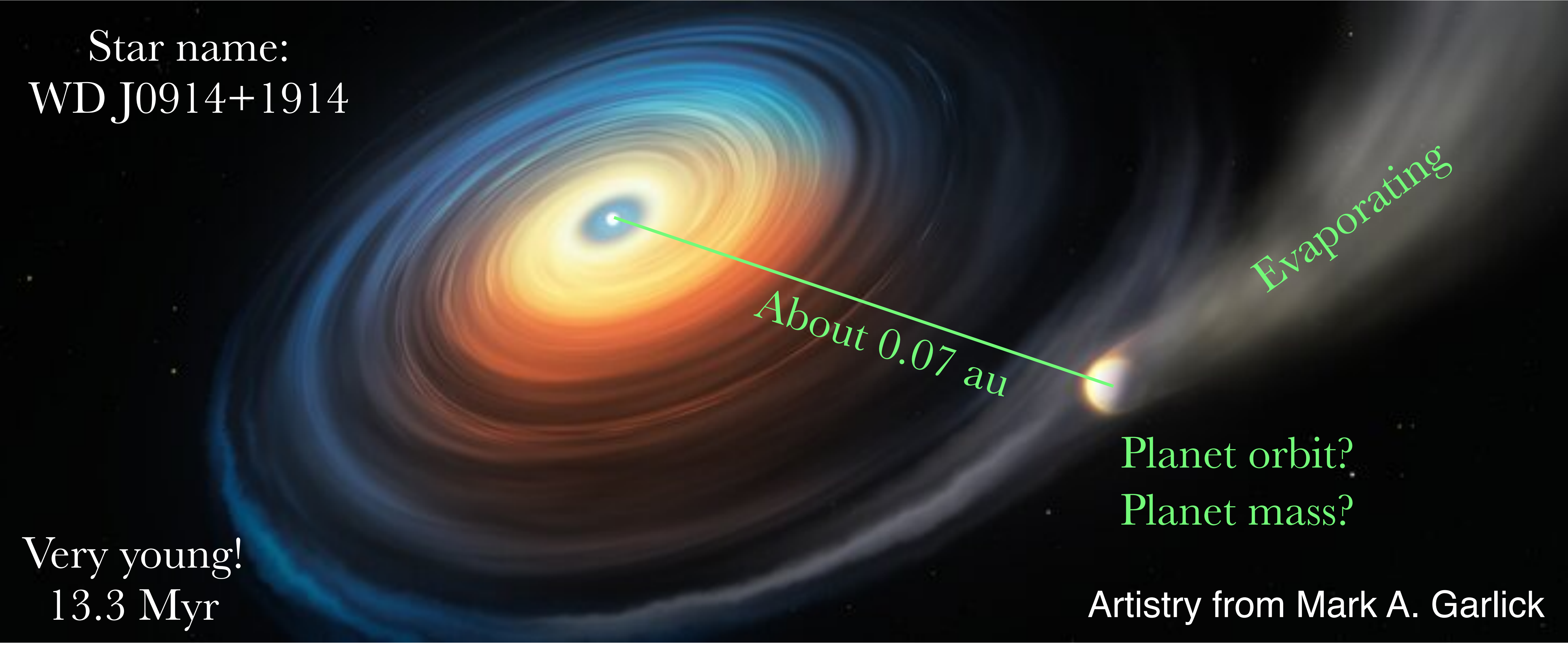


Planets around white dwarfs: physical and dynamical constraints

Dimitri Veras
(University of Warwick)

Results from *Exostar*

The Astrophysical Journal, 885:31 (12pp), 2019 November 1

***TESS* Asteroseismology of the Known Red-giant Host Stars HD 212771 and HD 203949**

Tiago L. Campante[1,2,3], Enrico Corsaro[4], Mikkel N. Lund[3,5], Benoît Mosser[6], Aldo Serenelli[3,7,8], Dimitri Veras[3,9,10,35], Vardan Adibekyan[1], H. M. Antia[11], Warrick Ball[5,12], Sarbani Basu[13], Timothy R. Bedding[3,5,14], Diego Bossini[1], Guy R. Davies[5,12], Elisa Delgado Mena[1], Rafael A. García[15,16], Rasmus Handberg[5], Marc Hon[17], Stephen R. Kane[18], Steven D. Kawaler[3,19], James S. Kuszlewicz[5,20], Miles Lucas[19], Savita Mathur[21,22], Nicolas Nardetto[23], Martin B. Nielsen[5,12,24], Marc H. Pinsonneault[3,25], Sabine Reffert[26], Víctor Silva Aguirre[5], Keivan G. Stassun[27,28], Dennis Stello[3,5,14,17], Stephan Stock[26], Mathieu Vrard[1], Mutlu Yıldız[29], William J. Chaplin[3,5,12], Daniel Huber[3,30], Jacob L. Bean[31], Zeynep Çelik Orhan[29], Margarida S. Cunha[1,2], Jørgen Christensen-Dalsgaard[3,5], Hans Kjeldsen[5,32], Travis S. Metcalfe[20,33], Andrea Miglio[5,12], Mário J. P. F. G. Monteiro[1,2], Benard Nsamba[1], Sibel Örtel[29], Filipe Pereira[1], Sérgio G. Sousa[1,2], Maria Tsantaki[1], and Margaret C. Turnbull[34]

MNRAS **489,** 2941–2953 (2019)

Tidal circularization of gaseous planets orbiting white dwarfs

Dimitri Veras[1,2★†] and Jim Fuller[3]

MNRAS **488,** 153–163 (2019)

Survivability of radio-loud planetary cores orbiting white dwarfs

Dimitri Veras[1,2★†] and Alexander Wolszczan[3,4]

MNRAS **493,** 765–775 (2020)

Constraining planet formation around 6–8 $M_\odot$ stars

Dimitri Veras[1,2★†] Pier-Emmanuel Tremblay,[2] J. J. Hermes,[3] Catriona H. McDonald[1,2] Grant M. Kennedy[1,2‡] Farzana Meru[1,2§] and Boris T. Gänsicke[1,2]

Synergy with Gänsicke et al. planet

Nature **576**, 61–64(2019)

Accretion of a giant planet onto a white dwarf star

Boris T. Gänsicke[1,2*], Matthias R. Schreiber[3], Odette Toloza[1], Nicola P. Gentile Fusillo[1], Detlev Koester[4] & Christopher J. Manser[1]

+

MNRAS **489,** 2941–2953 (2019)

Tidal circularization of gaseous planets orbiting white dwarfs

Dimitri Veras[1,2★†] and Jim Fuller[3]

MNRAS **492,** 6059–6066 (2020)

The dynamical history of the evaporating or disrupted ice giant planet around white dwarf WD J0914+1914

Dimitri Veras[1,2★†] and Jim Fuller[3]

Problem:
Shrinking post-scattered orbits in short times

$$a \gtrsim 2 \text{ au} \longrightarrow \text{a} \lesssim 0.1 \text{ au}$$
$$e \gtrsim 0.95 \longrightarrow e \approx 0.0$$

(One) solution:
Invoke chaotic tides

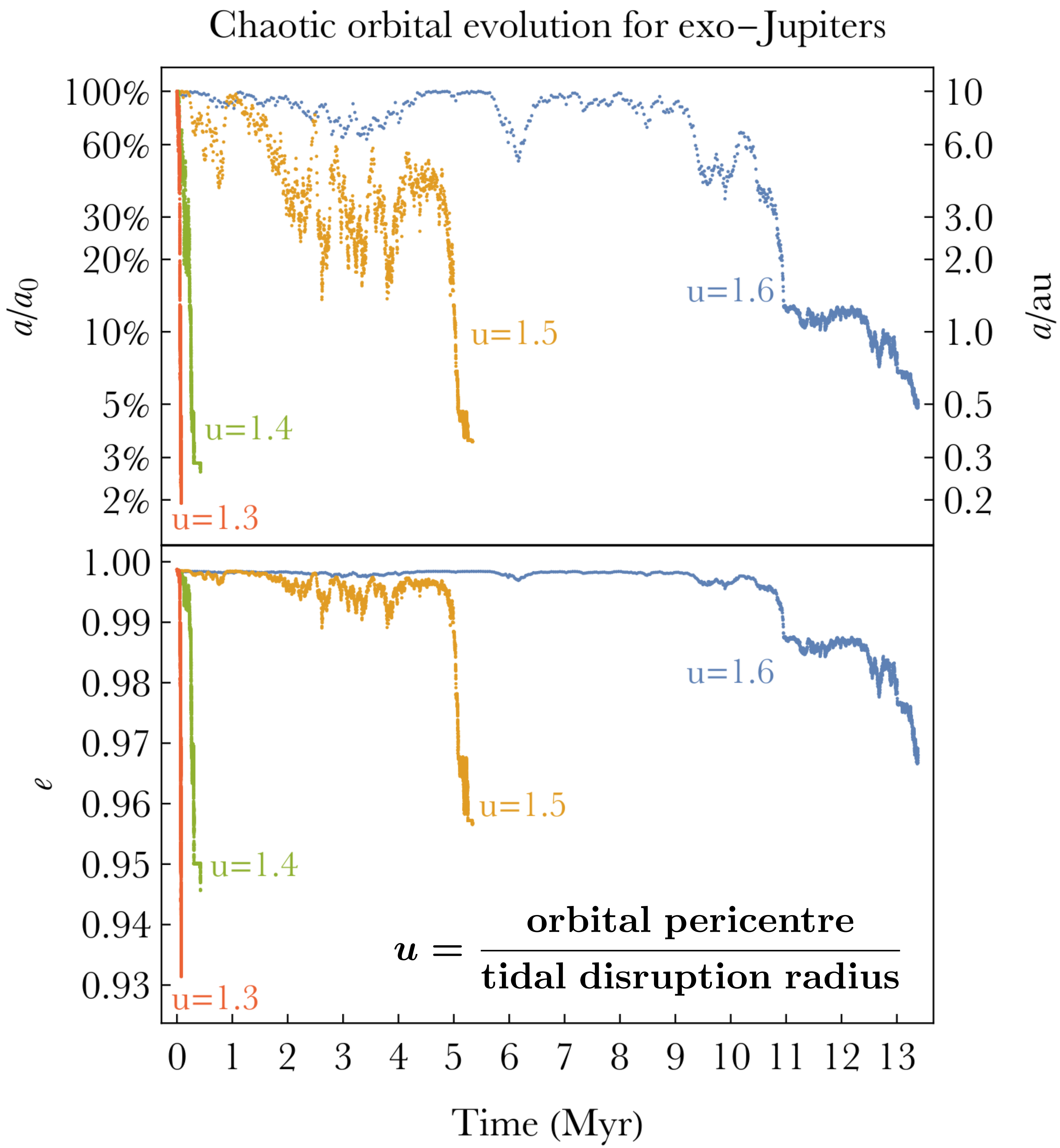
Stochastic orbital evolution which occurs due to excitation of f modes within the planet and the resulting exchange of energy between those modes and the angular orbital momentum

Activates only for highly eccentric orbits

- **Mardling** (1995a,b)
- **Ivanov & Papaloizou** (2004, 2007)
- **Wu** (2018)
- **Vick & Lai** (2018)
- **Vick, Lai & Anderson** (2019)
- **Teyssandier, Lai & Vick** (2019)

Chaotic tides examples

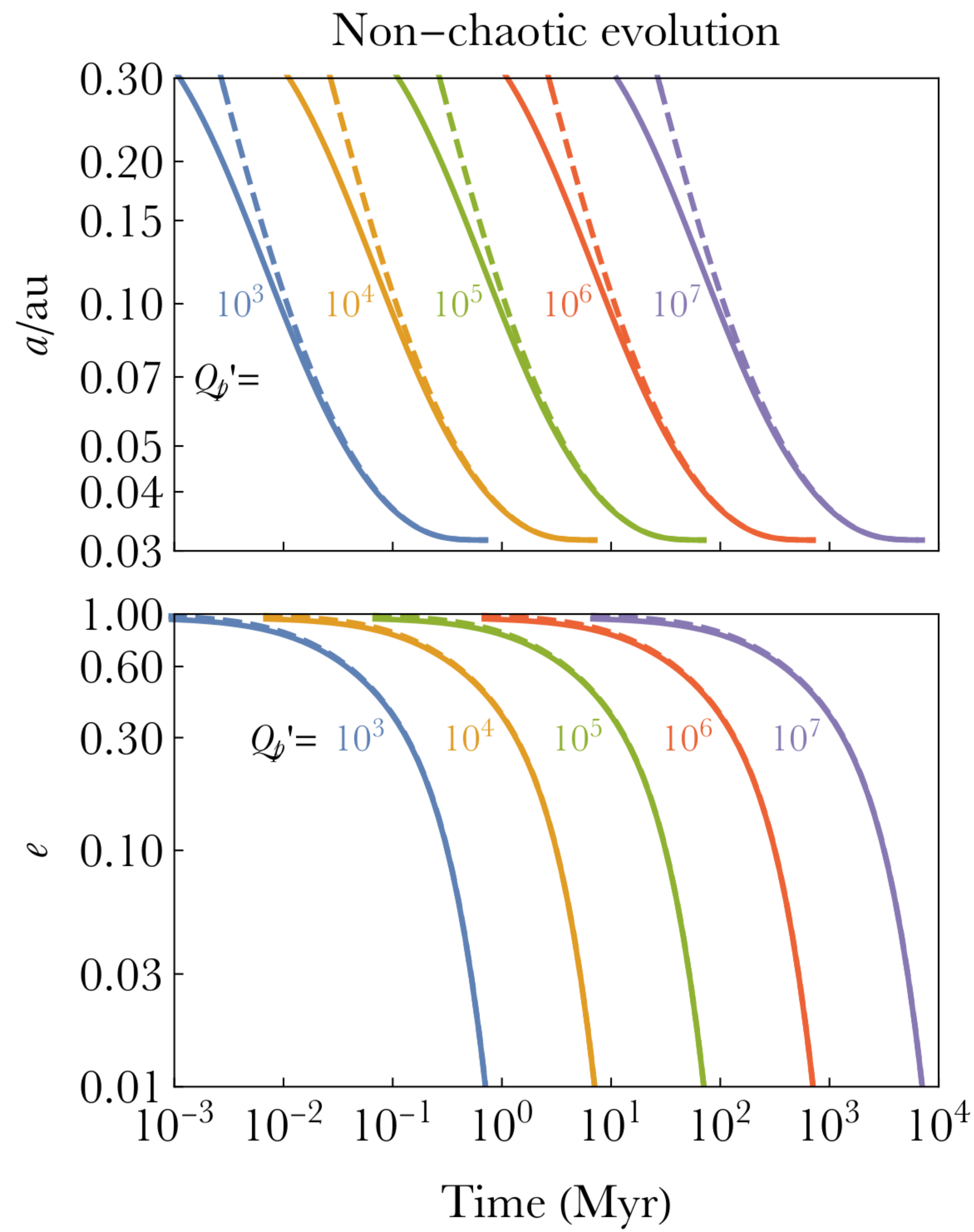
Veras & Fuller (2019)



Post-chaotic evolution

Veras & Fuller (2019)

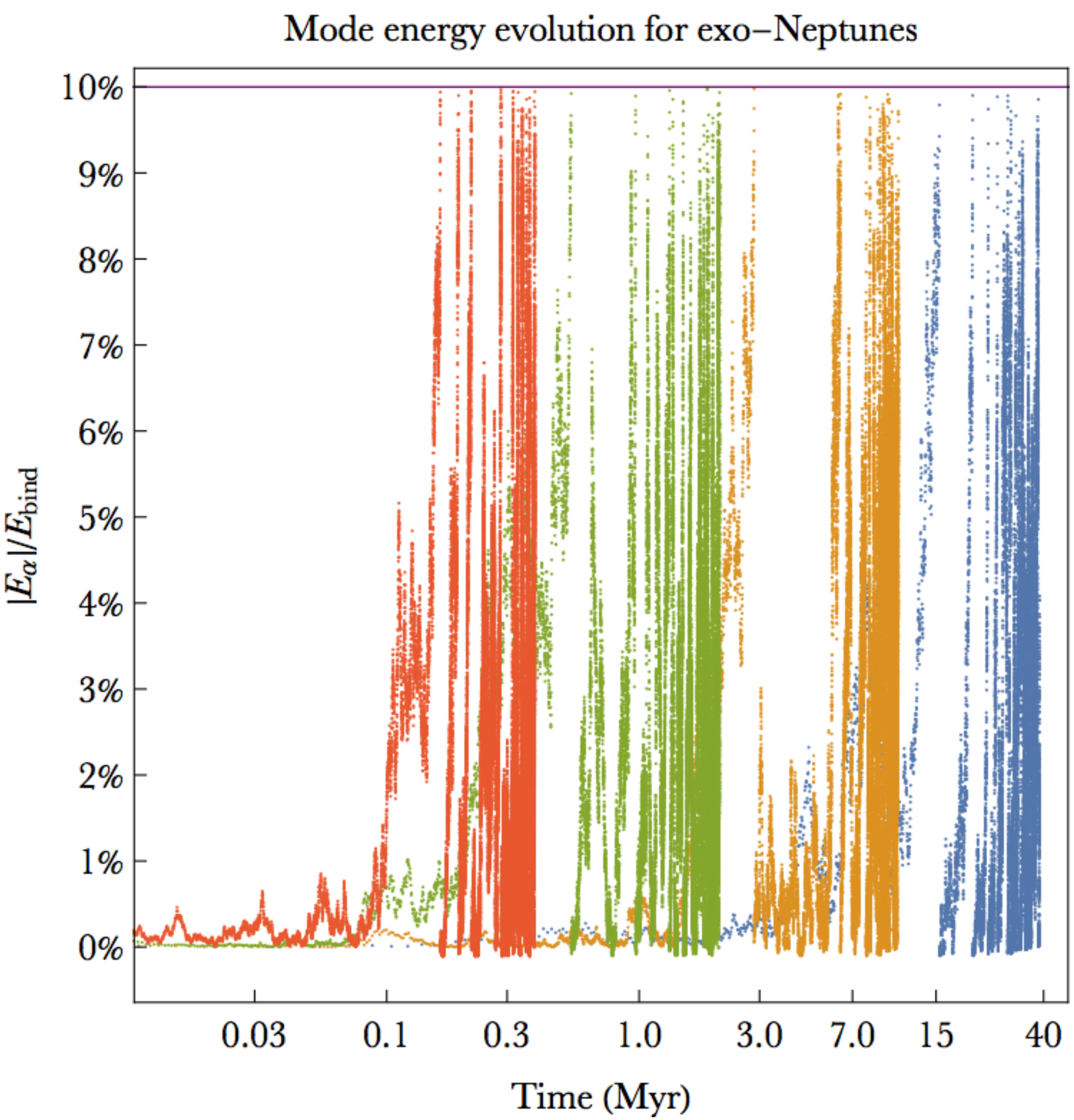
Standard equilibrium weak friction tidal approximation from Hut (1981)



Q'_p equals the modified planetary quality factor

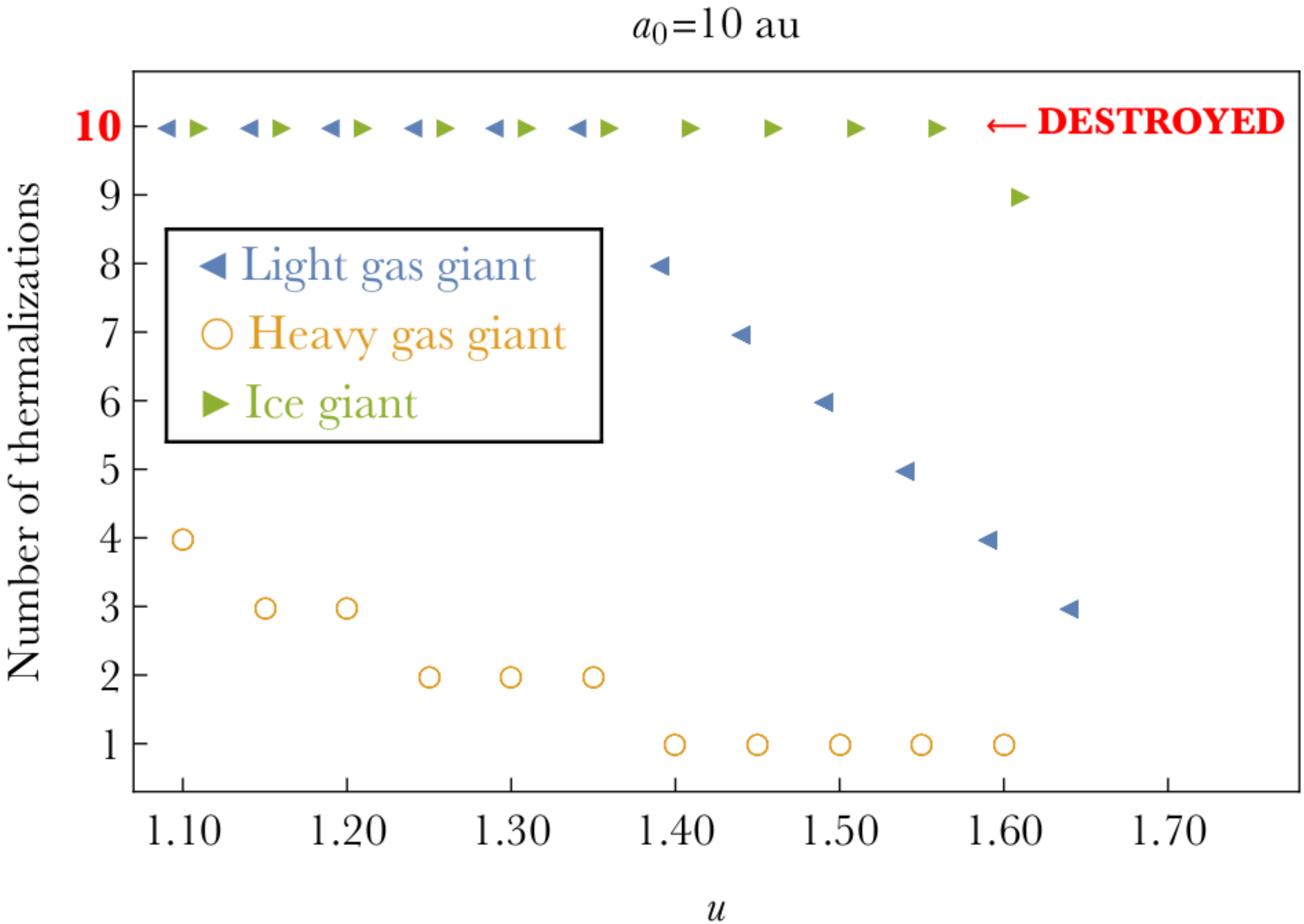
Interesting twist: Planet potentially disruption

Veras & Fuller (2019)



Interesting twist:
Planet potentially disruption

Veras & Fuller (2019)



Gravitational scattering inwards

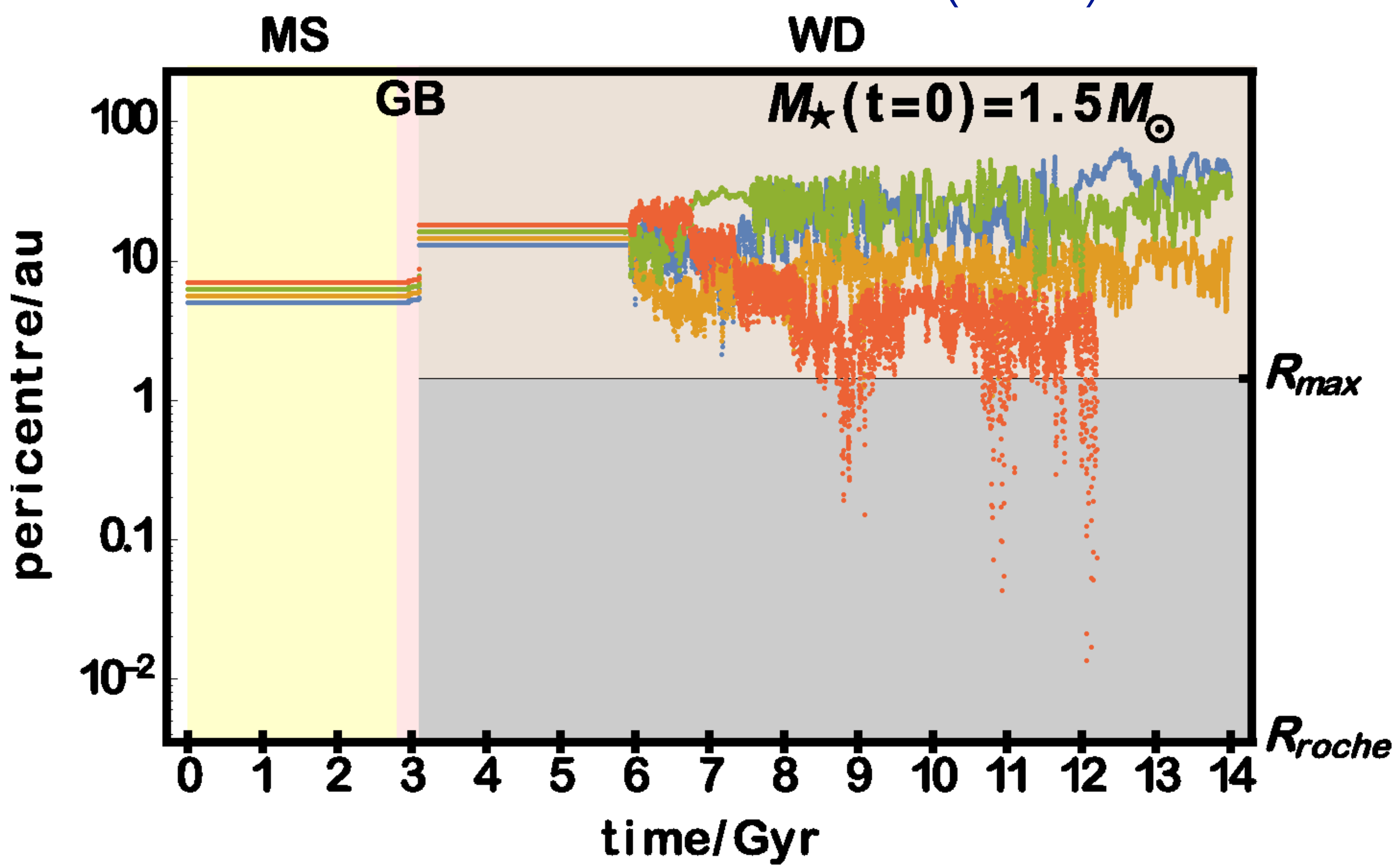
Nature **576**, 61–64(2019)

Accretion of a giant planet onto a white dwarf star

Boris T. Gänsicke[1,2]*, Matthias R. Schreiber[3], Odette Toloza[1], Nicola P. Gentile Fusillo[1], Detlev Koester[4] & Christopher J. Manser[1]

Veras & Gänsicke (2015)

Scattering with other planets →

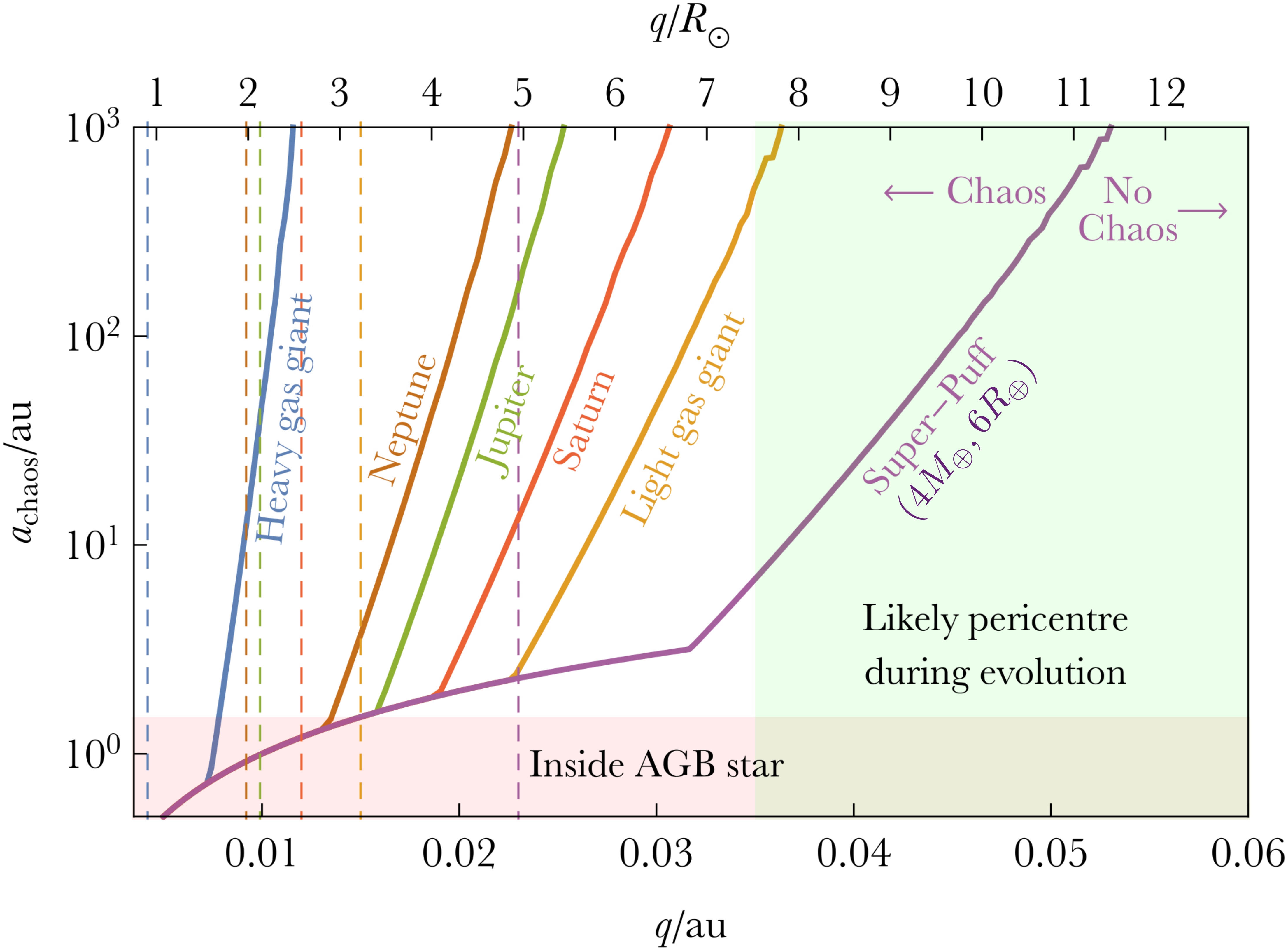


Scattering with other stars → **Stephan, Naoz & Gaudi (In Prep)**

Physical properties of planet

Veras & Fuller (2020)

Boundary to initiate chaotic evolution around WD J0914+1914



Follow-up studies of this system

—Exploring why no rocky pollutants

MNRAS **493**, 4692–4699 (2020)

The white dwarf planet WD J0914+1914 b: barricading potential rocky pollutants?

Dimitri Veras [1,2★†]

—Exploring stability regions of gas disc

MNRAS in press, arXiv: 2007.16174

Short-term stability of particles in the WD J0914+1914 white dwarf planetary system

Euaggelos E. Zotos[1], Dimitri Veras[2,3★†], Tareq Saeed[4], Luciano A. Darriba[5,6]

—Exploring binary scattering

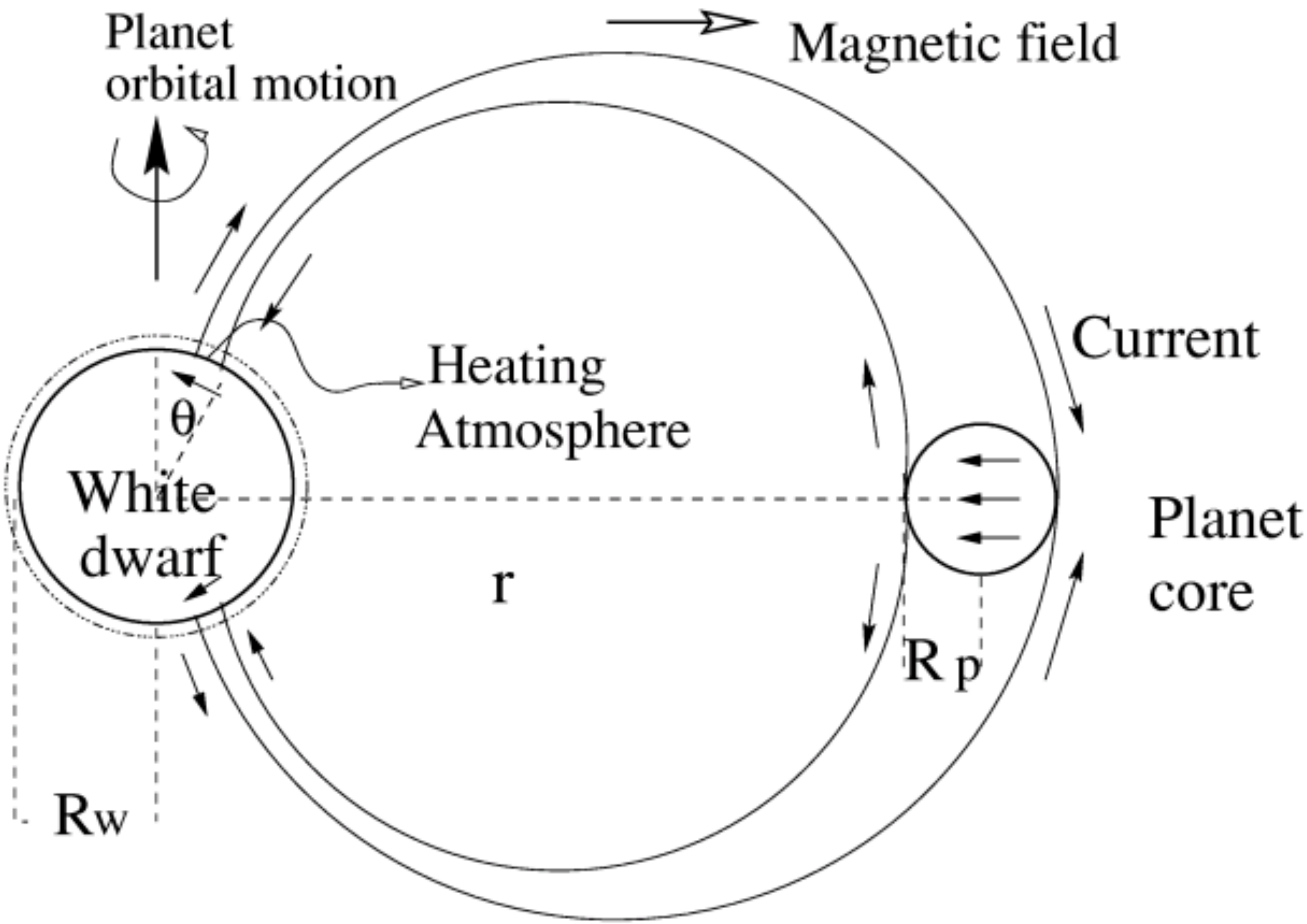
Stephan, Naoz & Gaudi (In Prep)

MNRAS **488,** 153–163 (2019)

Survivability of radio-loud planetary cores orbiting white dwarfs

Dimitri Veras [1,2★†] and Alexander Wolszczan [3,4]

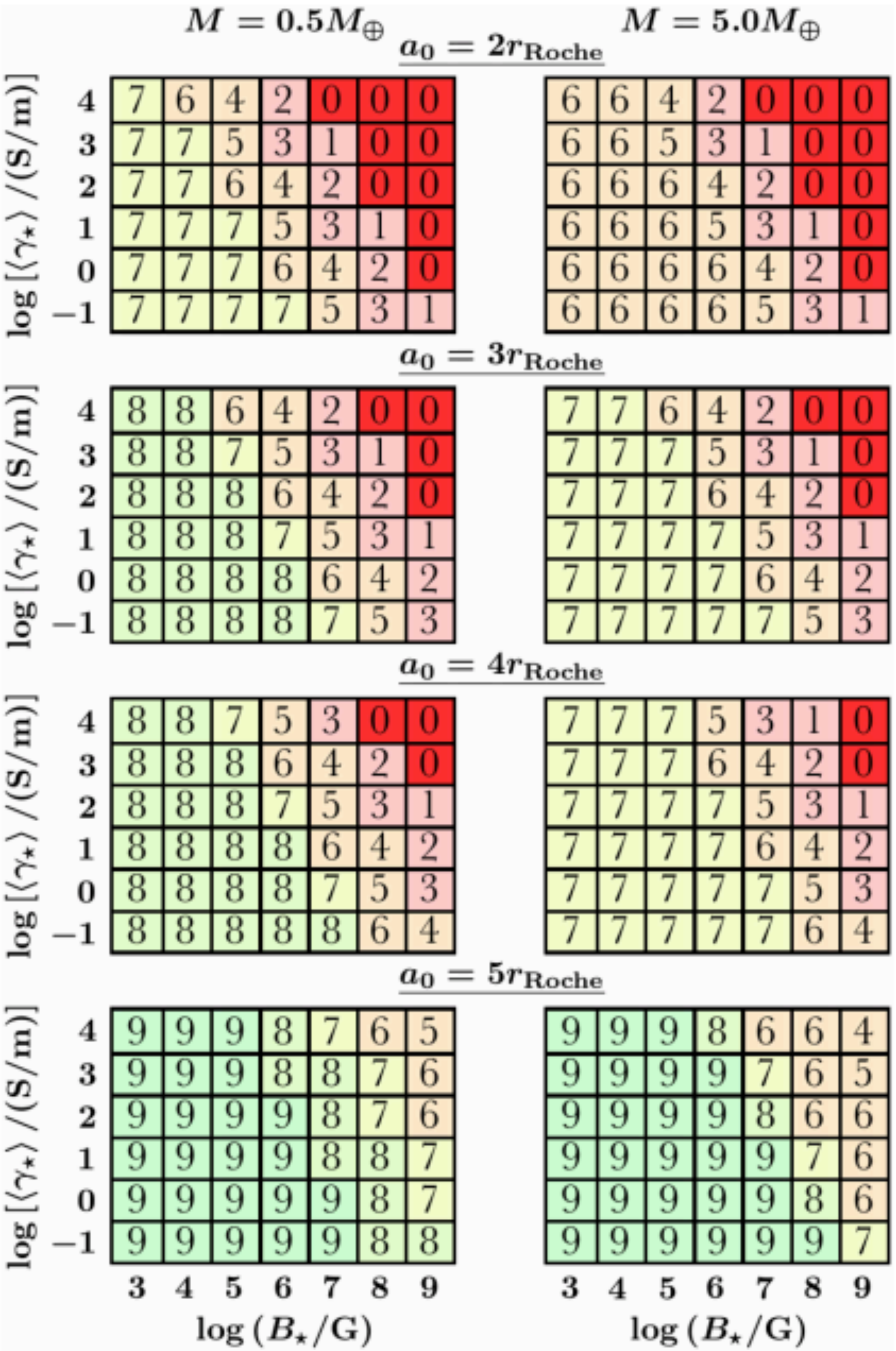
Li, Ferrario & Wickramasinghe (1998)



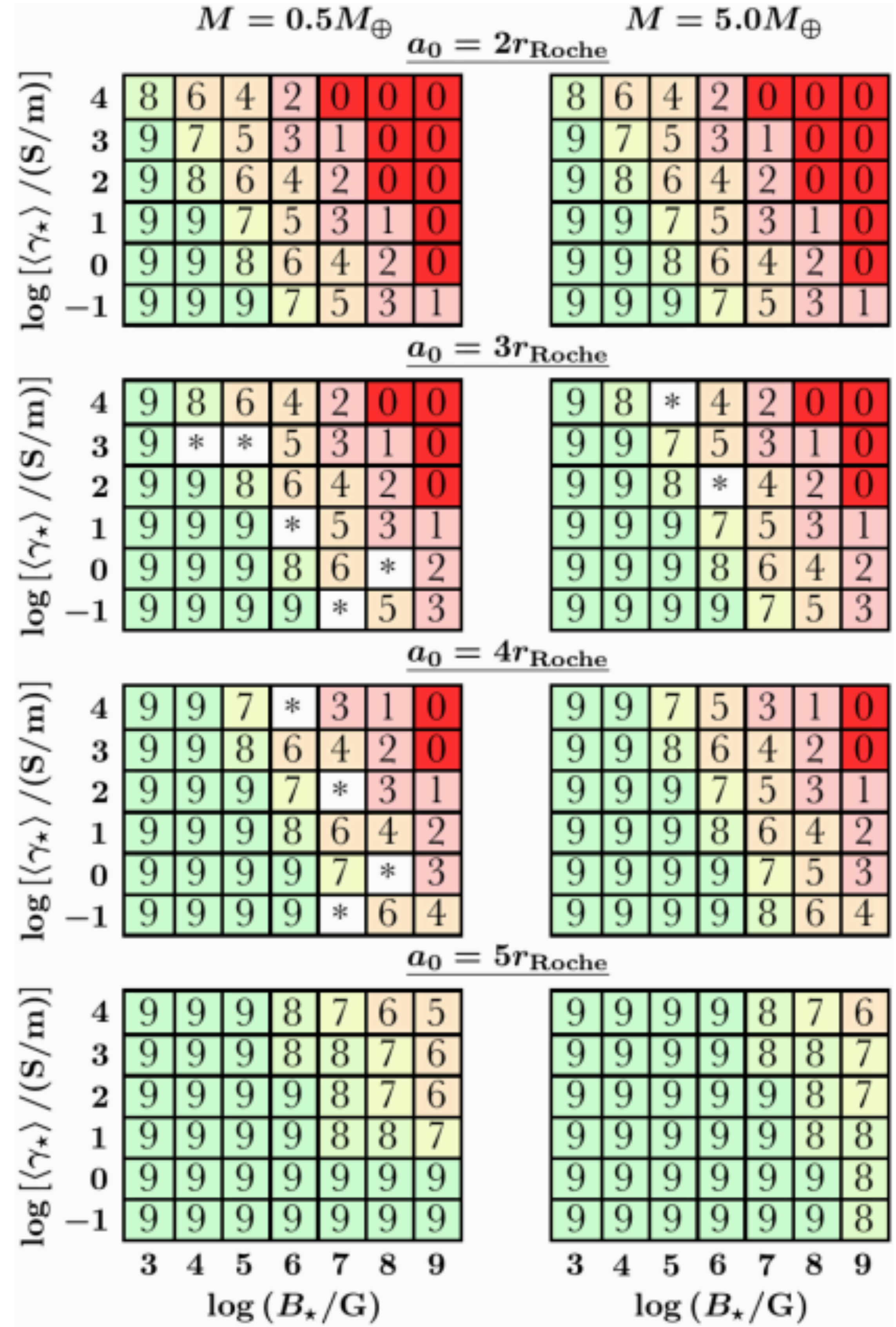
Radio-loud white dwarf planets

Veras & Wolszczan (2019)

Dynamic viscosity = 10^{21} Pa s



Dynamic viscosity = 10^{24} Pa s



Radio-loud white dwarf planets

Survival timescales even longer from circuit breakage due to magnetic flux tube twisting?

Lai (2012)

$$\frac{a}{|\dot{a}|} = 5.7 \times 10^{15} \zeta_\phi^{-1} \left(\frac{M_\star}{1\,M_\odot}\right)^{1/2} \left(\frac{R_\star}{1\,R_\odot}\right)^{-6} \left(\frac{B_\star}{1\,\mathrm{G}}\right)^{-2} \times \left(\frac{R_p}{1\,R_J}\right) \left(\frac{\bar{\rho}_p}{1\,\mathrm{g\,cm^{-3}}}\right) \left(\frac{a}{0.04\,\mathrm{AU}}\right)^{11/2} \mathrm{yr}$$

Results from *Exostar*

THE ASTROPHYSICAL JOURNAL, 885:31 (12pp), 2019 November 1

TESS Asteroseismology of the Known Red-giant Host Stars HD 212771 and HD 203949

Tiago L. Campante[1,2,3], Enrico Corsaro[4], Mikkel N. Lund[3,5], Benoît Mosser[6], Aldo Serenelli[3,7,8], Dimitri Veras[3,9,10,35], Vardan Adibekyan[1], H. M. Antia[11], Warrick Ball[5,12], Sarbani Basu[13], Timothy R. Bedding[3,5,14], Diego Bossini[1], Guy R. Davies[5,12], Elisa Delgado Mena[1], Rafael A. García[15,16], Rasmus Handberg[5], Marc Hon[17], Stephen R. Kane[18], Steven D. Kawaler[3,19], James S. Kuszlewicz[5,20], Miles Lucas[19], Savita Mathur[21,22], Nicolas Nardetto[23], Martin B. Nielsen[5,12,24], Marc H. Pinsonneault[3,25], Sabine Reffert[26], Víctor Silva Aguirre[5], Keivan G. Stassun[27,28], Dennis Stello[3,5,14,17], Stephan Stock[26], Mathieu Vrard[1], Mutlu Yıldız[29], William J. Chaplin[3,5,12], Daniel Huber[3,30], Jacob L. Bean[31], Zeynep Çelik Orhan[29], Margarida S. Cunha[1,2], Jørgen Christensen-Dalsgaard[3,5], Hans Kjeldsen[5,32], Travis S. Metcalfe[20,33], Andrea Miglio[5,12], Mário J. P. F. G. Monteiro[1,2], Benard Nsamba[1], Sibel Örtel[29], Filipe Pereira[1], Sérgio G. Sousa[1,2], Maria Tsantaki[1], and Margaret C. Turnbull[34]

MNRAS **489,** 2941–2953 (2019)

Tidal circularization of gaseous planets orbiting white dwarfs

Dimitri Veras[1,2★†] and Jim Fuller[3]

MNRAS **488,** 153–163 (2019)

Survivability of radio-loud planetary cores orbiting white dwarfs

Dimitri Veras[1,2★†] and Alexander Wolszczan[3,4]

MNRAS **493,** 765–775 (2020)

Constraining planet formation around 6–8 $M_\odot$ stars

Dimitri Veras,[1,2★†] Pier-Emmanuel Tremblay,[2] J. J. Hermes,[3] Catriona H. McDonald,[1,2] Grant M. Kennedy,[1,2‡] Farzana Meru[1,2§] and Boris T. Gänsicke[1,2]