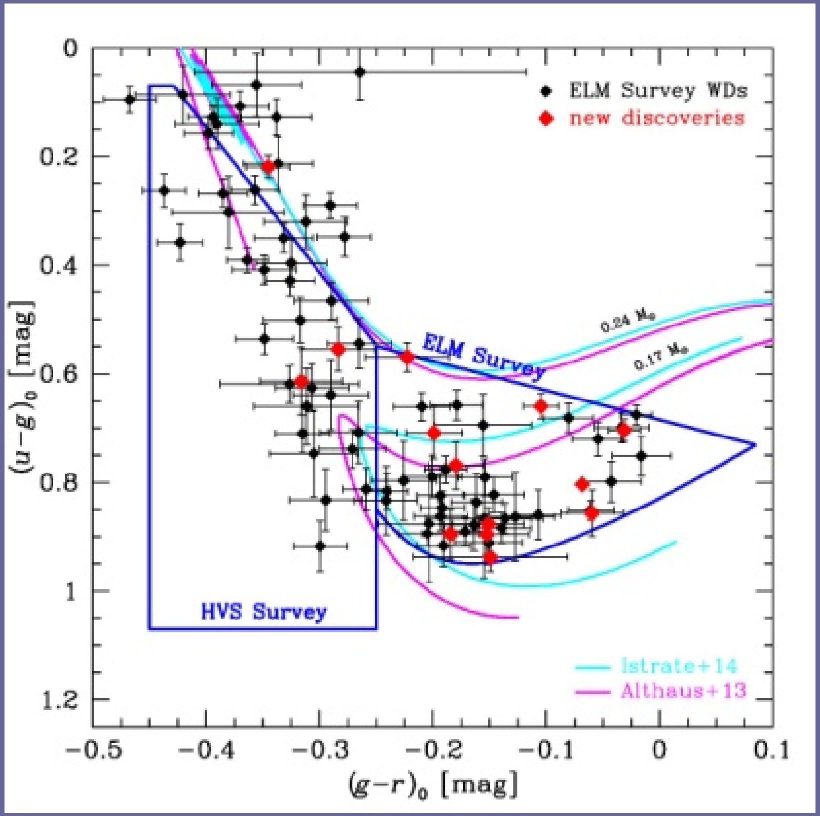
q < 0.25 = stable

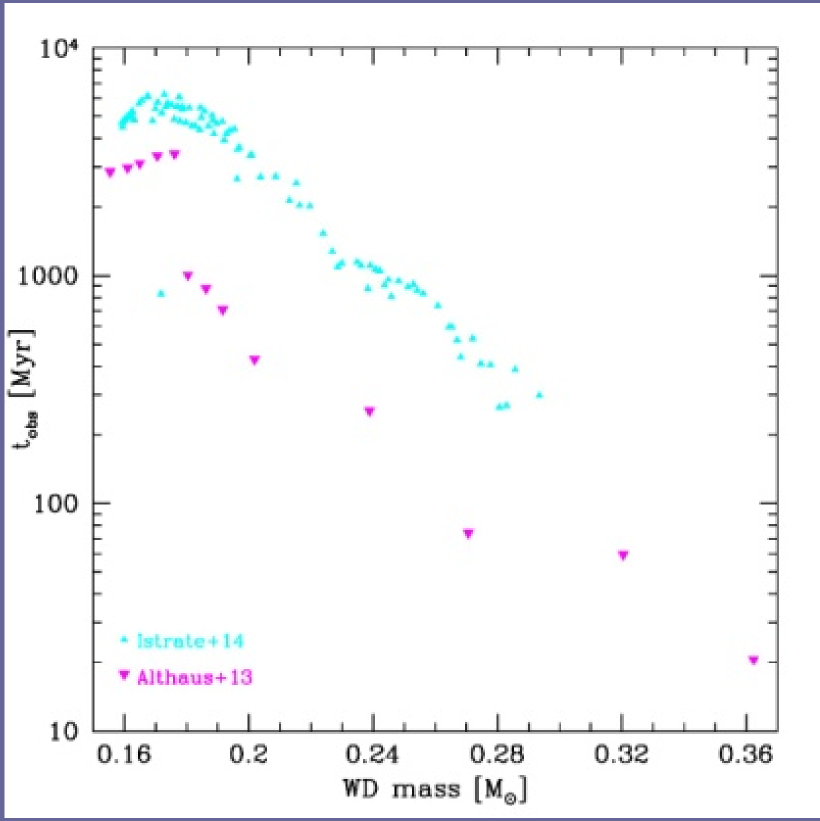
Or,
All merge? (Shen 2015)
All stable? (Kremer et al 2015)
Explode? (Bildsten; Guillichon; Shen; Dan; Waldmann)

Low Mass WD Merger Rate

1. Local space density: $\rho_0 \sim 4 \times 10^{-6}\ \mathrm{pc}^{-3}$

2. Back out rate, correcting for [1/t(obs), 1/t(merge)] ~ **$3 \times 10^{-3}\ \mathrm{yr}^{-1}$**



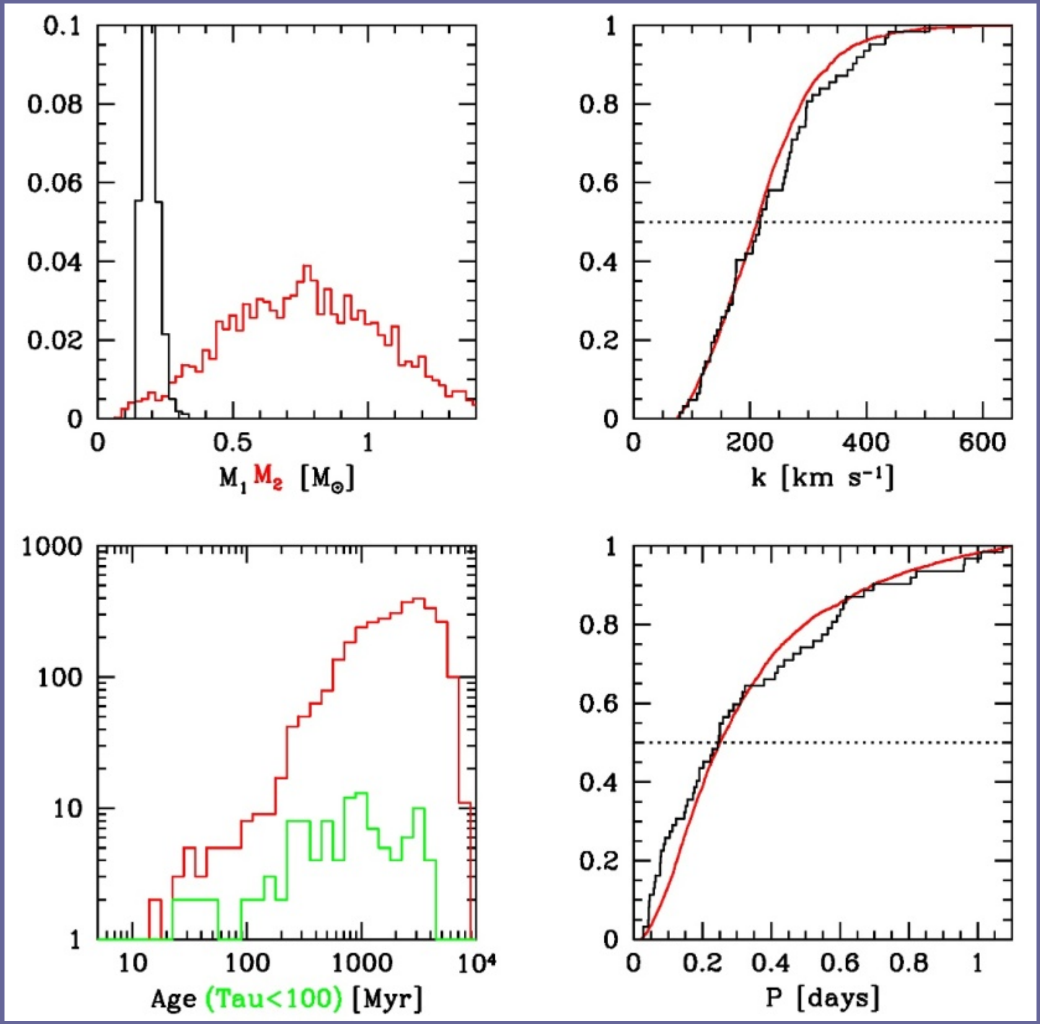


Brown et al 2015

Low Mass WD Merger Rate

or,

3. Forward model rate to match observed distributions ~ **5 x 10^{-3} yr^{-1}**



Brown et al 2015

Rate Comparison

ELM WD binaries ~ **4 x 10^{-3} yr^{-1}** …

R CrB stars ~ **3 x 10^{-3} yr^{-1}** (Zhang et al 2014)

AM CVn systems ~ **1 x 10^{-4} yr^{-1}** (Carter et al 2013)

Underluminous SNe ~ **1 x 10^{-4} yr^{-1}** (Foley et al 2009)

→ ELM WD binaries can explain AM CVn + underluminous SNe, but the majority merge into R CrB stars.