Highly-magnetized white dwarfs:

Formation mechanisms and implications for PNe.

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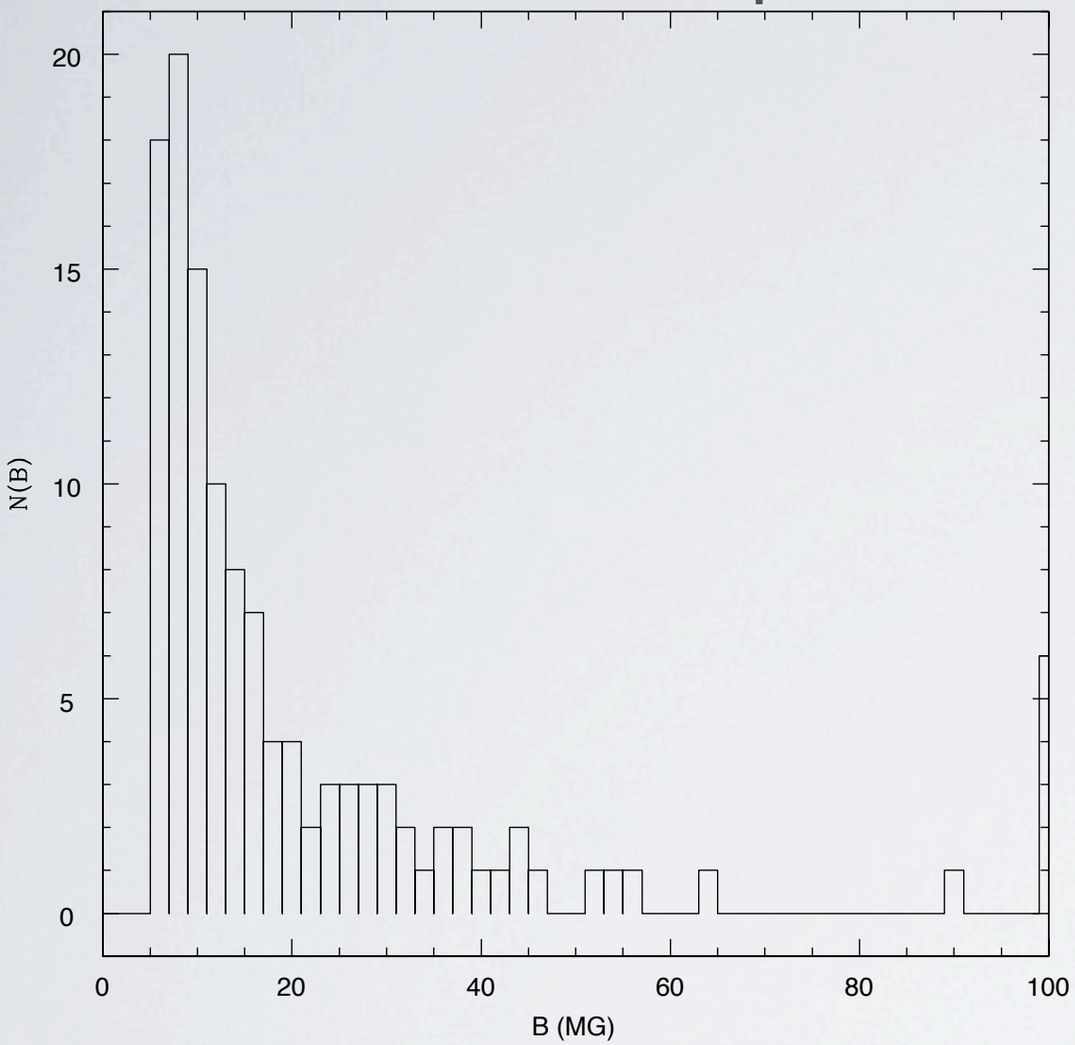
If the formation of HFMWDs is **independent of binary evolution**...

... then the **fraction** of HFMWDs in **single stars should be the same as in binary systems**.

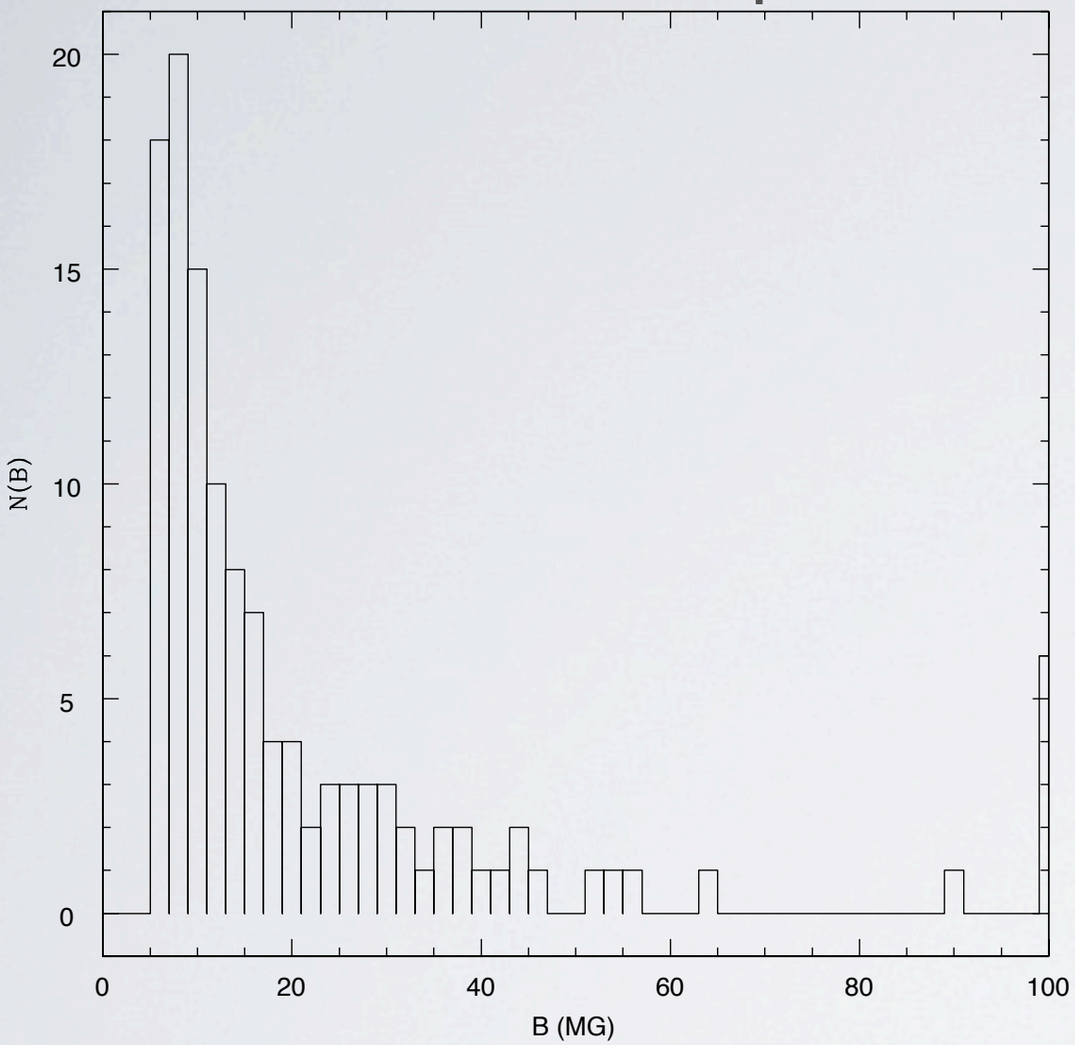


- SDSS identified ~1,200 detached WD + M dwarf binaries

None are HMWDs

Kepler et al. 2013

(see also Tout 08)



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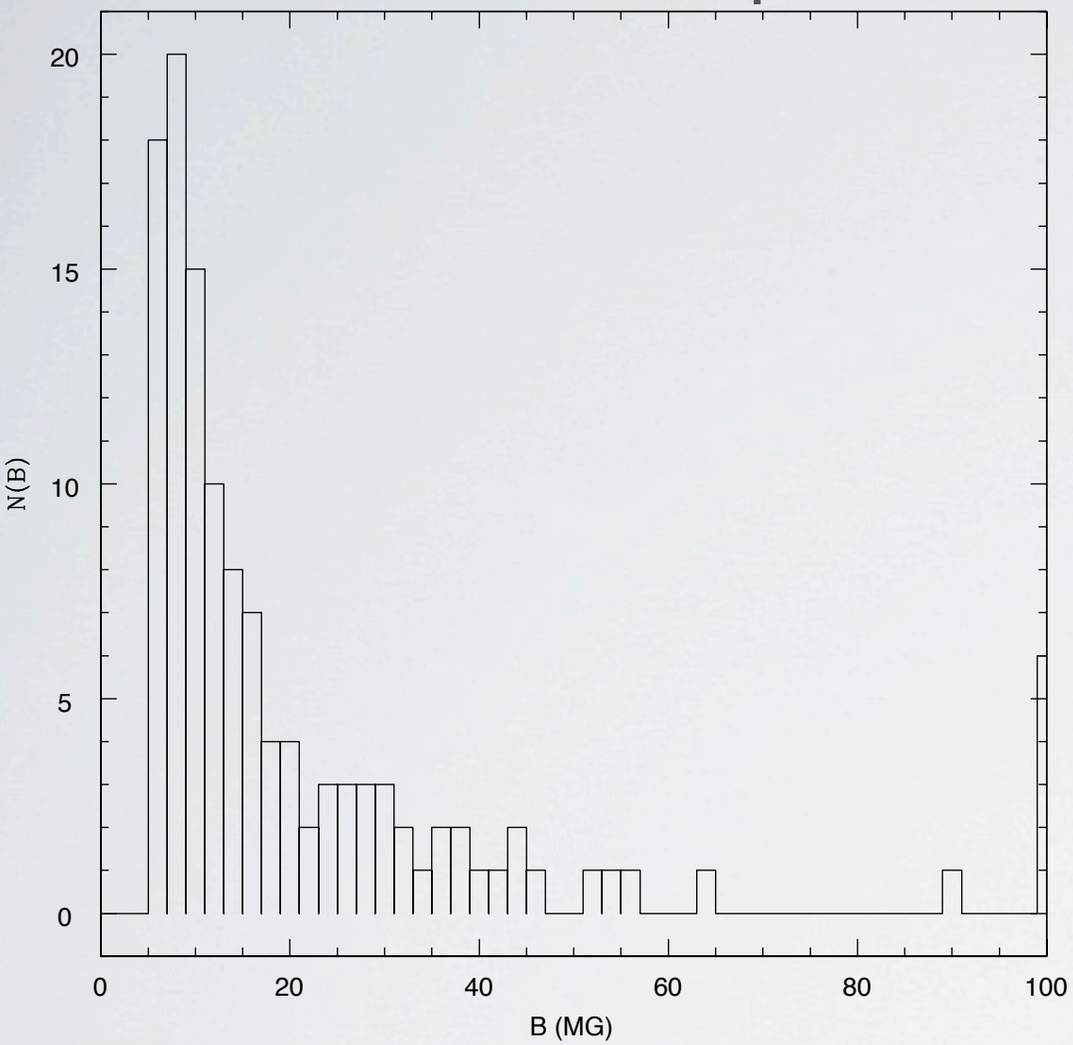
Should we have found HFMWDs in binaries?



Kepler et al. 2013

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Should we have found HFMWDs in binaries?

- Within 20 pc, 109 WDs:
  20% have a main-sequence companion

Probability of obtaining samples this different from the same underlying population is: 5.7×10^{-10} or 6.2σ

Nordhaus et al. 2011

- HFMWD: **no detached companion** present.

- non-magnetic WDs: **detached companion** present.

Two options:

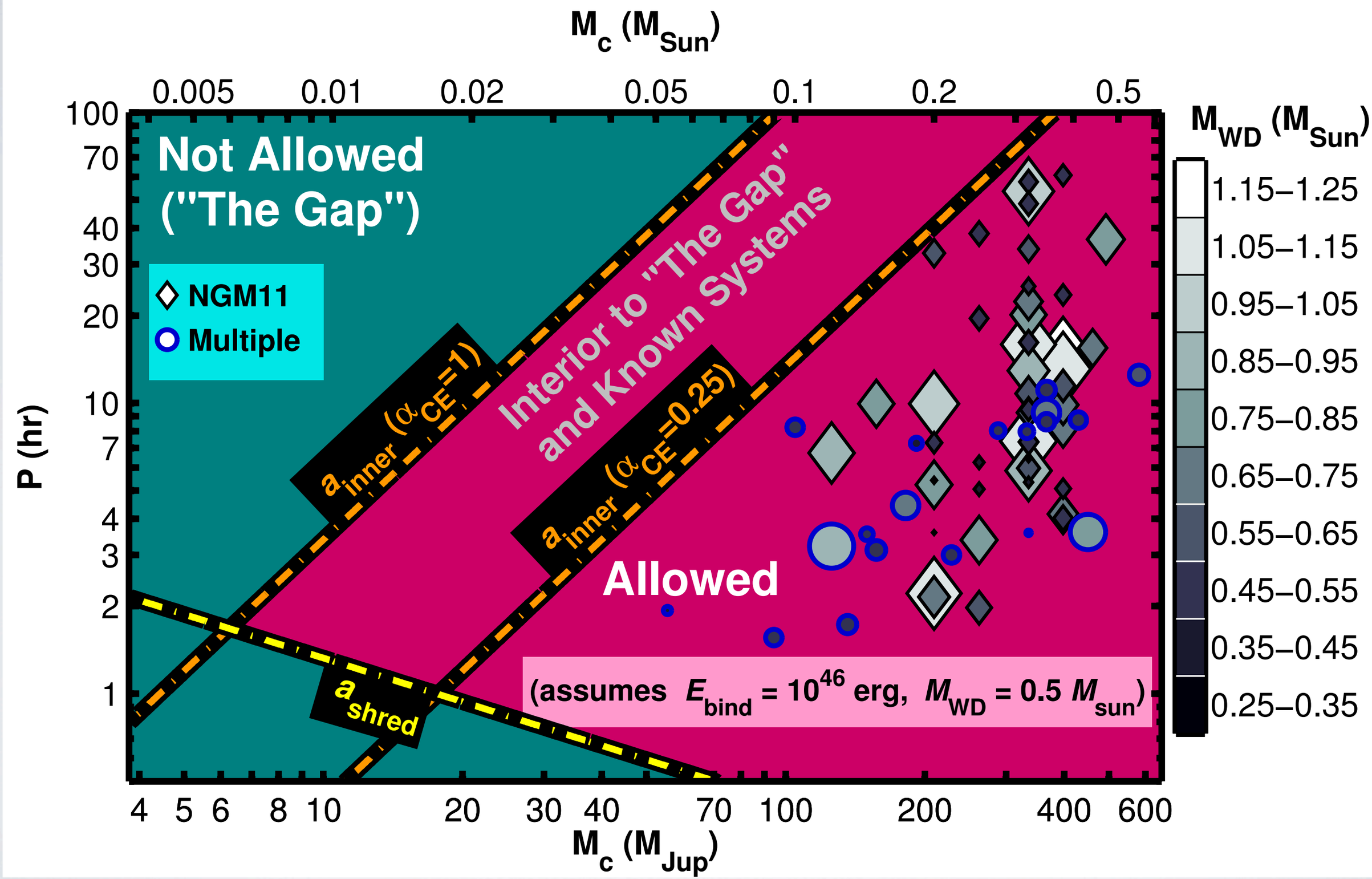
1. Presence of detached, long-period companions prevents formation of HFMWD.

2. Orbiting companions were present but were destroyed during formation of HFMWD.

Formation of high-field magnetic white dwarfs from common envelopes

Nordhaus et al. 2011 PNAS 108, 8

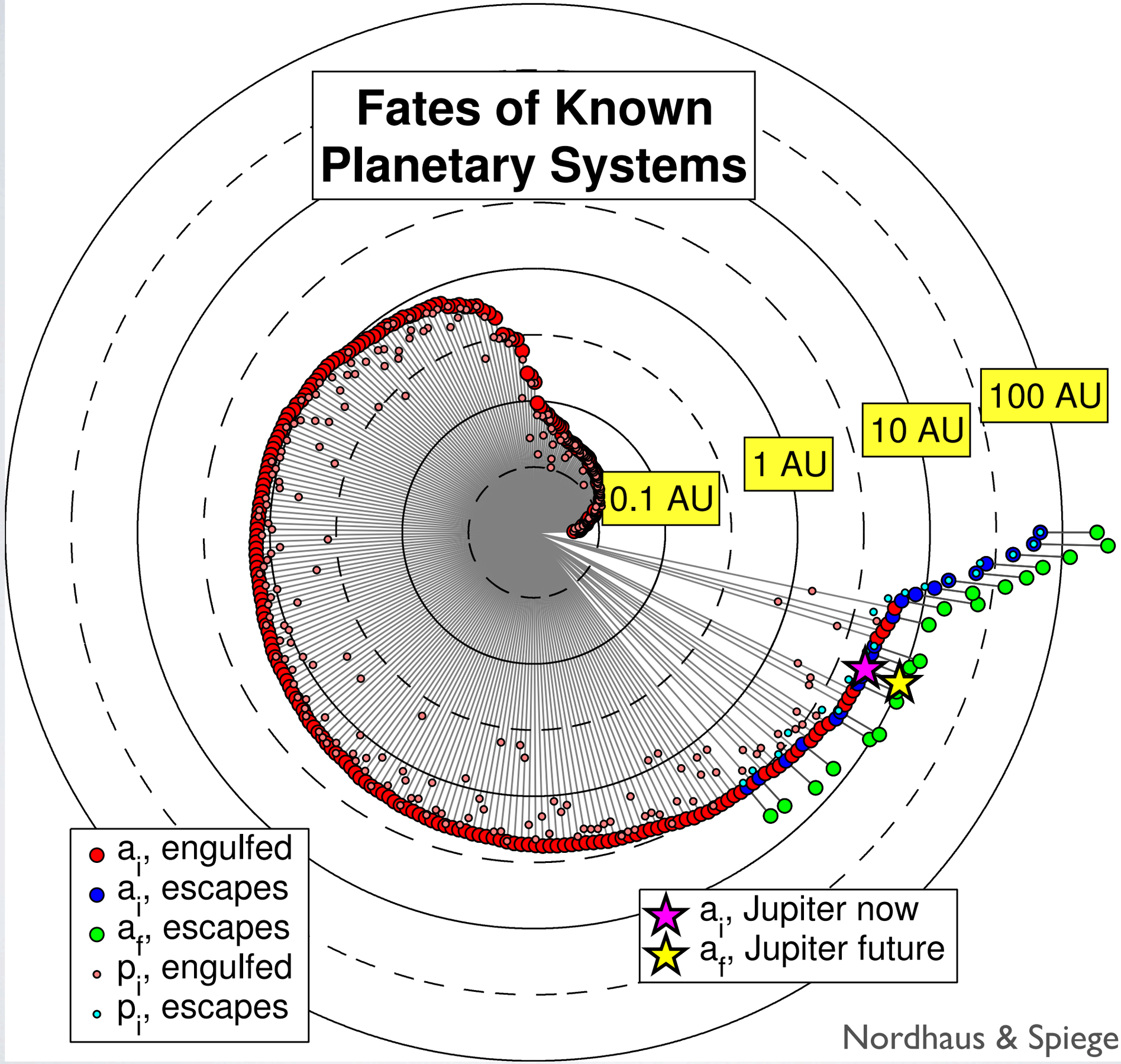
Collaborators: Sarah Wellons (Harvard)
Dave Spiegel (IAS)
Brian Metzger (Columbia)
Eric Blackman (Rochester)



Nordhaus & Spiegel MNRAS 2013 432, 500

Nordhaus et al. 2010 MNRAS 408, 631

Fates of Known Planetary Systems



Nordhaus & Spiegel 2013

Magnetized WD

Outflow

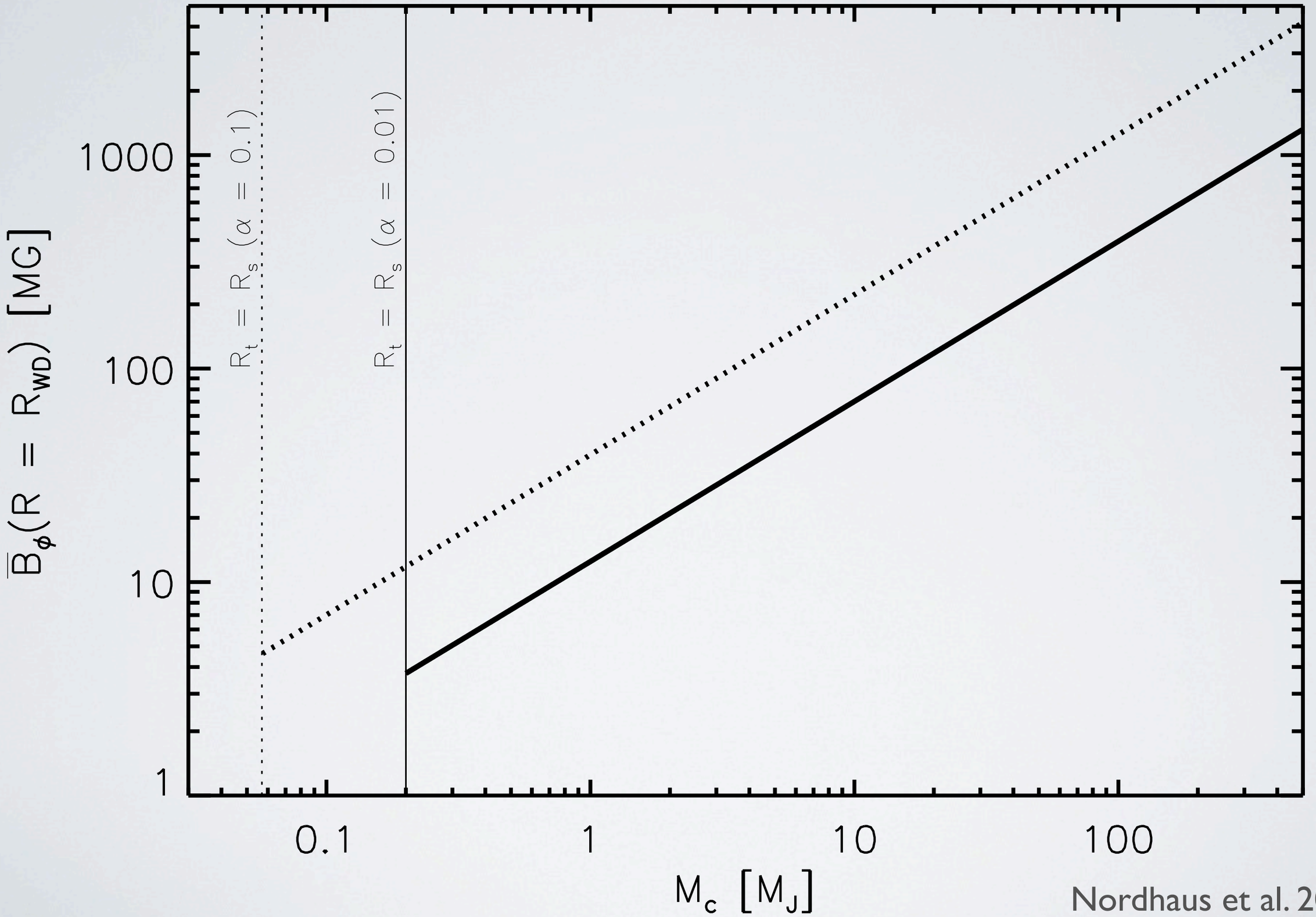
Inflow

Boundary Layer

WD

For shaping PNe see
Reyes-Ruiz & Lopez
2001

Nordhaus et al. 2011 PNAS 108,8
Nordhaus & Blackman 2006 MNRAS 370, 2004
Nordhaus, Blackman & Frank 2007 MNRAS 376, 599



Nordhaus et al. 2011

Important Points:

- B-field amplification at convective-radiative boundary with downward diffusion not sufficient.

- Companion disrupts; hypercritical accretion initially.

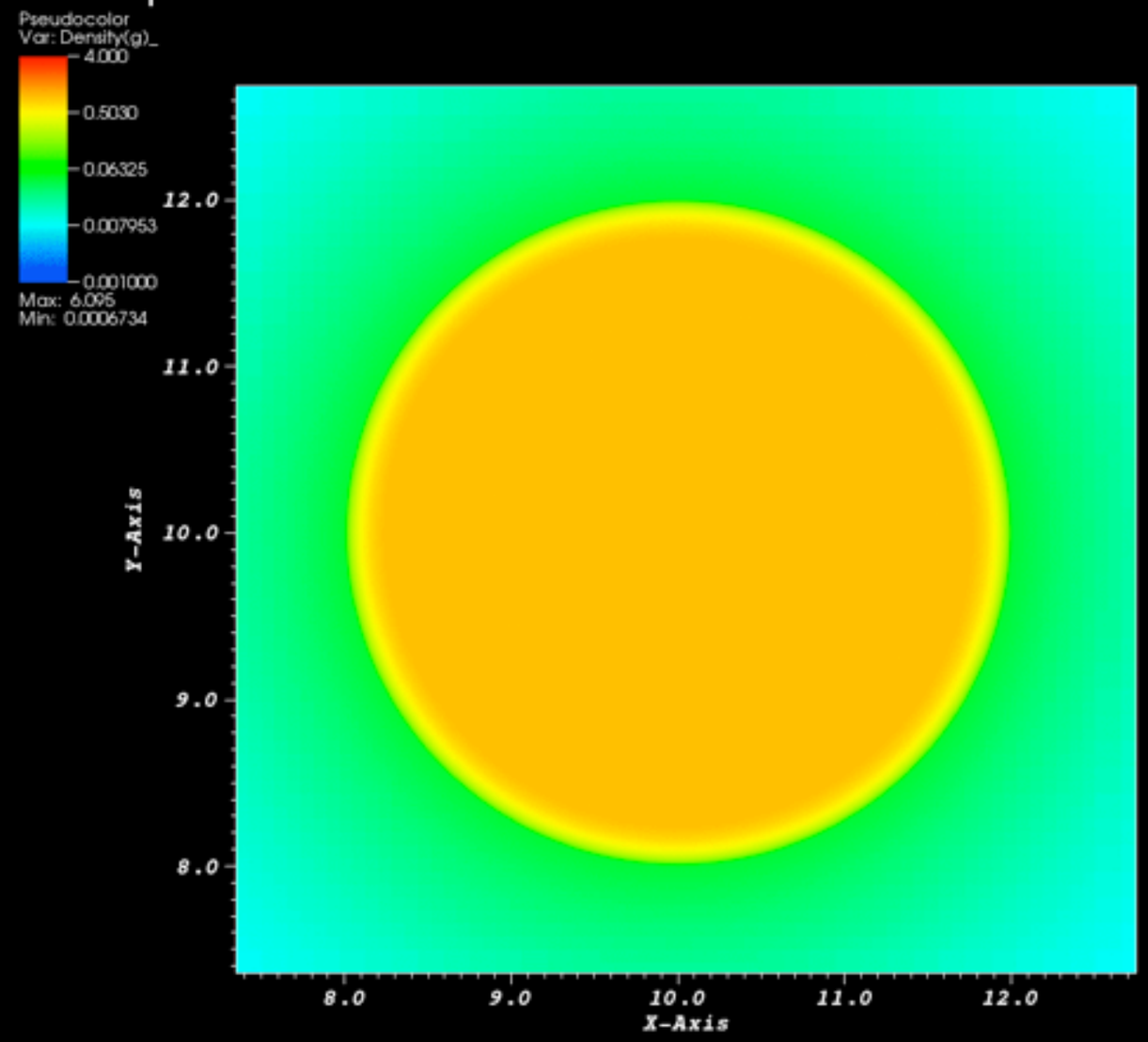
- Fields amplify in disk, accrete onto WD surface, survive through termination of the AGB phase.

Important Caveats:

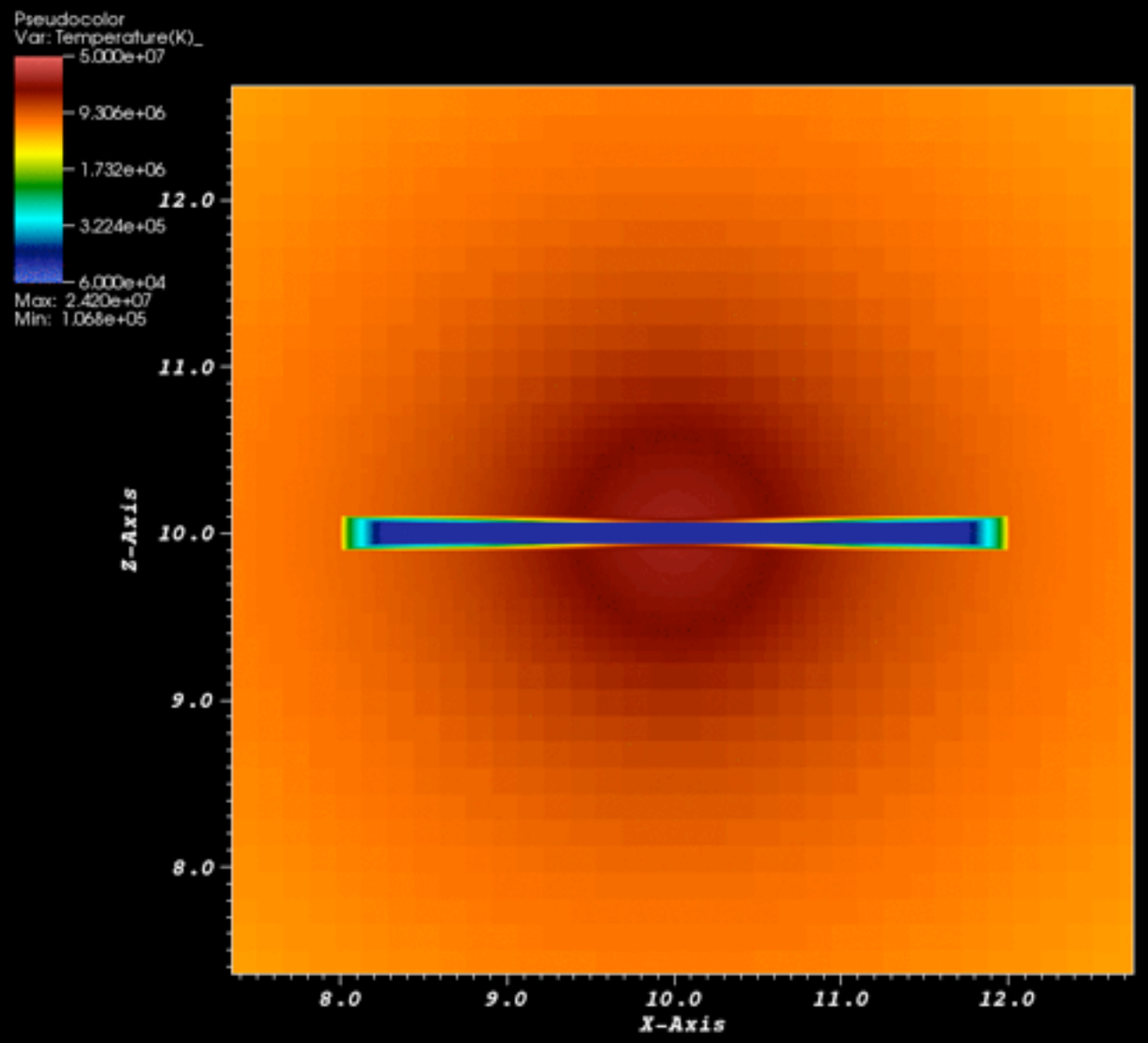
- How long does the disk survive?

- Hydrogen-rich material deposited in He-burning layer could trigger thermonuclear runaway.

1 Jupiter Mass Accretion Disk



Density

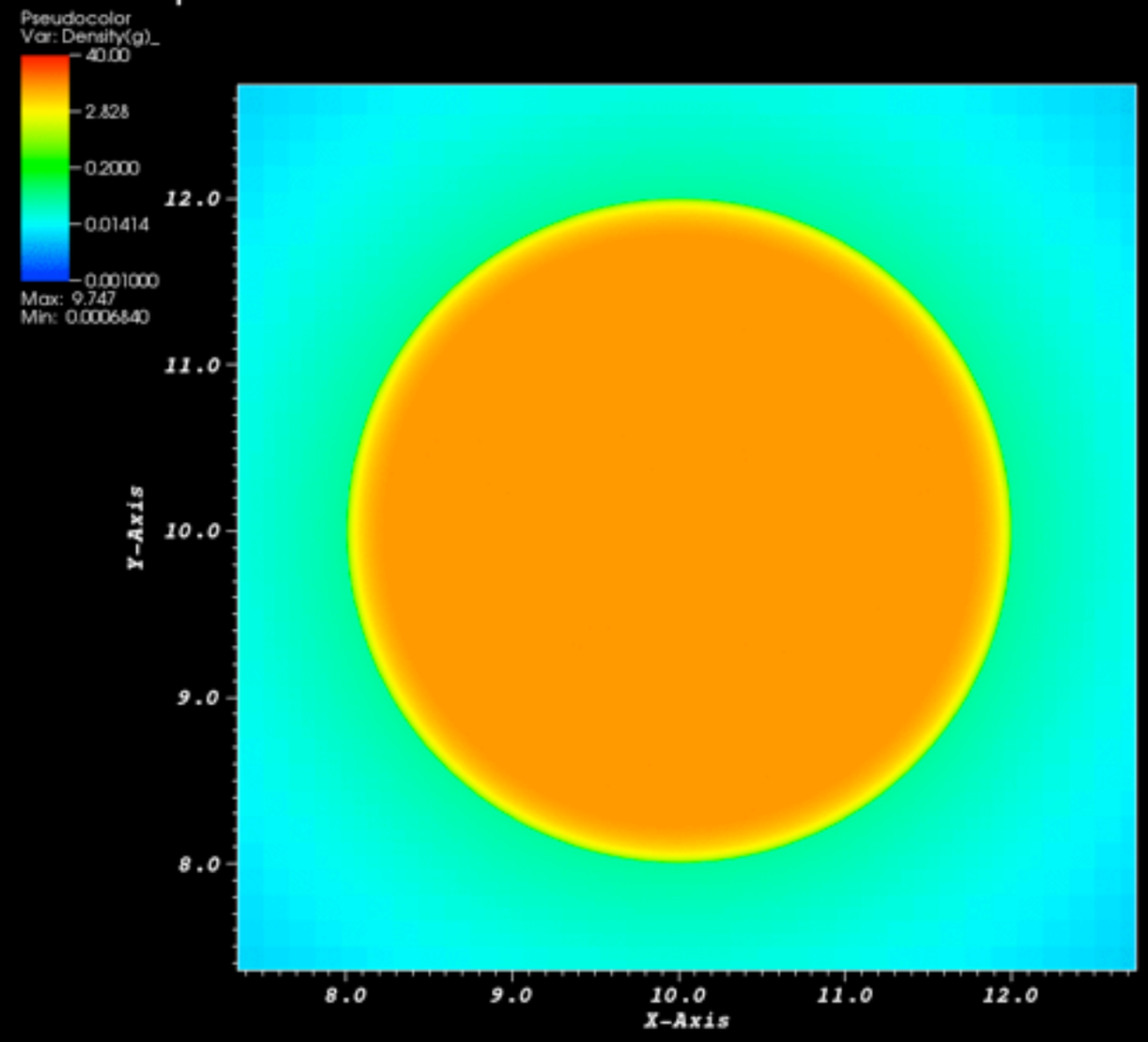


Temperature

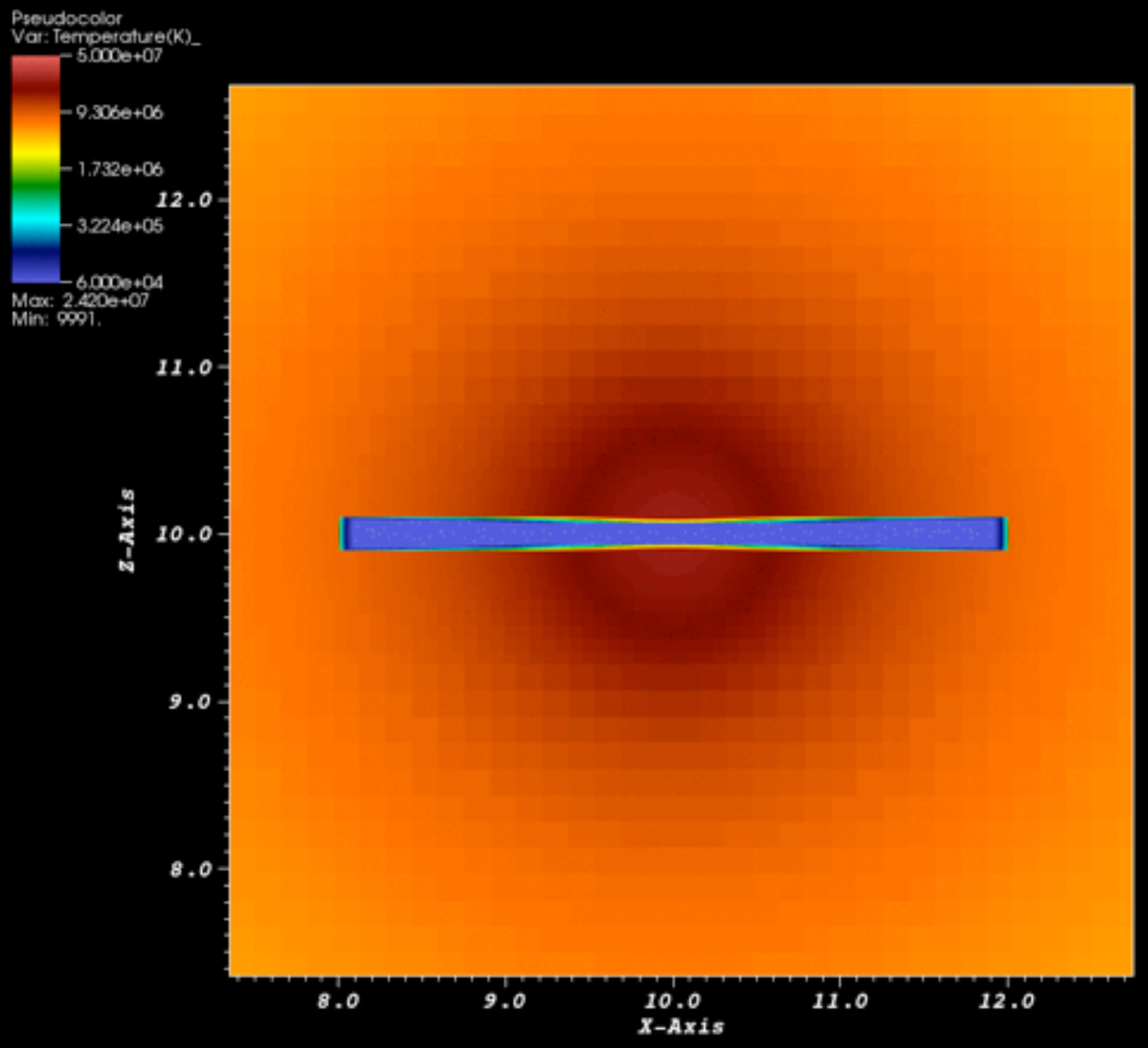
Time=0 orbits

Nordhaus & Di Lernia AstroBEAR

10 Jupiter Mass Accretion Disk



Density



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Nordhaus & Di Lernia AstroBEAR