Component Masses and Space Densities of AM Canum Venaticorum Stars

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Overview

- Introduction
- Nature of the donor stars
- Gravitational waves
- Space Density
- Conclusion

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  - Implications for SN Ia?
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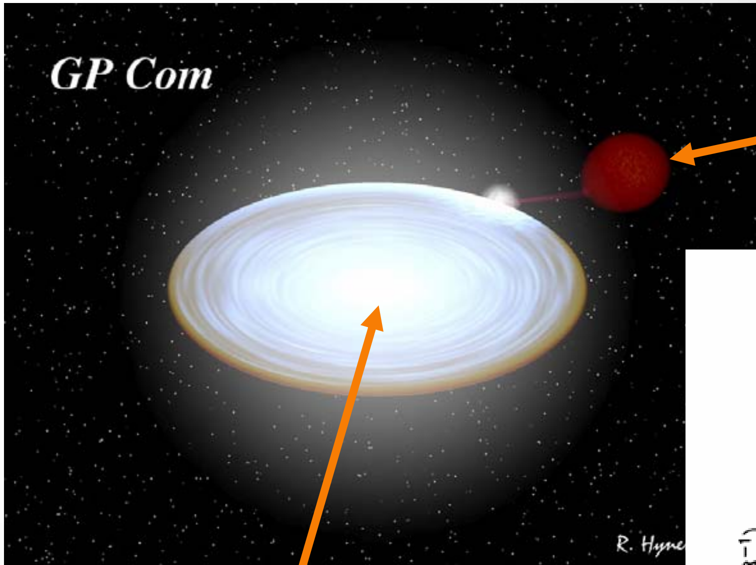
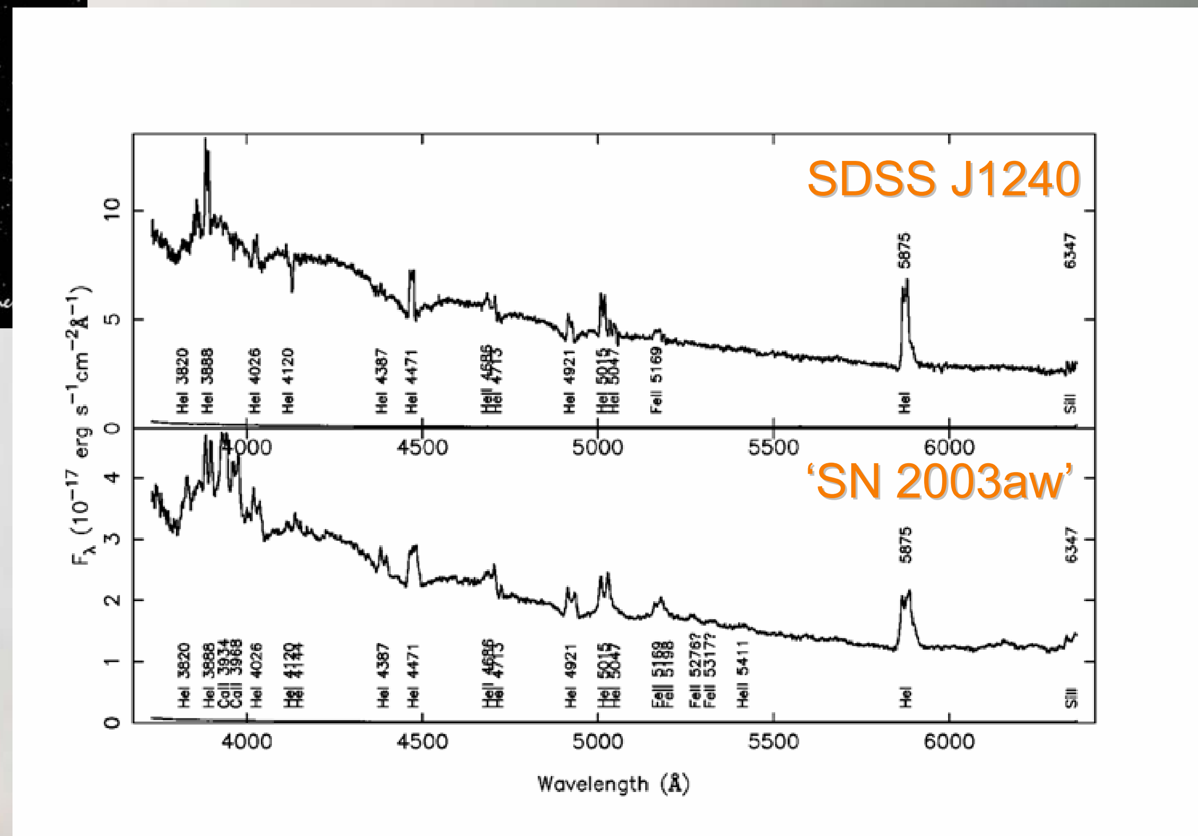
AM CVns: What are they…



Cool, WD-like donor

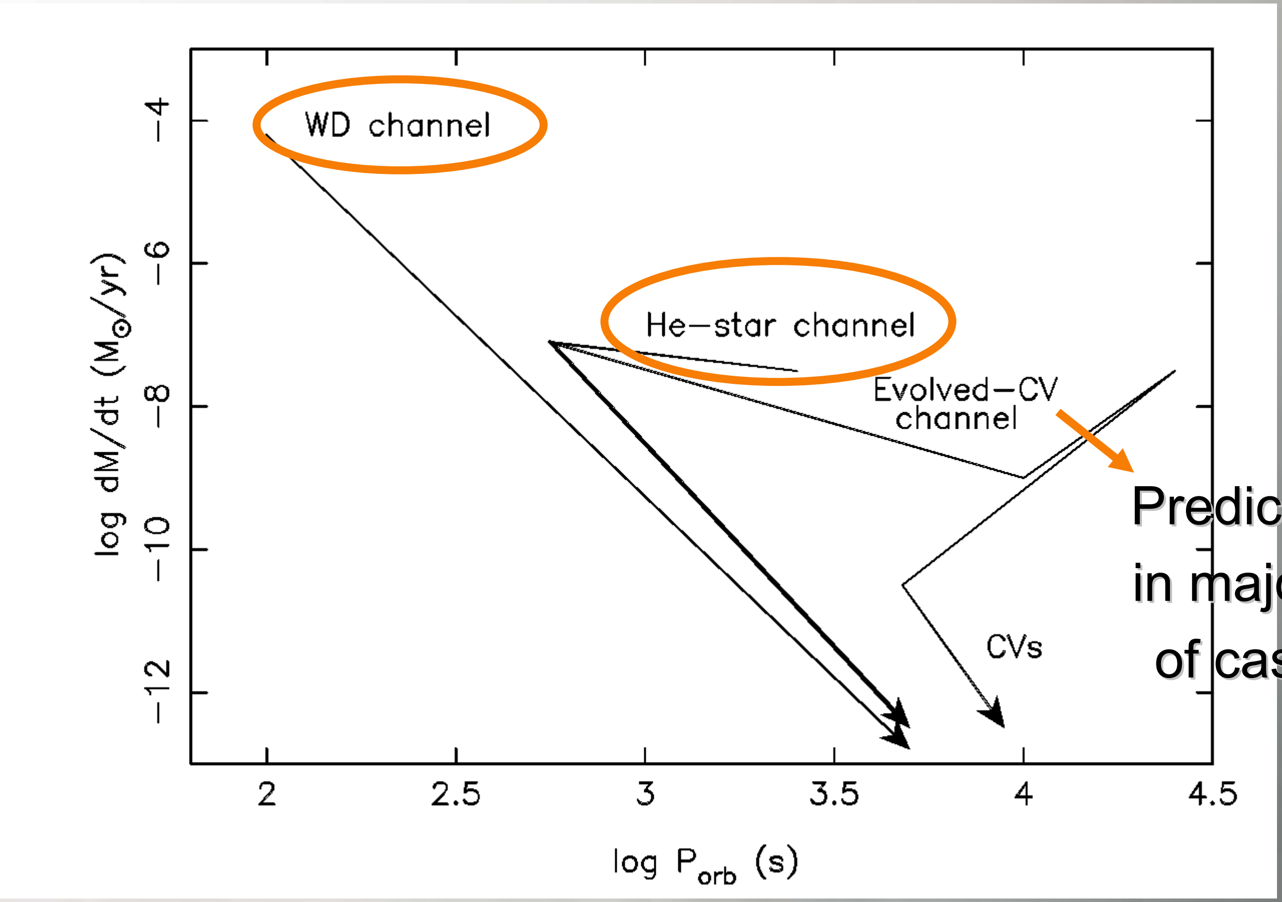
Hot WD accretor



Questions

- Knowns
  - They are ultracompact binaries (P<1h);
  - They are WDs accreting almost pure He;
- Unknowns
  - How are they produced;
  - In what numbers;
  - (Are they possible SN Ia progenitors?)

Proposed formation channels



Predicts H in majority of cases

How to tell

Entropy of the donor star strongly dependent on formation channel

↓

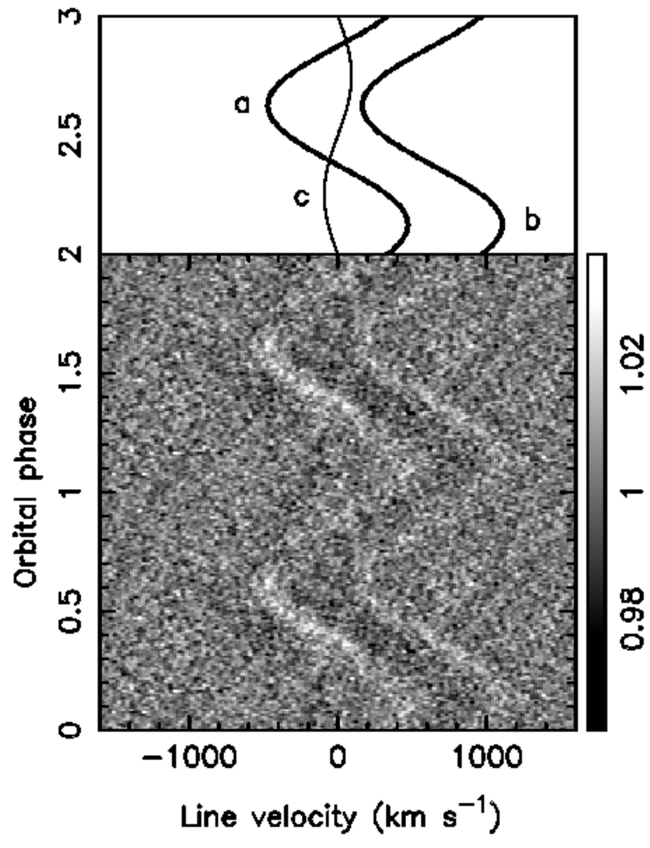
Hotter donor larger for given mass

↓

Hotter donor more massive for given P_{orb}

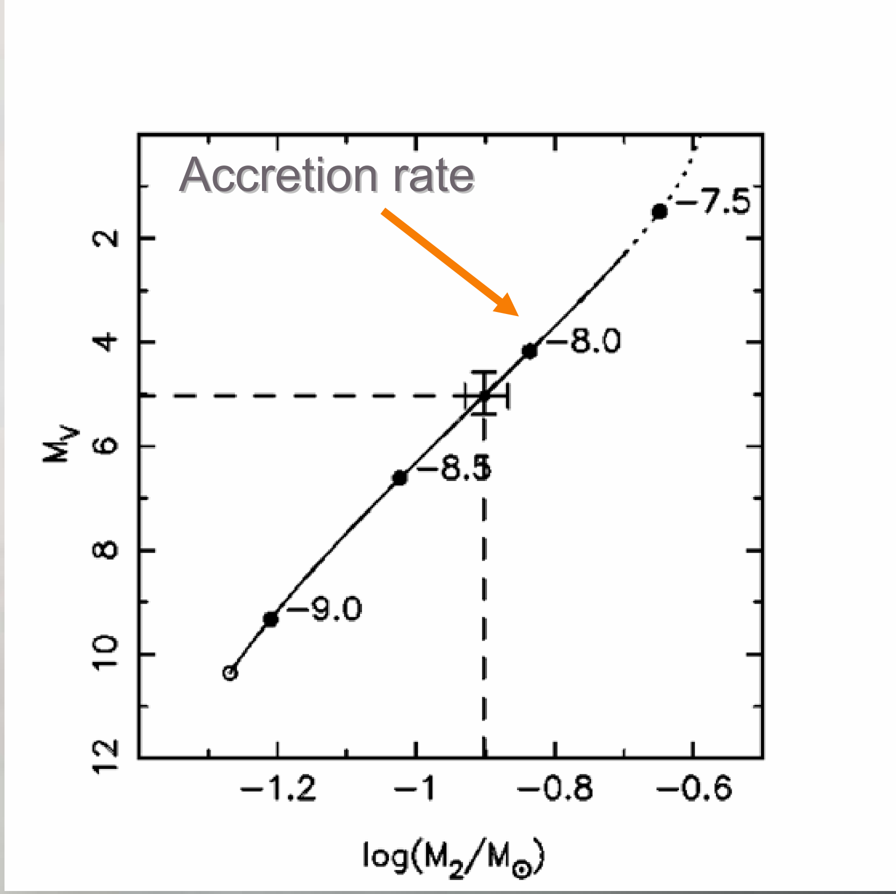
Donor mass indicators: I. kinematics

- Detection of emission feature from accreting star suggests that donor star is heavy
- $q=M_2/M_1=0.18$
- Degenerate donor would indicate $M_1=0.2\ M_{Sun}$



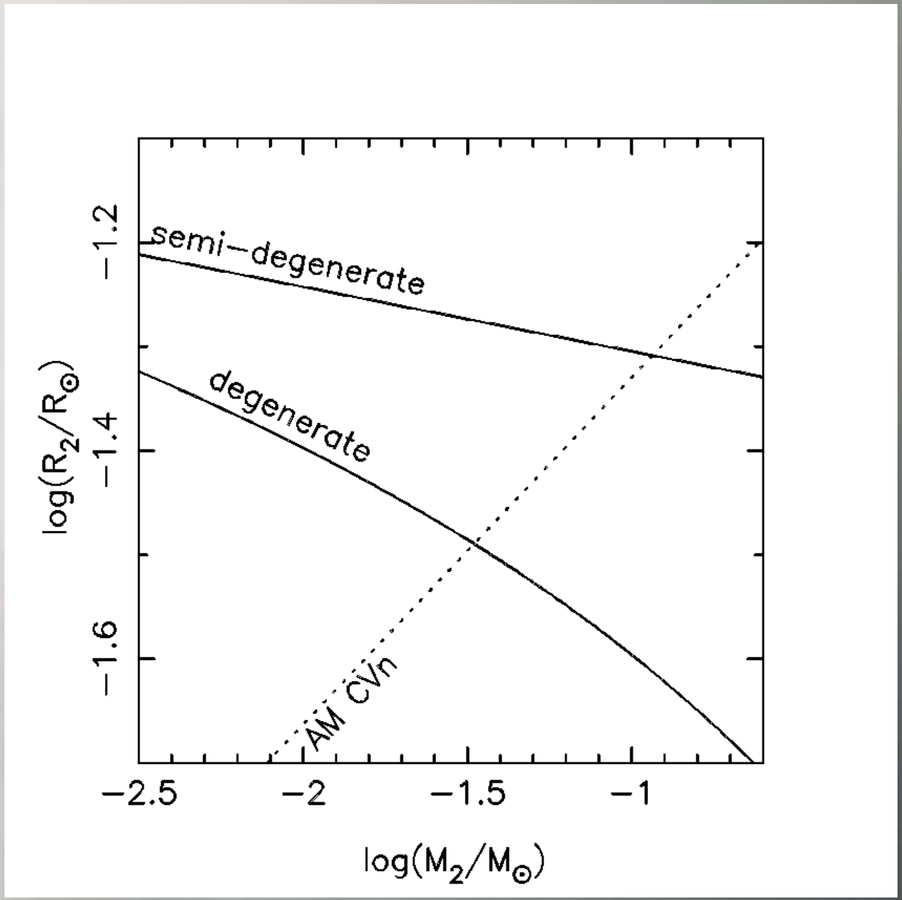
Donor mass indicators: II. luminosity

- HST parallax gives $M_V = 4.9$
- Assumption that GWR sets accretion rate implies that donor must be massive in order to explain (bolometric) luminosity



In terms of masses and radii…

- Roche-lobe filling condition gives constraint on M, R
- Combined with theoretical M–R relation, M and R are fixed
- Conversely, can discriminate between M–R relations if we measure M or R



Nelemans et al. 2001 parametrization

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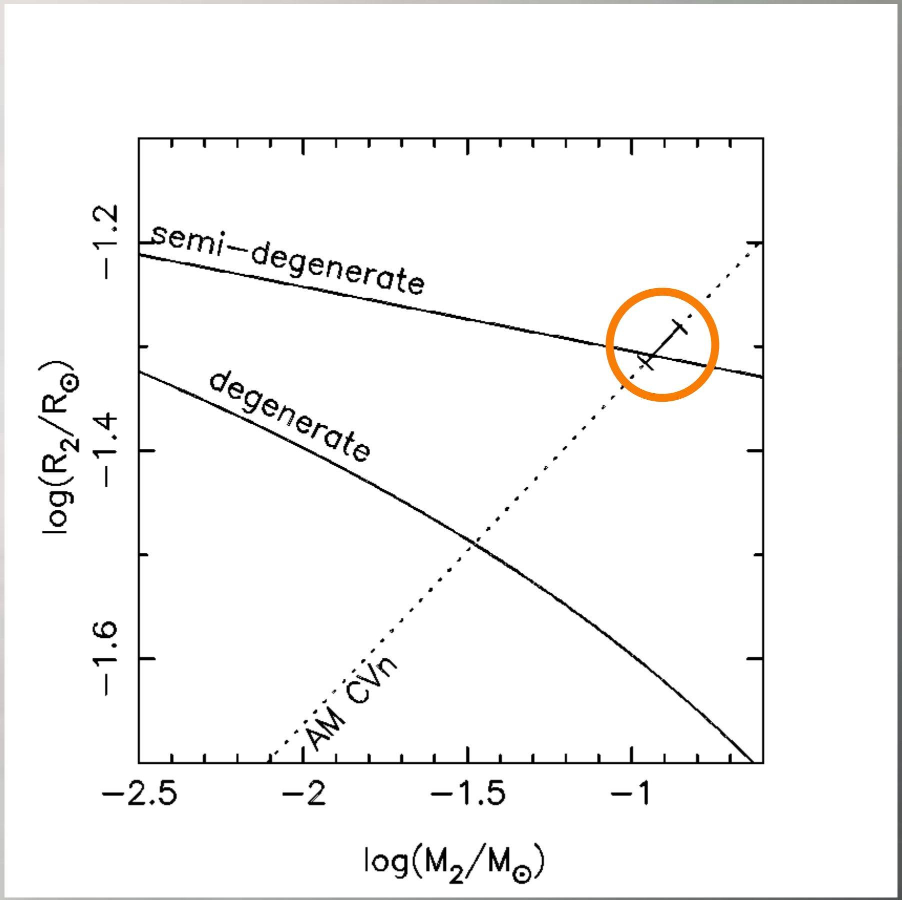
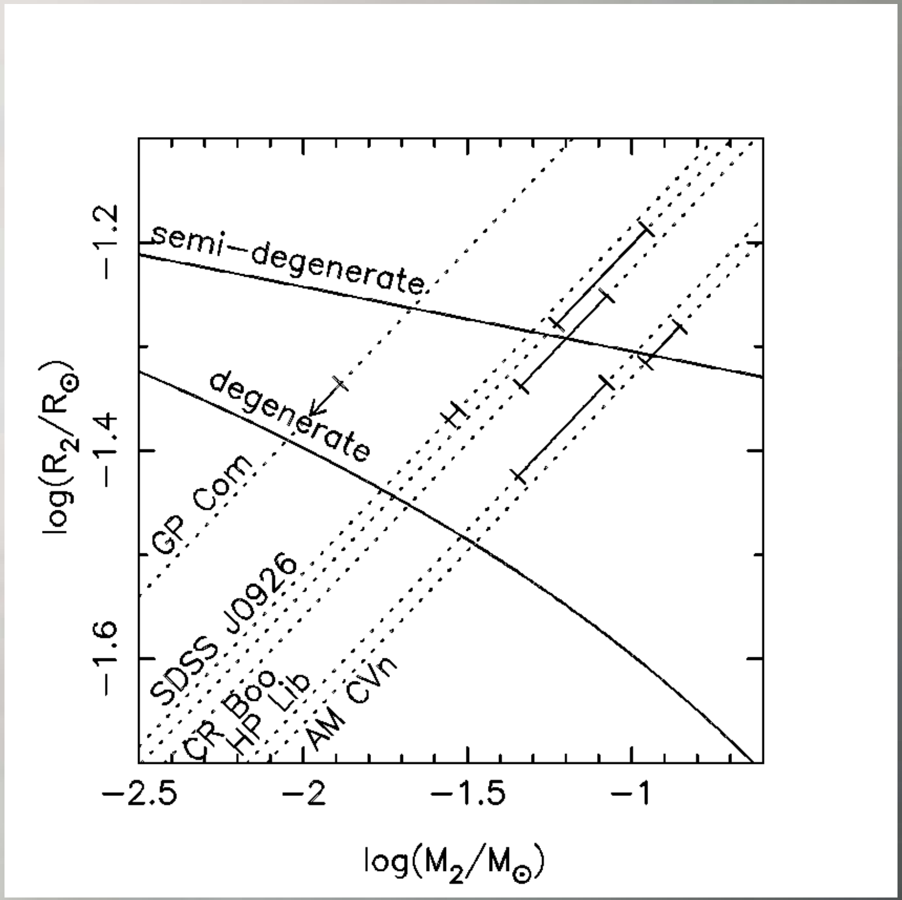


Roelofs et al. 2006

And even more systems…

- Donors appear to be quite hot in general, at least at short P_{orb}
- Suggestive of He-star channel
- But possible selection effects whereby only warm donors from WD channel survive



Roelofs et al. 2007; Marsh et al. 2007

Implications

- He-star channel implies that significant fraction of systems should show He-burning products
  - So far not observed; but need UV spectra (STIS!)
- Implications of accretion of C/O rich material for SN .Ia (Yungelson et al. in prep.)
- Compare with improved evolutionary models (Deloye et al. 2007) to see what it means for WD channel

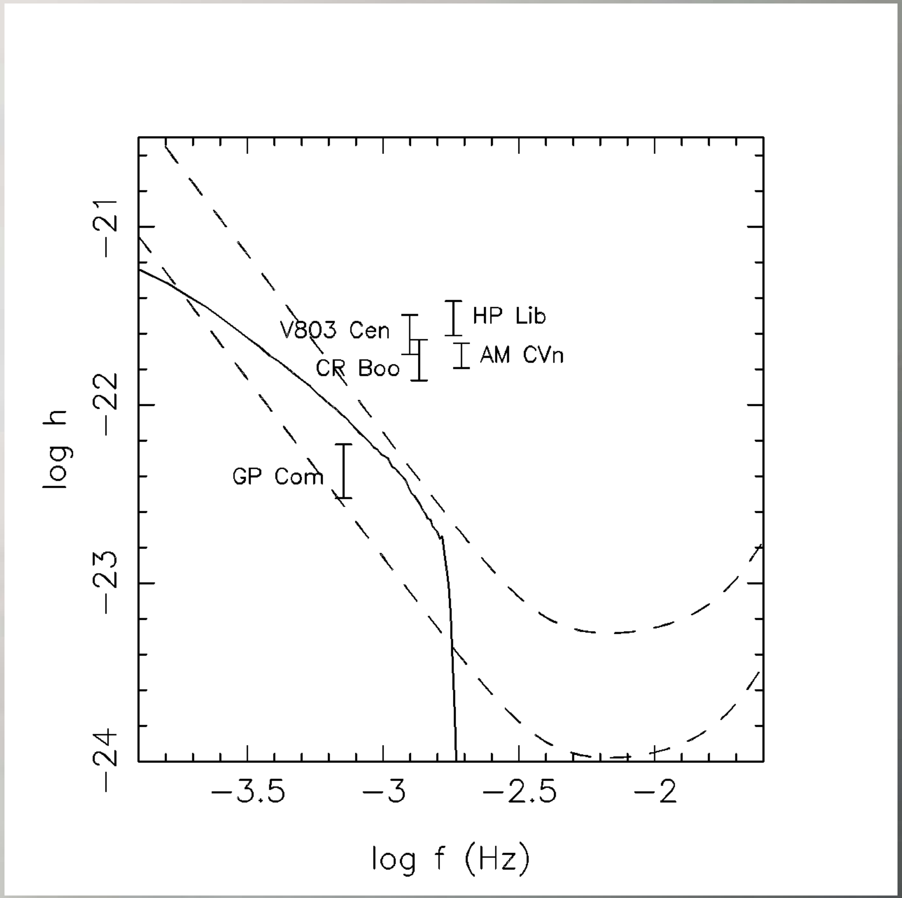
The accretor masses

	AM CVn	HP Lib	CR Boo	V803Cen	GP Com
M_1/M_{Sun}	0.68±0.06	0.45–0.72	0.60–0.98	0.64–1.04	<0.62±0.0 5

- The once-fashionable edge-lit detonation scenario: even if it works, the masses (densities) will be too low to resemble a 'real' SN Ia

No SN Ia, but gravitational waves from AM CVns

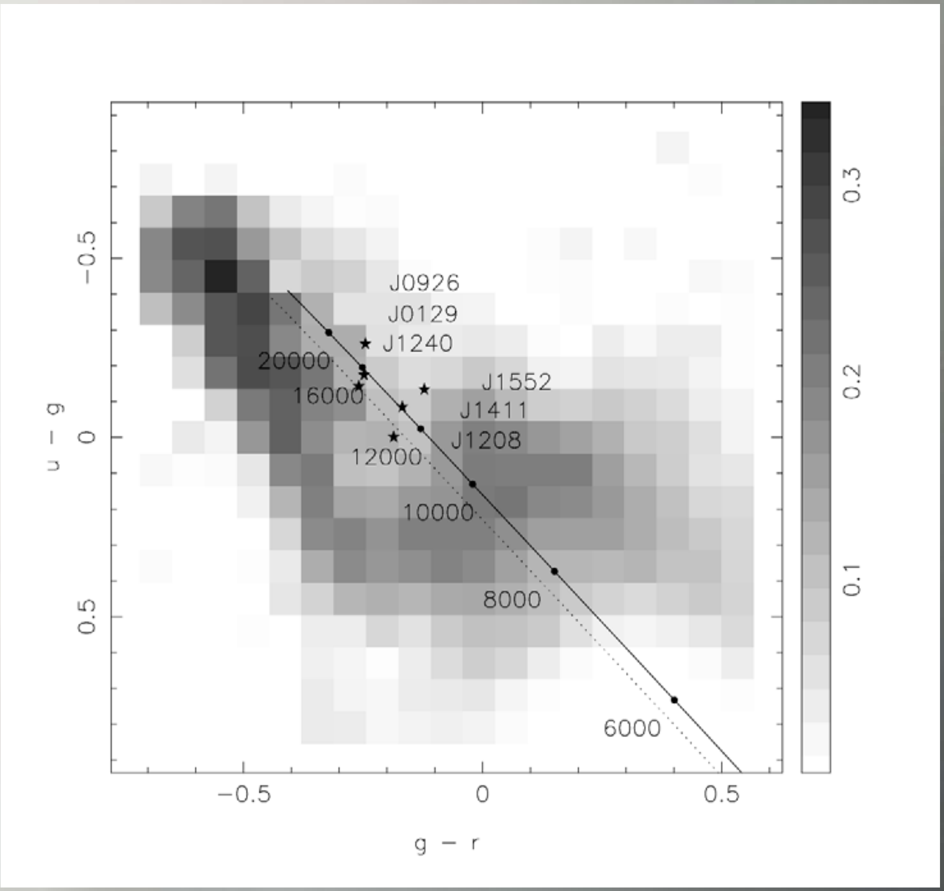
- Stronger sources due to heavier donors
- Only known sources observable with current or planned GW detectors
- LISA great tool (also) for galactic astronomy!



Roelofs et al. 2006

But until LISA flies…

- SDSS provides first sample that allows population study
- N = 6
- "Know the sample"
- $\rho_0 = 2 \times 10^{-6}\ \mathrm{pc}^{-3}$



Roelofs et al. 2007

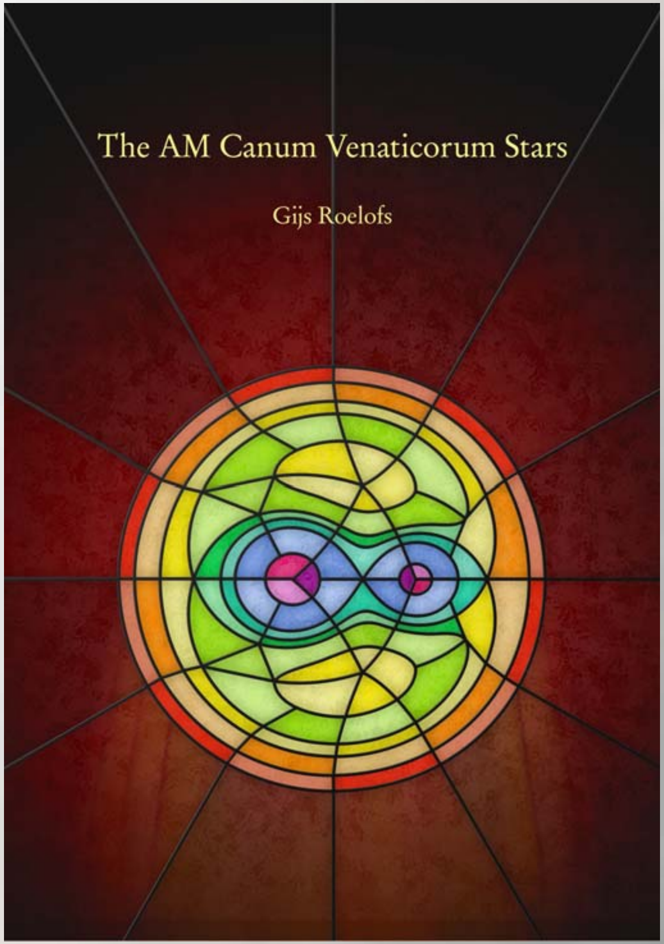
Space density of AM CVn stars

- Rarer than expected based on population synthesis models (e.g. Nelemans et al. 2001)
- WD channel cannot be as prolific as predicted in optimistic scenarios
- Suggests that either:
  - Common-envelope outcome different
  - Mass transfer between WDs not often stabilized due to spin-orbit coupling
- Initial SN .Ia rate estimate (Bildsten et al. 2007) probably needs to be lowered by factor 3-10

In a nutshell

- Donors in AM CVn heavier than expected
- AM CVns itself rarer than expected
- Implications for binary evolution (work in progress)
- Only *known* detectable GW sources; great class of objects for GW astronomy
- Unlikely SN Ia progenitors based on inferred system masses, and rarer SN .Ia than initially estimated

Still some free copies of my thesis available!

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