LISA astronomy of interacting white dwarf binaries

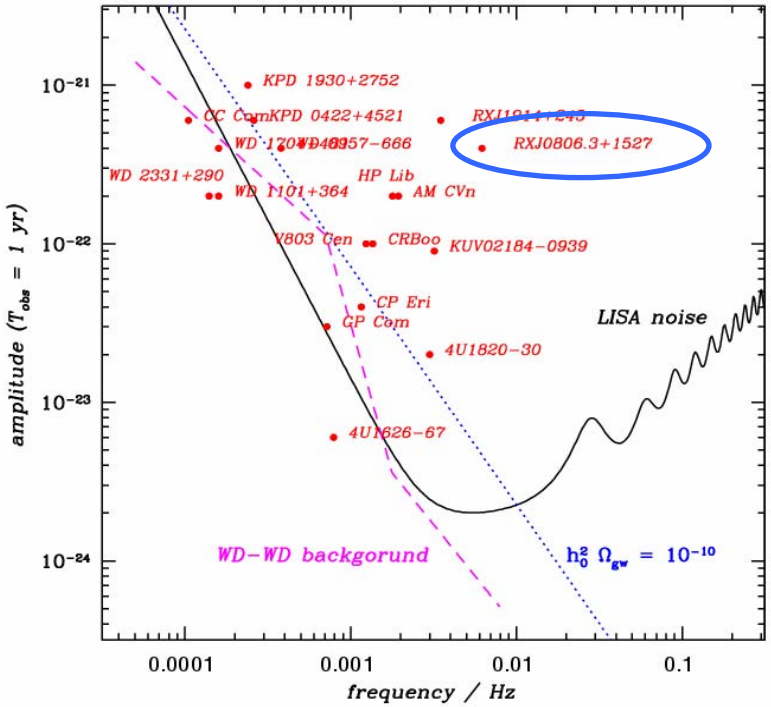
A. Stroeer, A. Vecchio,
E. Wickham & G. Nelemans

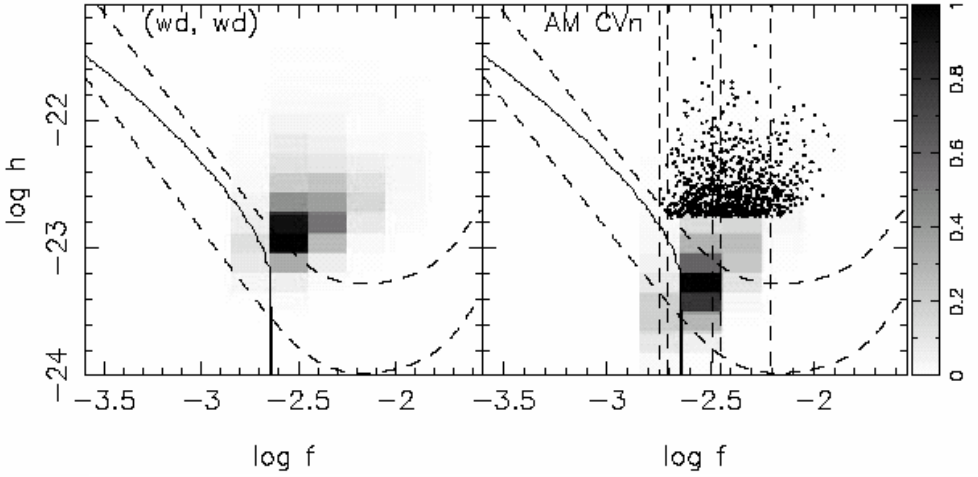
8th Capra Meeting
14th July, 2005

UNIVERSITY OF BIRMINGHAM

Interacting white dwarfs

Verification binaries





Type	Birth rate (year^{-1})	Resolved systems	With frequency change
(wd, wd)	2.9×10^{-2}	12 163	560
AM CVn	1.8×10^{-3}	10 117	49
(ns, wd)	1.4×10^{-4}	21	3
(ns, ns)	3.2×10^{-5}	1	0
(bh, wd)	3.8×10^{-5}	1	0
(bh, ns)	1.0×10^{-5}	0	0
Total		22 303	614

(Nelemans et al, 2001; Nelemans, 2003)

UNIVERSITY OF BIRMINGHAM

Motivations

- Guaranteed (and abundant) sources: minimum LISA science requirement
- Crucial test-bed for LISA data analysis and science exploitation
- “Simple” signal to search for:
  - Sufficiently sparse in parameter space, although overlapping in time-domain and (partially) in frequency domain
  - “Small” parameter space: source geometry (4 parameters) + spindowns
- New science challenge – this is not a “clean source”: radiation reaction + tidal effects, mass transfer….
- Need (and test-bed) for multi-band astronomy (GAIA, optical/X-ray,…)

UNIVERSITY OF BIRMINGHAM

Complex science exploitation

- If "clan" evolution and frequency drift observable:
  - From GW amplitude A_{gw} and df/dt derive distance (D) and chirp mass (Mc): standard candles, population studies,…
- In real life, one needs to test whether evolution is clean or not:
  - If df/dt and d^2f/dt^2 both observable then compute braking index n (=11/3 for pure radiation reaction)
  - If only df/dt observable, then if position good enough and GAIA provides D, then from D and A_{gw} obtain chirp mass and do consistency check between df/dt observed by LISA and predicted by GR
  - If source observable in optical/X-ray additional information on mass ratio
  - If source not observable in other bands, then only limits on mass and distance

UNIVERSITY OF BIRMINGHAM

The work plan

- Study how well one is expected to be able in theory to extract information (LISA + other telescopes)
  - Only leading order term in expected errors
  - One source at the time
  - Gaussian and stationary noise, no gaps,…
- Implement a data analysis scheme that is suitable for the problem at hand:
  - F-statistic search (sufficiently straightforward to tailor the existing "pipelines" developed for LSC pulsar searches)
  - Information extraction pipelines: MCMC,…
- Carry out "LISA Mock Data Challenges": characterise, tune, change…