# From common envelope to cataclysmic variable: an overview of white dwarfs in close binaries



Part 1: Detached systems (Dr. Steven Parsons, University of Sheffield) Part 2: Cataclysmic variables (Dr. Anna Pala, ESO)



#### **Common Envelope Evolution**

Original binary has large mass ratio ( $M_1/M_2 \gtrsim 3.2$ )

Original separation less than a few AU

Evolution of the primary effectively terminated at onset of CE

Orbital energy used to expel the envelope, leading to short period binaries

Most common outcome: WD+dM binary

#### **Detached WD+dM binaries**

Large number of known systems (>3000, Rebassa-Mansergas et al. 2016)

Easy to analyse (no contamination from accretion, both stars visible at optical wavelengths, often eclipsing)

Excellent population for testing binary evolution models





Rebassa-Mansergas et al. 2010

### The results of CE evolution

**He-core white dwarfs** 



Rebassa-Mansergas et al. 2011

## The results of CE evolution

An inefficient loss of the envelope

How efficiently orbital energy is converted into kinetic energy of the CE is parametrized as  $\alpha$ 

Low  $\alpha$  > CE inefficiently removed > substantial AM loss > very short periods

See also:

Camacho et al. 2014

Zorotovic et al. 2014



#### SDSS1434+5335 SDSS2318-0935 SDSS0924+0024 SDSS1646+4223 SDSS1519+3536 SDSS1506-0120 SDSS1705+2109 SDSS0246+0041 SDSS1414 - 0133SDSS1718+610 SDSS1558+2642 \$2339-0020 SDSS1524+5040 SDSS1429+5750 SDSS2120-0058 SDSS2114-0103 SDSS1143+0009 SDSS1047+0523 SDSS1731+6233 DSS1212-0123 DSS0110+1326 DSS2132+0031 SDSS1724+5620 DSS2240-0935 DSS0238-0005 DSS1348 + 1834DSS2216+0102 DSS0303-0054 DSS1548+4057 DSS1411+1028 SDSS1529+0020 SDSS2123+0024 SDSS0052-0053 SDSS1648+2811 SDSS1435+3733 IK Peg Feige 24 IN CMa RE J1016-0520 RE J2013+4002 EG UMa UZ Sex UX CVn HZ 9 RXJ2130.6+4710 DE CVn EC 13349-3237 EC 14329-1625 EC 12477-1738 GK Vir BPM 6502 RR Cae CSS 080502 CC Cet LM Com MS Peg LTT 560 NN Ser GD 448 Toonen & Nelemans, 2013 WD0137-3457 0 0.2 0.4 0.6 0.8 $\alpha$

α~0.2-0.3

Zorotovic et al. 2010

#### The evolution of WD+dM binaries



Schreiber et al. 2010

#### The evolution of WD+dM binaries

#### Evidence of detached CVs crossing the period gap



Zorotovic et al. 2016





Age-metallicity relation – Rebassa-Mansergas et al. 2016

Active 0.9

Fraction 0.7

0.8

0.6

0.5

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 $\langle [Fe/H] \rangle \pm \sigma (dex)$ 

#### **Extending to higher masses**



Adapted from Hernandez et al. 2021



Parsons et al. 2016

#### **Detached WD+MS binaries are great laboratories**

WD+dM catalogues:

**Ren** et al. 2018, MNRAS, 477, 4641 - White dwarf-main sequence binaries from LAMOST: the DR5 catalogue **Rebassa-Mansergas** et al. 2016, MNRAS, 458, 3808 - The SDSS spectroscopic catalogue of white dwarf-main-sequence binaries: new identifications from DR 9-12

WD+AFGK catalogues:

**Ren** et al. 2020, ApJ, 905, 38 - The White Dwarf Binary Pathways Survey. V. The Gaia White Dwarf Plus AFGK Binary Sample and the Identification of 23 Close Binaries

**Rebassa-Mansergas** et al. 2017, MNRAS, 472, 4193 - The white dwarf binary pathways survey - II. Radial velocities of 1453 FGK stars with white dwarf companions from LAMOST DR 4

**Parsons** et al. 2016, MNRAS, 463, 2125 - The white dwarf binary pathways survey - I. A sample of FGK stars with white dwarf companions