Constraining properties of disintegrating exoplanets

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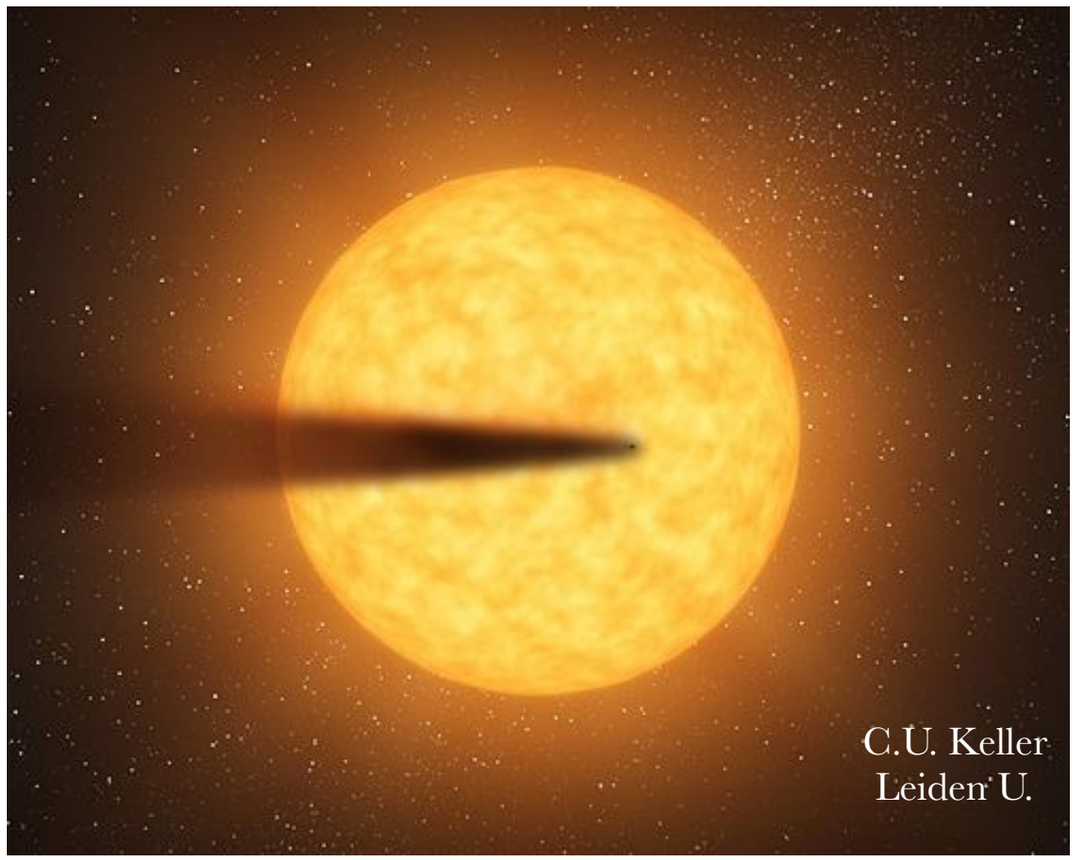
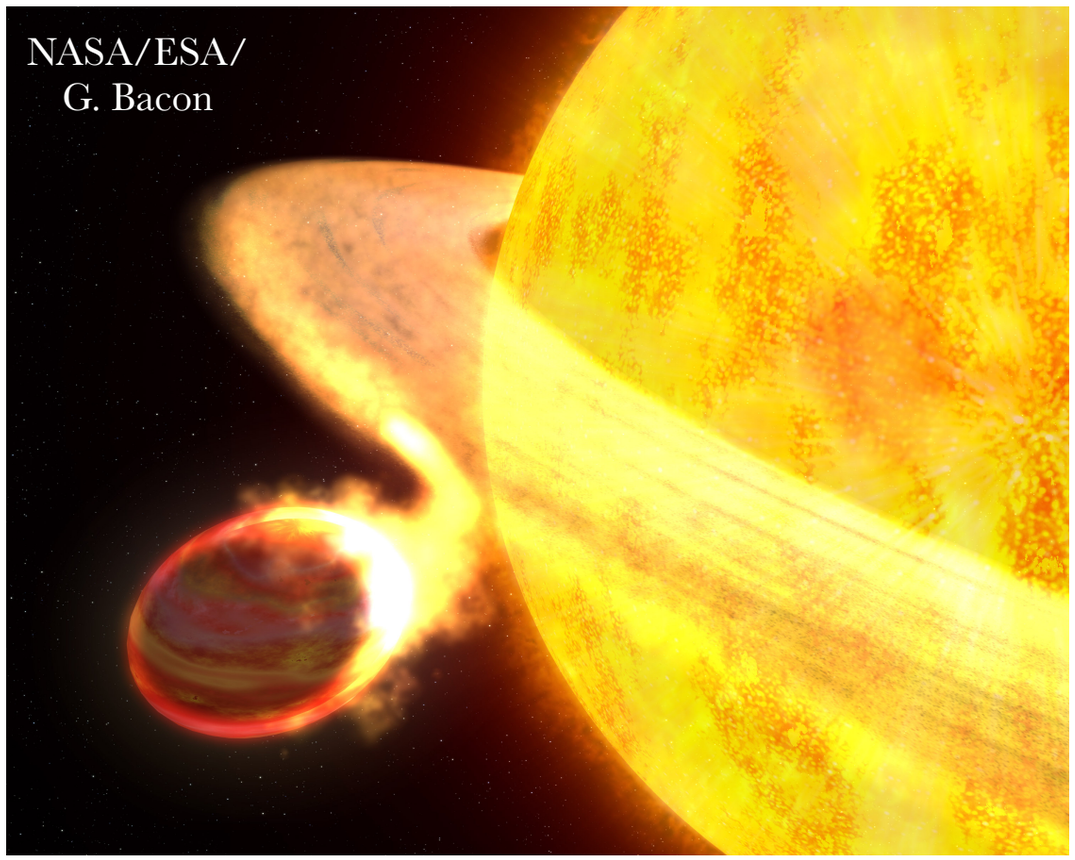
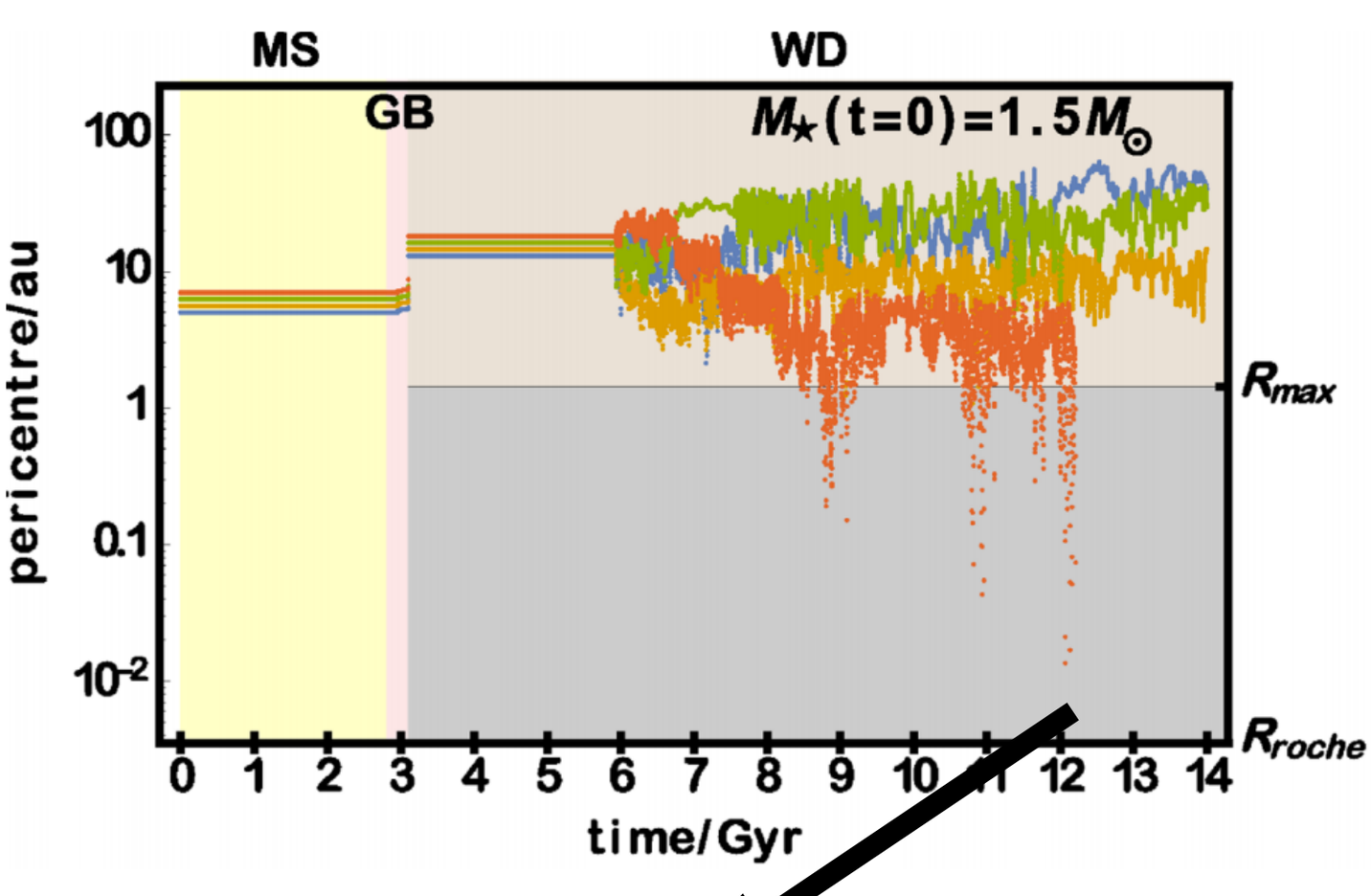
Disintegrating/evaporating planets





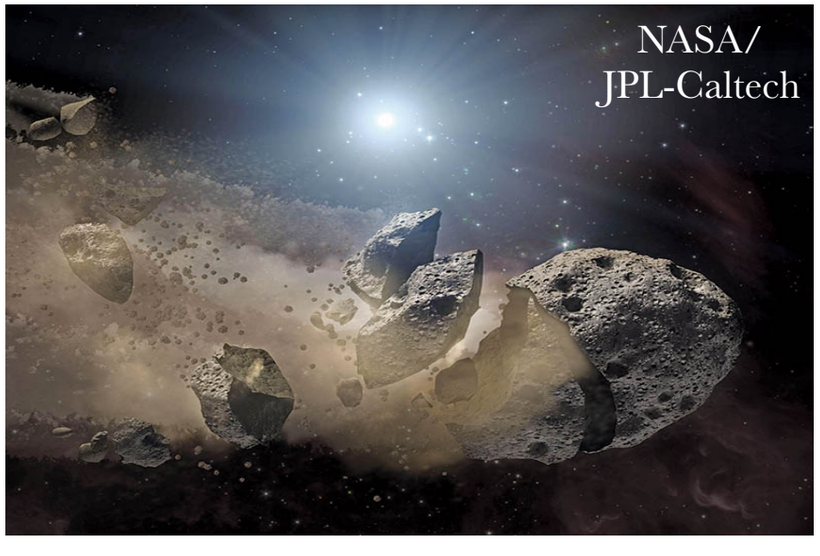
KELT-9 b	P ~35 hours	Gaudi+ 2017
WASP-12 b	P ~26 hours	Hebb+ 2009
KOI 2700 b	P ~22 hours	Rappaport+ 2014
KIC 12557548B b	P ~16 hours	Rappaport+ 2012
K2-22 b	P ~9 hours	Sanchis-Ojeda+ 2015
WD 1145+017 b	P ~4.5 hours	Vanderburg+ 2015

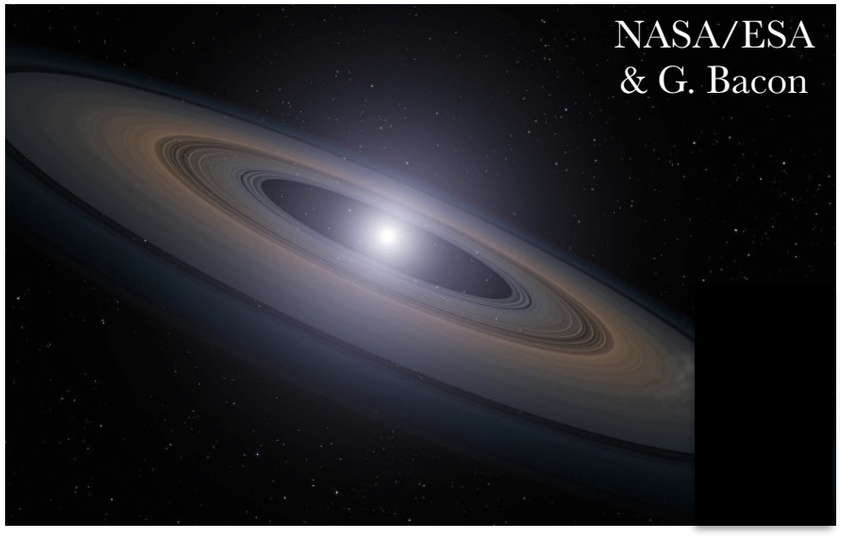


Fate of planetary systems

Veras & Gänsicke (2015)

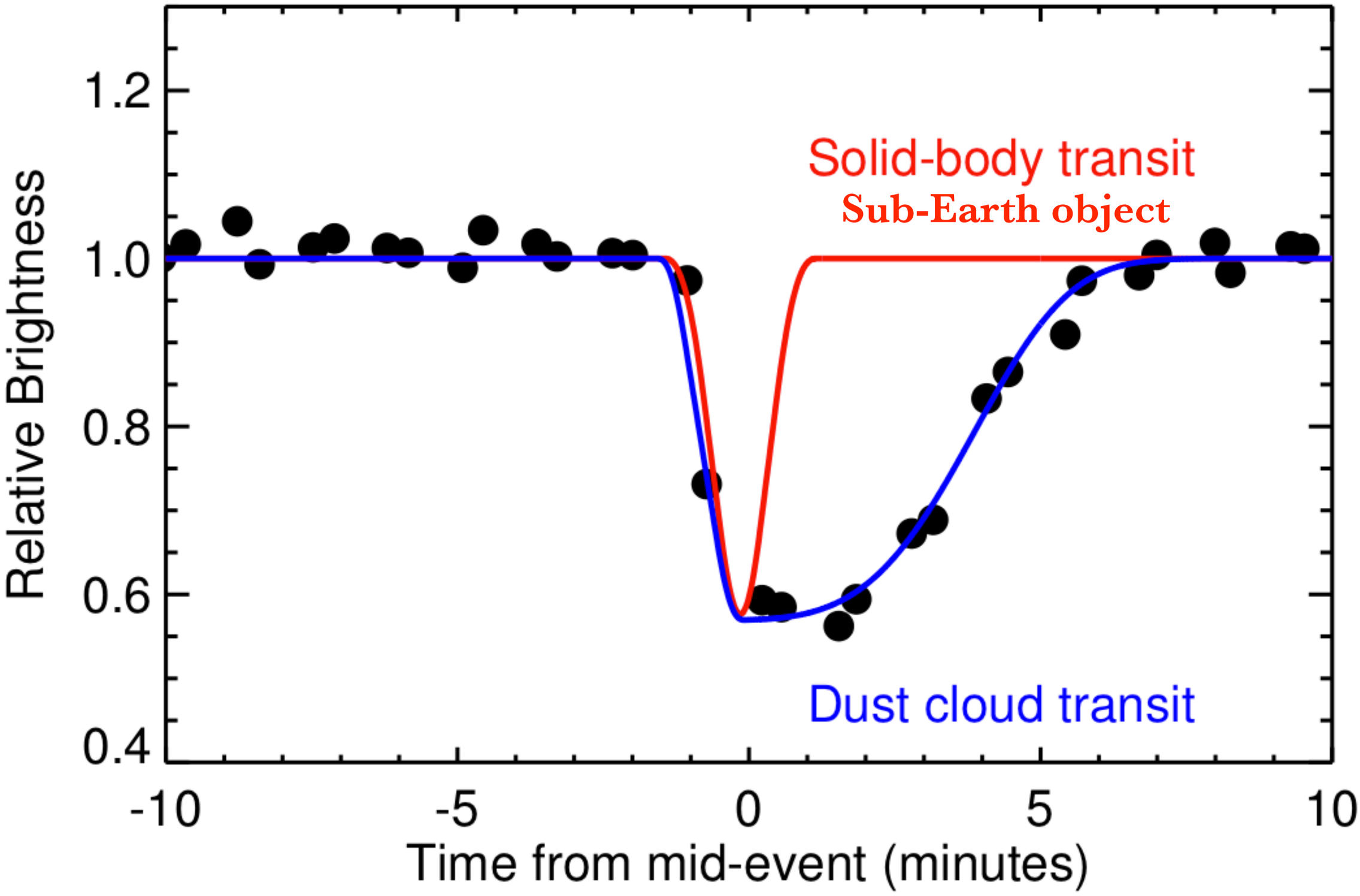
break-up → **form disc** → **pollute white dwarf**





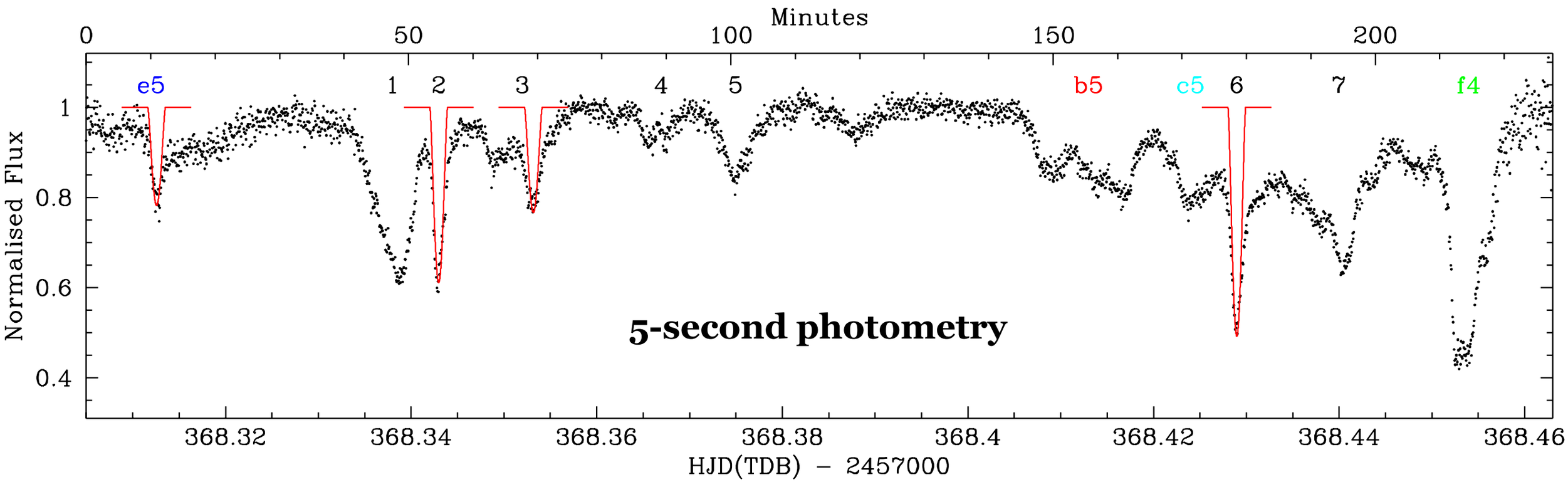
WD 1145+017 transits

Vanderburg et al. (2015, Nature, 526, 546-549)



WD 1145+017 transits

Gänsicke et al. (2016, ApJL, 818, L7)



WD 1145+017 b papers (so far)

Observational

Vanderburg et al. (2015, Nature, 526, 546-549)	2015
Alonso et al. (2016, A&A, 589, L6) Gänsicke et al. (2016, ApJL, 818, L7) Rappaport et al. (2016, MNRAS, 458, 3904) Xu et al. (2016, ApJL, 816, L22) Zhou et al. (2016, MNRAS, 463, 4422)	2016
Croll et al. (2017, ApJ, 836, 82) Gary et al. (2017, MNRAS, 465, 3267) Hallakoun et al. (2017, MNRAS, 469, 3213) Redfield et al. (2017, ApJ, 839, 42) Kjurkchieva et al. (2017, PASA, 34, 32)	2017

Theoretical

Gurri et al. (2017, MNRAS, 464, 321)
Veras et al. (2017, MNRAS, 465, 1008)
Farihi et al. (2017, MNRAS, In Press)

Explaining observables

Veras et al. (2017, MNRAS, 465, 1008)

Collaborators

Philip J. Carter (University of Bristol, UK)

Zoë M. Leinhardt (University of Bristol, UK)

Boris T. Gänsicke (University of Warwick, UK)

Constraints

Disruption persists for 2 years

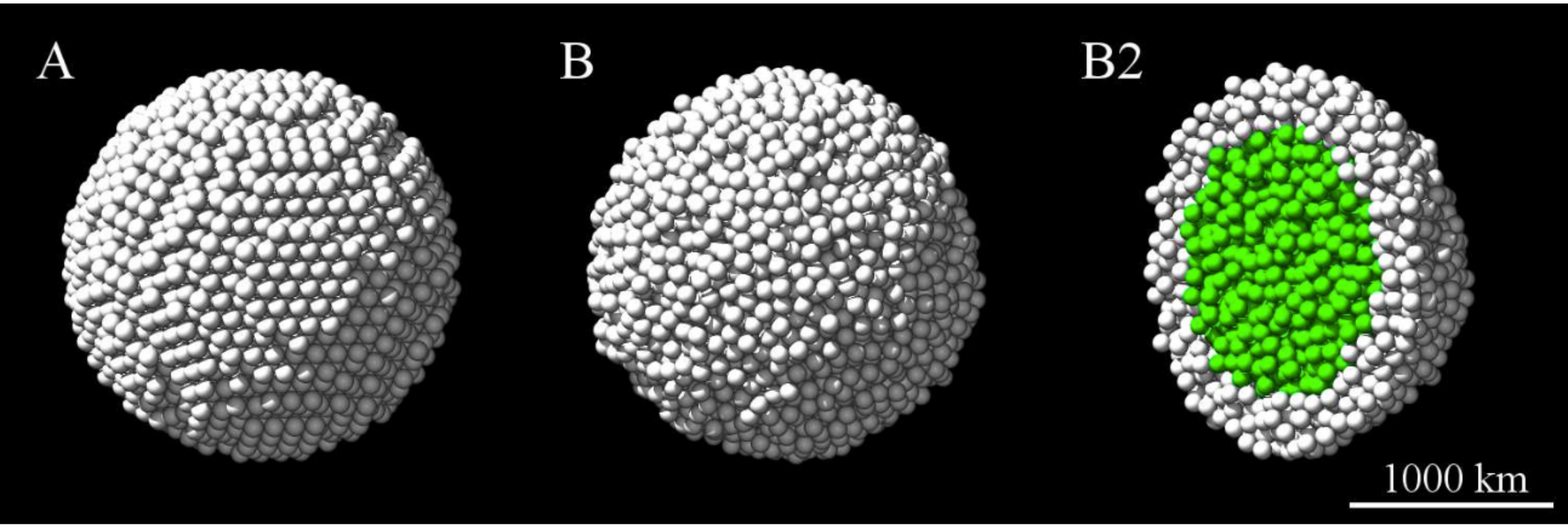
Disruption intermittent

Orbital period of ~4.499 hours

Rubble pile representations

Veras et al. (2017, MNRAS, 465, 1008)

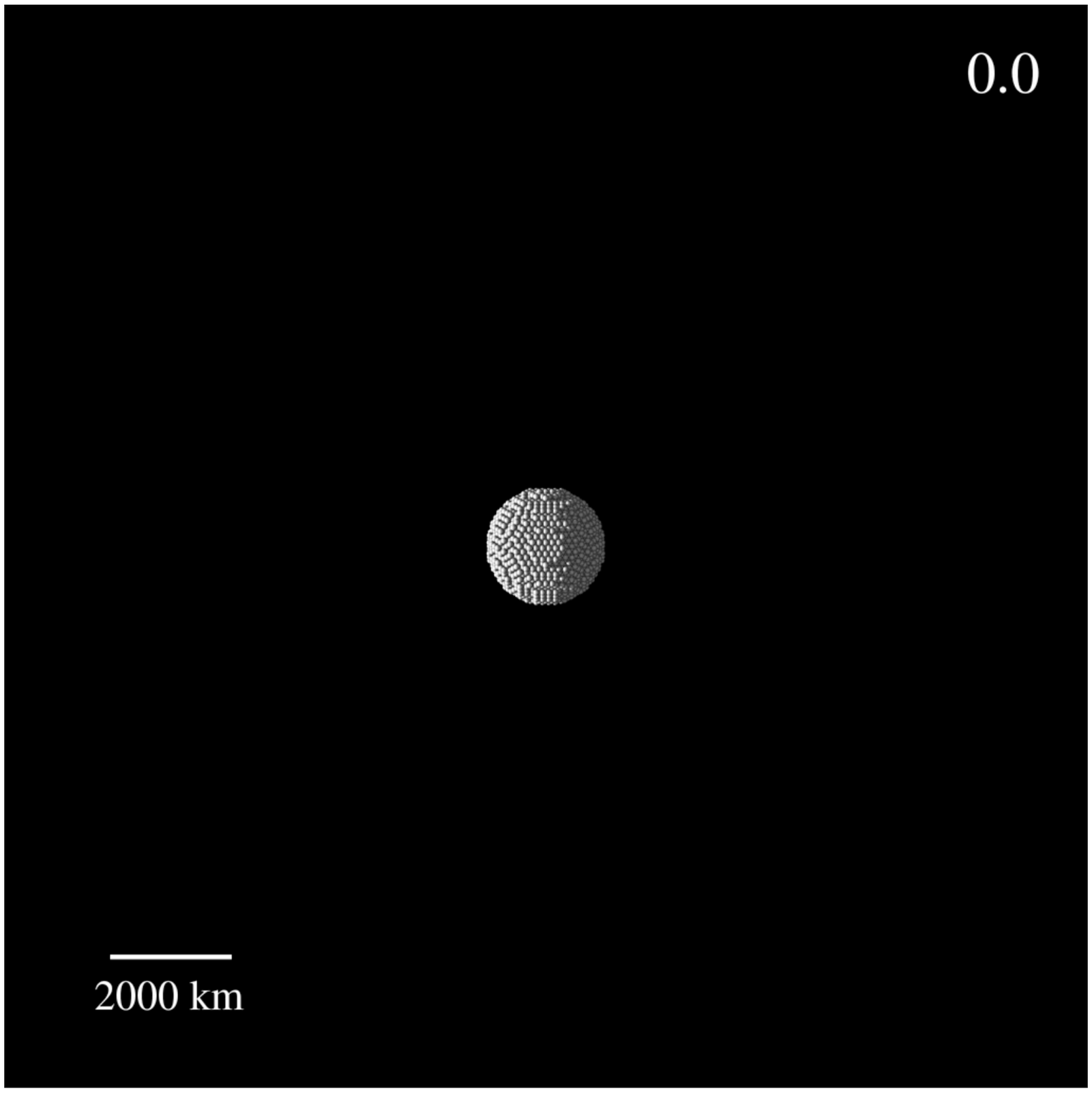
Homogeneous	**Homogeneous**	**Differentiated**
Hexagonal Closest Packing	Random Packing	Core + Mantle



Homogeneous: total disruption

Veras et al. (2017, MNRAS, 465, 1008)

homogeneous
$\rho = 2.6$ g/cm^3
$e = 0.0$
$P = 4.499$ h



Ring / disc formation

Veras et al. (2017, MNRAS, 465, 1008)

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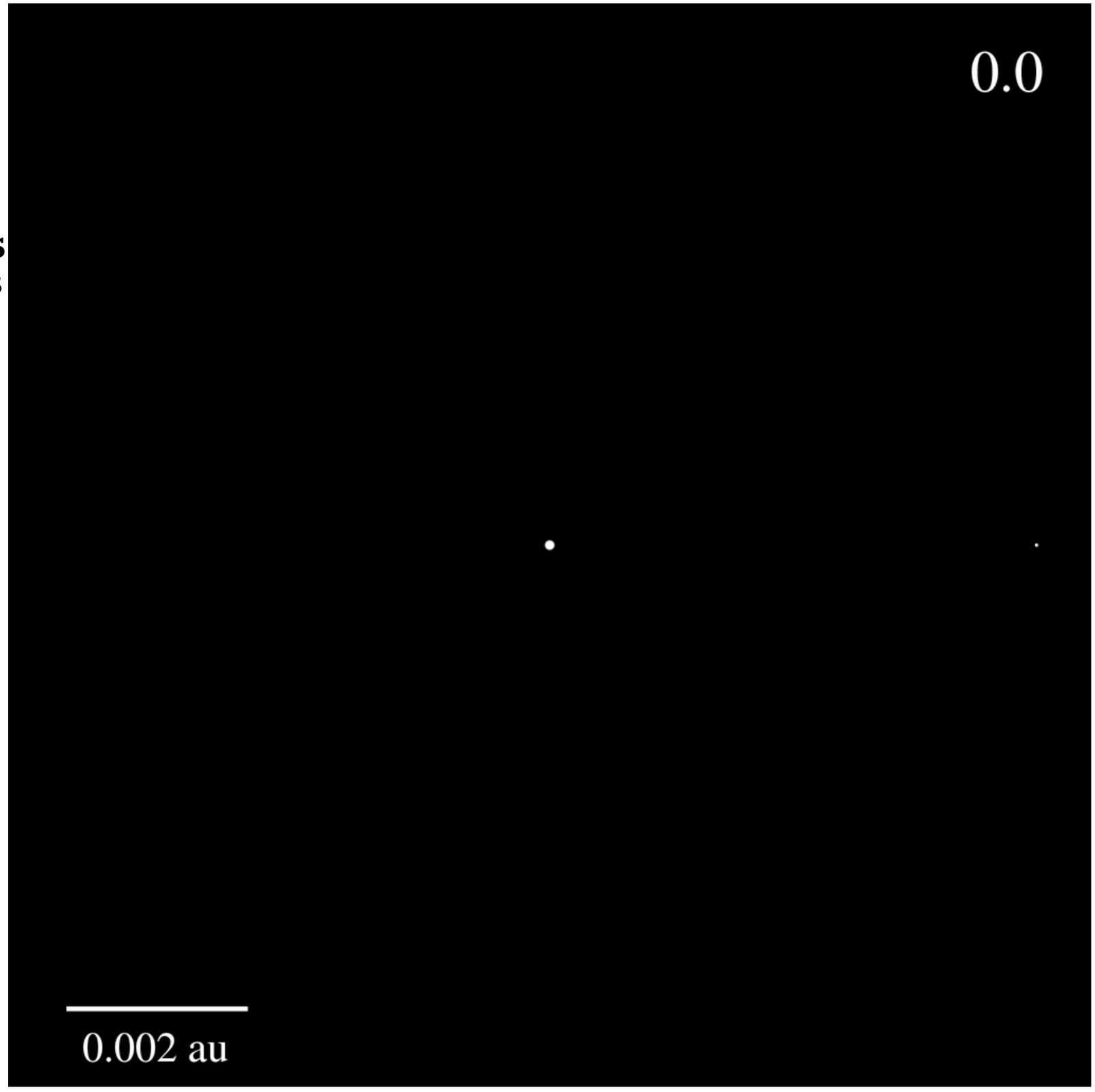
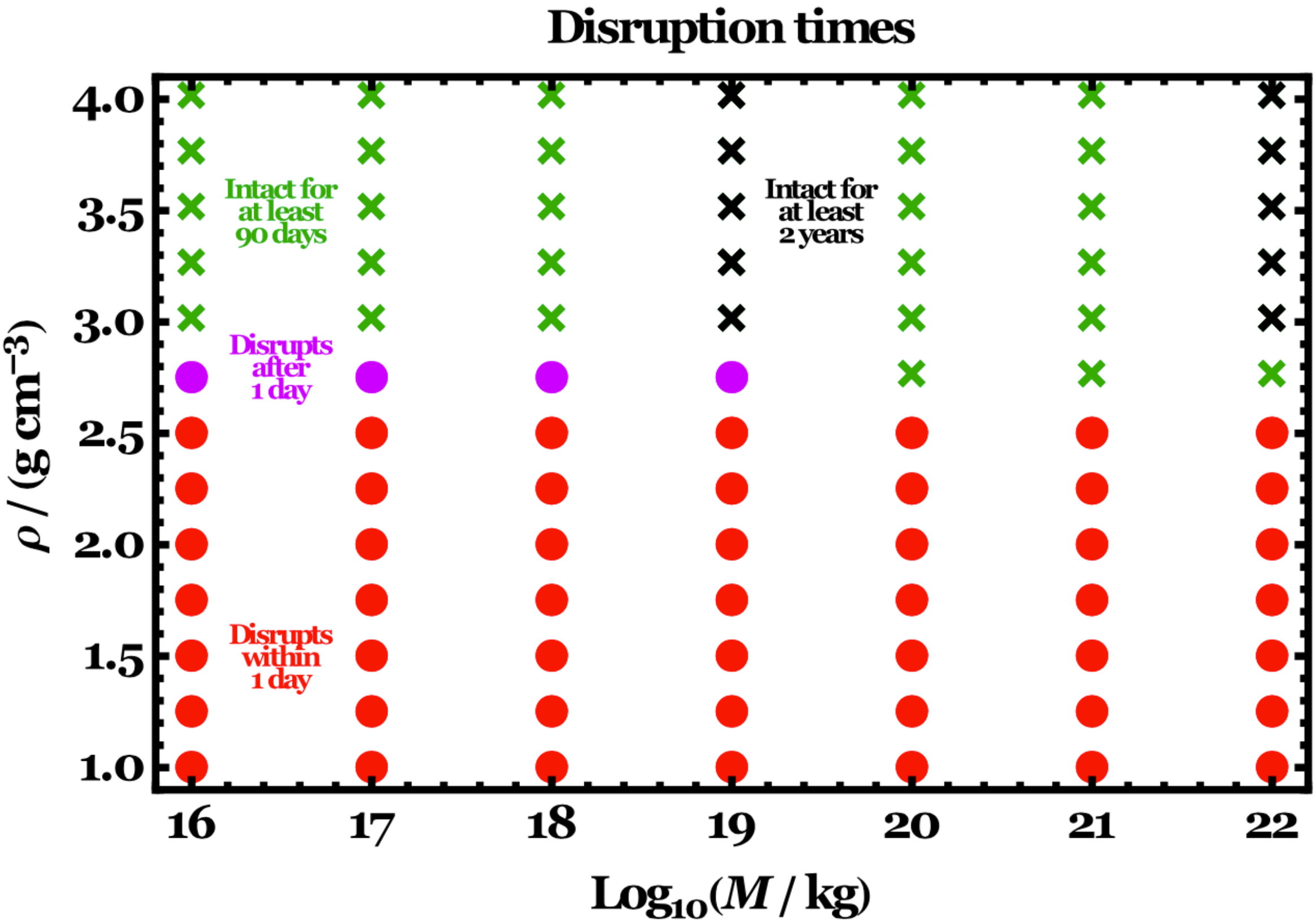


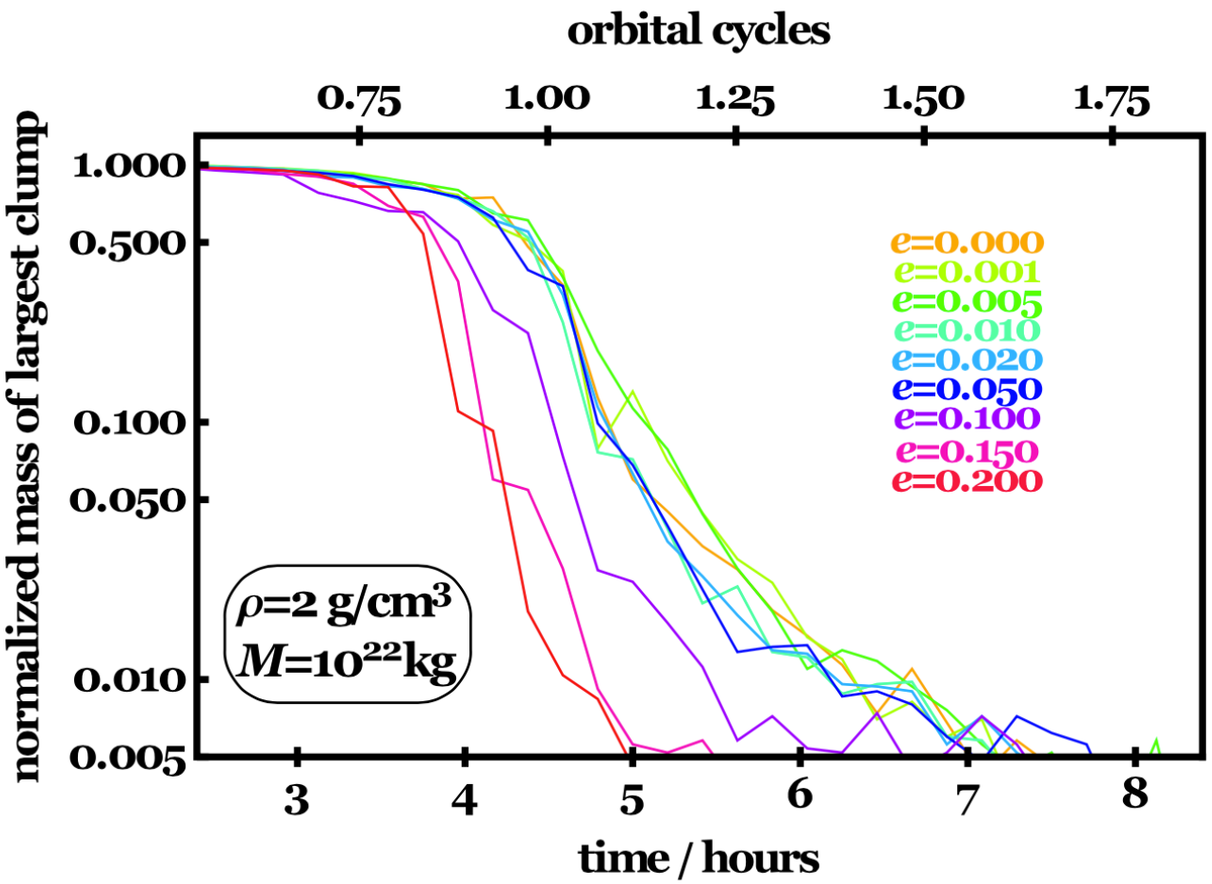
Disruption timescales: density

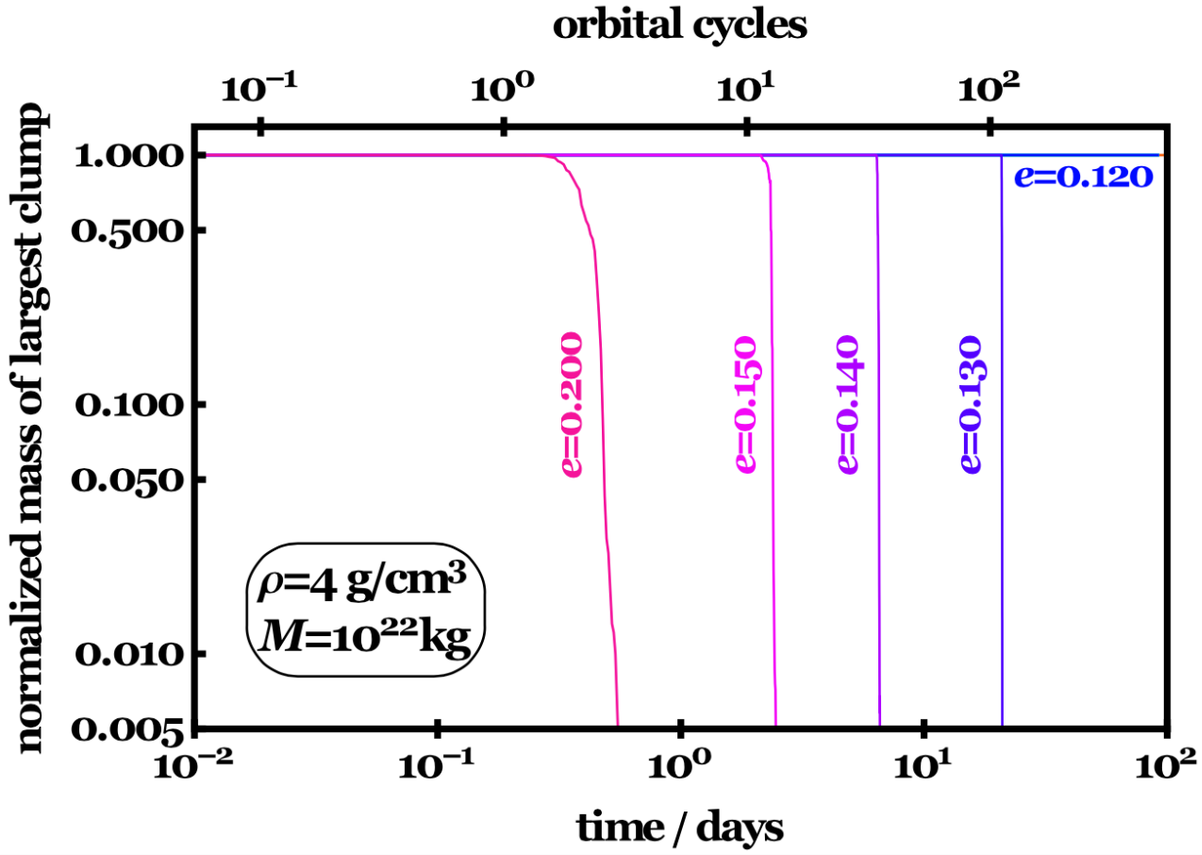
Veras et al. (2017, MNRAS, 465, 1008)



Disruption timescales: eccentricity

Veras et al. (2017, MNRAS, 465, 1008)

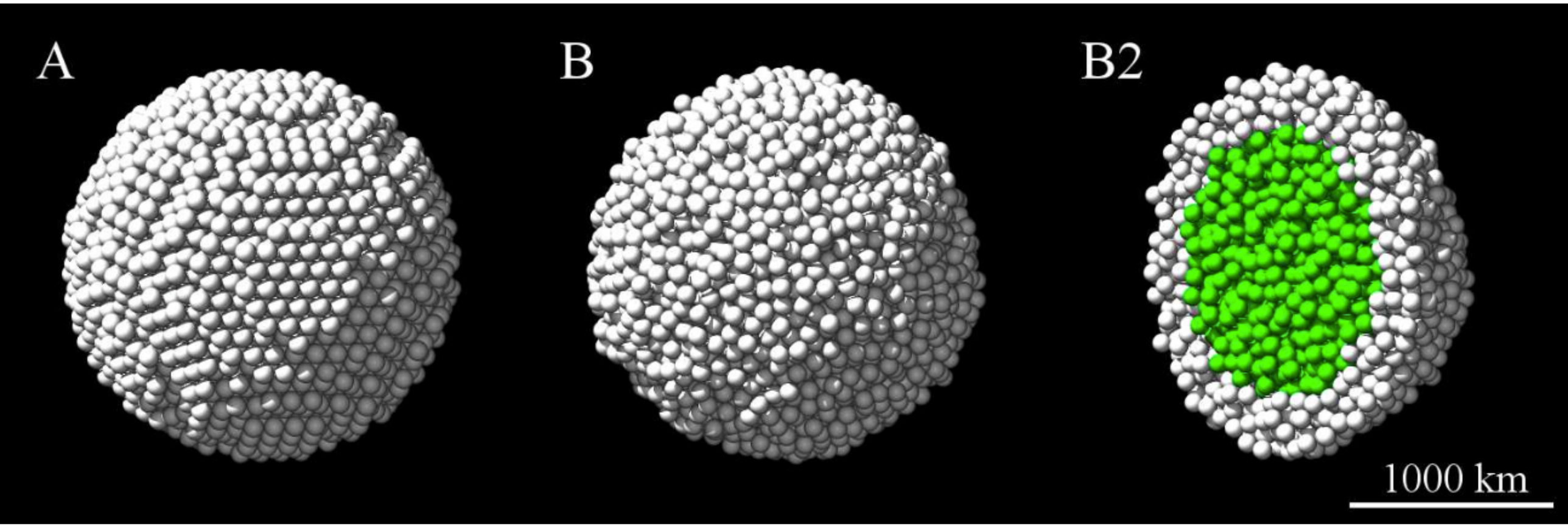




Rubble pile representations

Veras et al. (2017, MNRAS, 465, 1008)

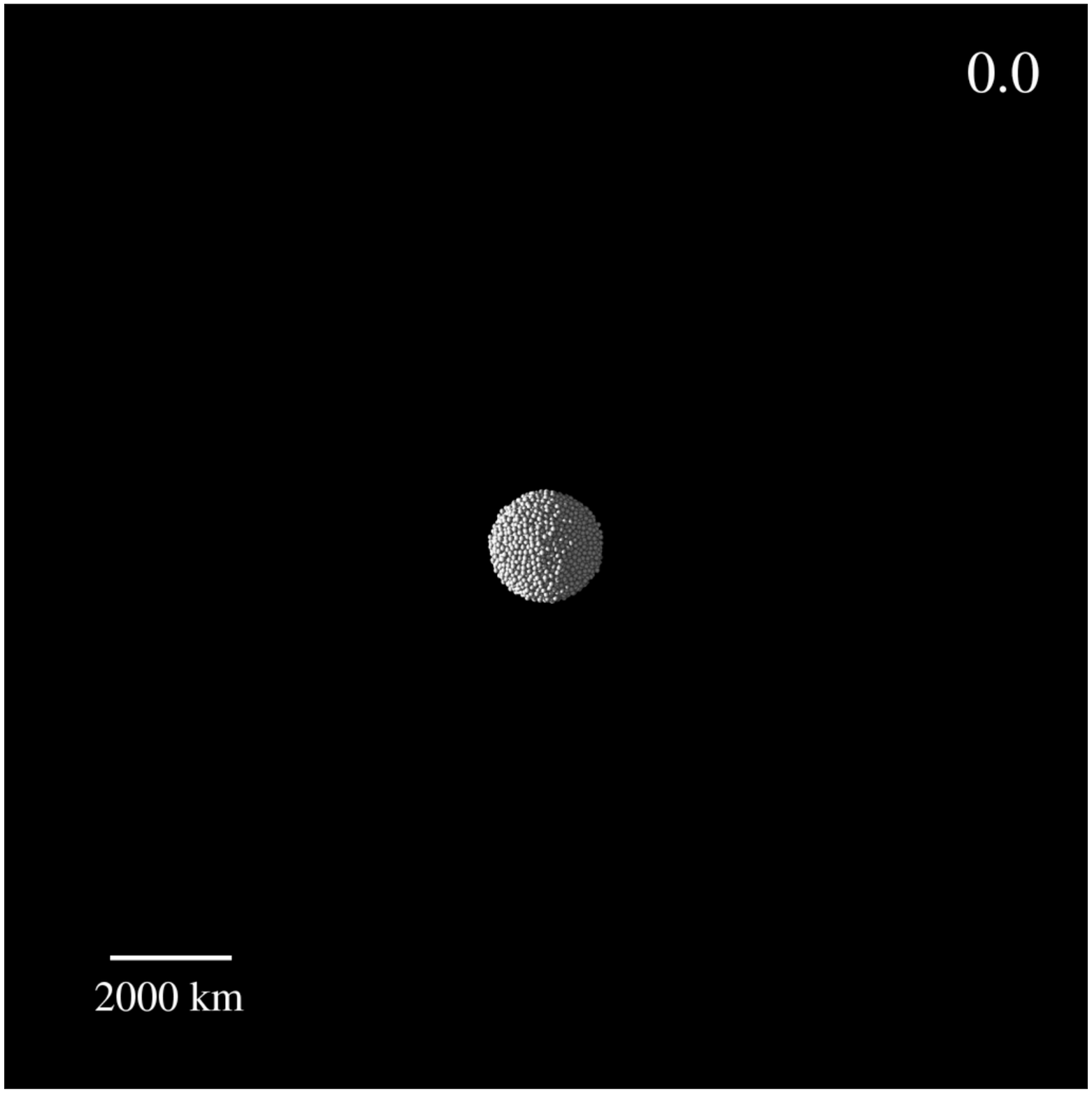
Homogeneous	**Homogeneous**	**Differentiated**
Hexagonal Closest Packing	Random Packing	Core + Mantle



Differentiated: Total disruption

Veras et al. (2017, MNRAS, 465, 1008)

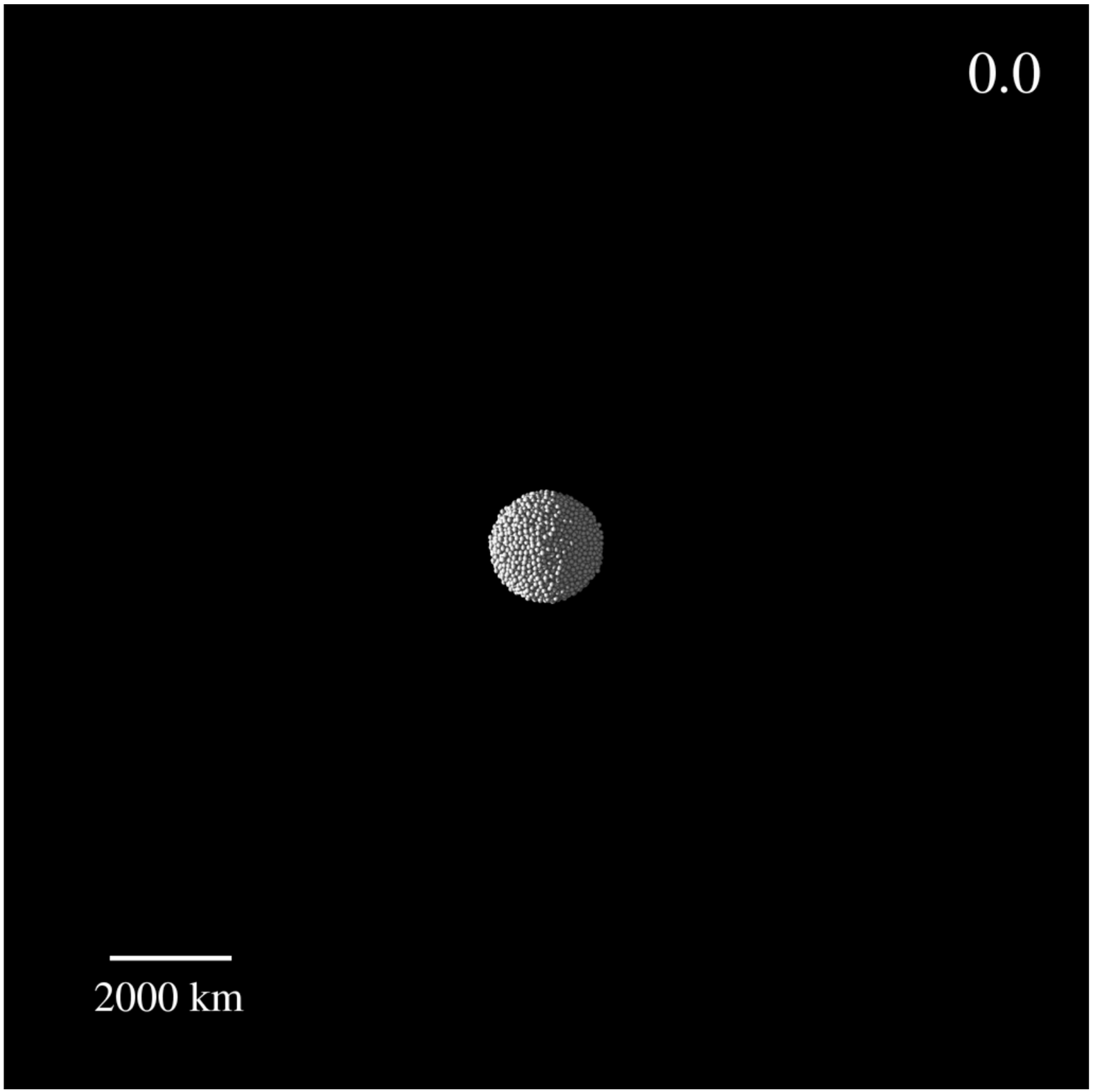
differentiated
$\rho = 3.5$ g/cm^3
$e = 0.1$
$P = 4.499$ h



Differentiated: Partial disruption

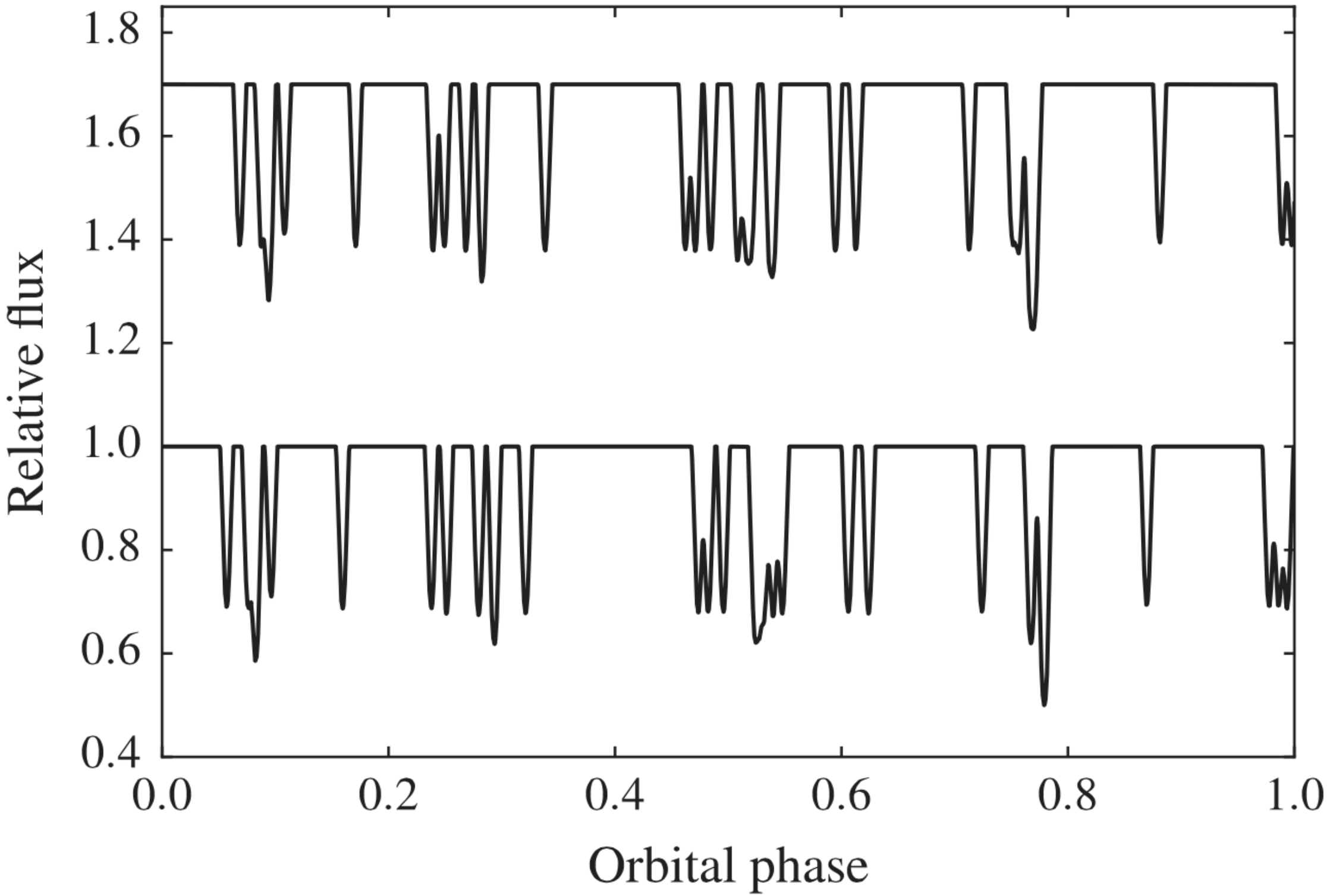
Veras et al. (2017, MNRAS, 465, 1008)

differentiated
$\rho = 3.5$ g/cm^3
$e = 0.0$
$P = 4.499$ h



Resulting transit curves

Veras et al. (2017, MNRAS, 465, 1008)



Conclusions

Veras et al. (2017, MNRAS, 465, 1008)

Asteroid disintegrating around WD 1145+017:

— Differentiated, not homogeneous

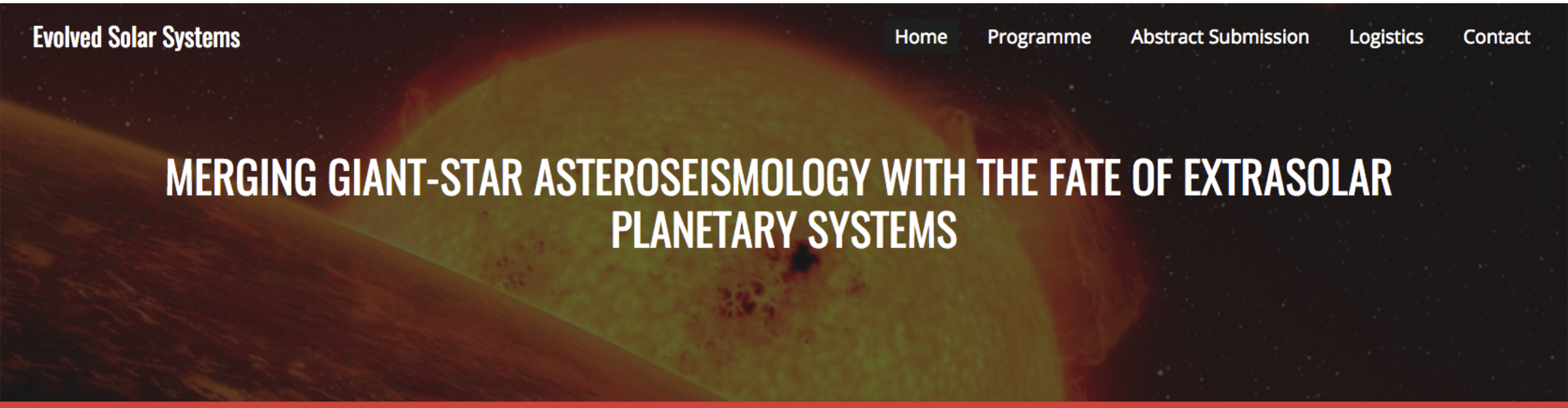
— Eccentricity < 0.01

— Bulk density 3-4 g/cm^3

From just orbital period and transit curves

Merging exoplanets & asteroseismology

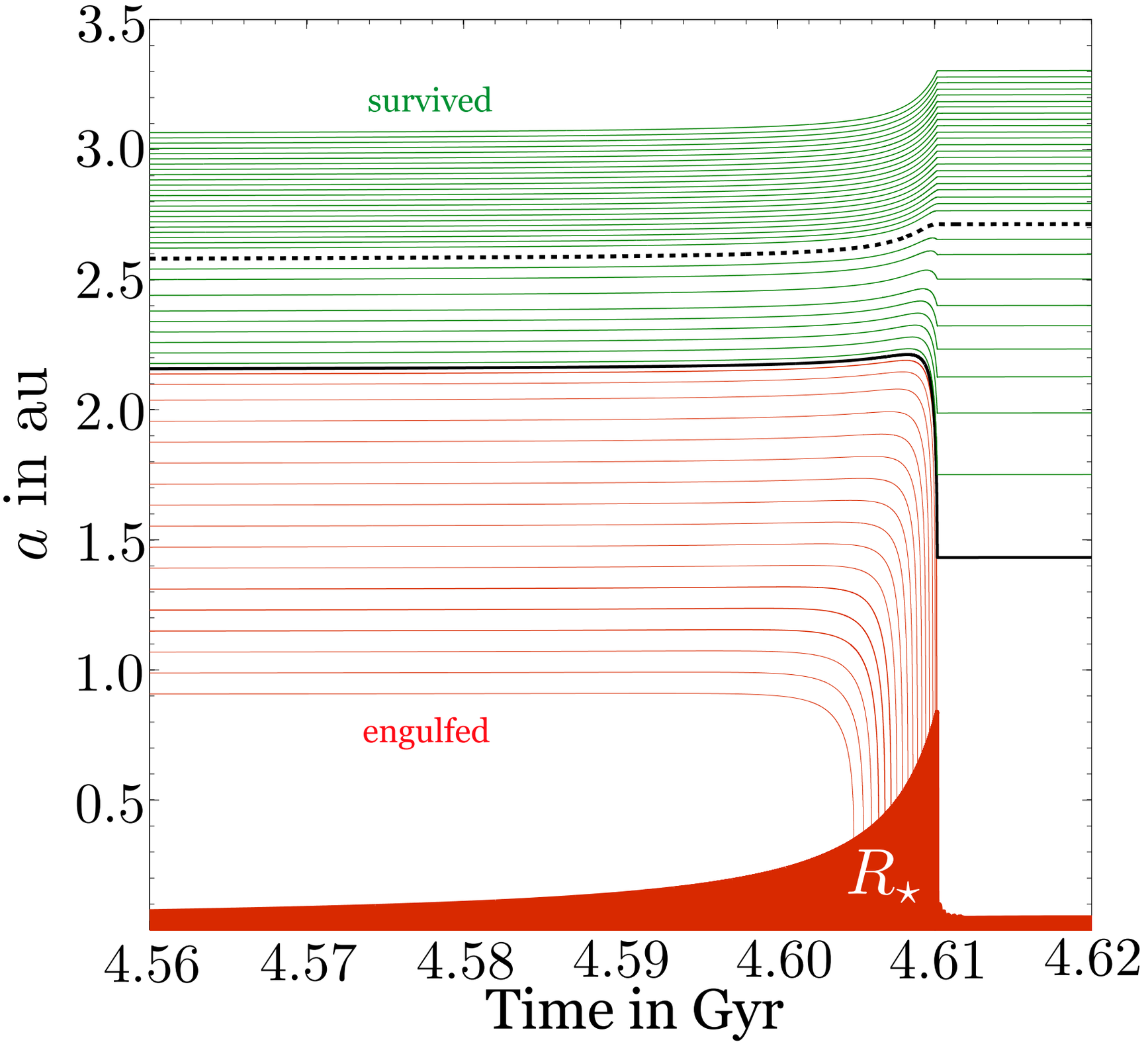
9 March 2018



goo.gl/bVLBc9

Fate of planetary systems: red giant branch

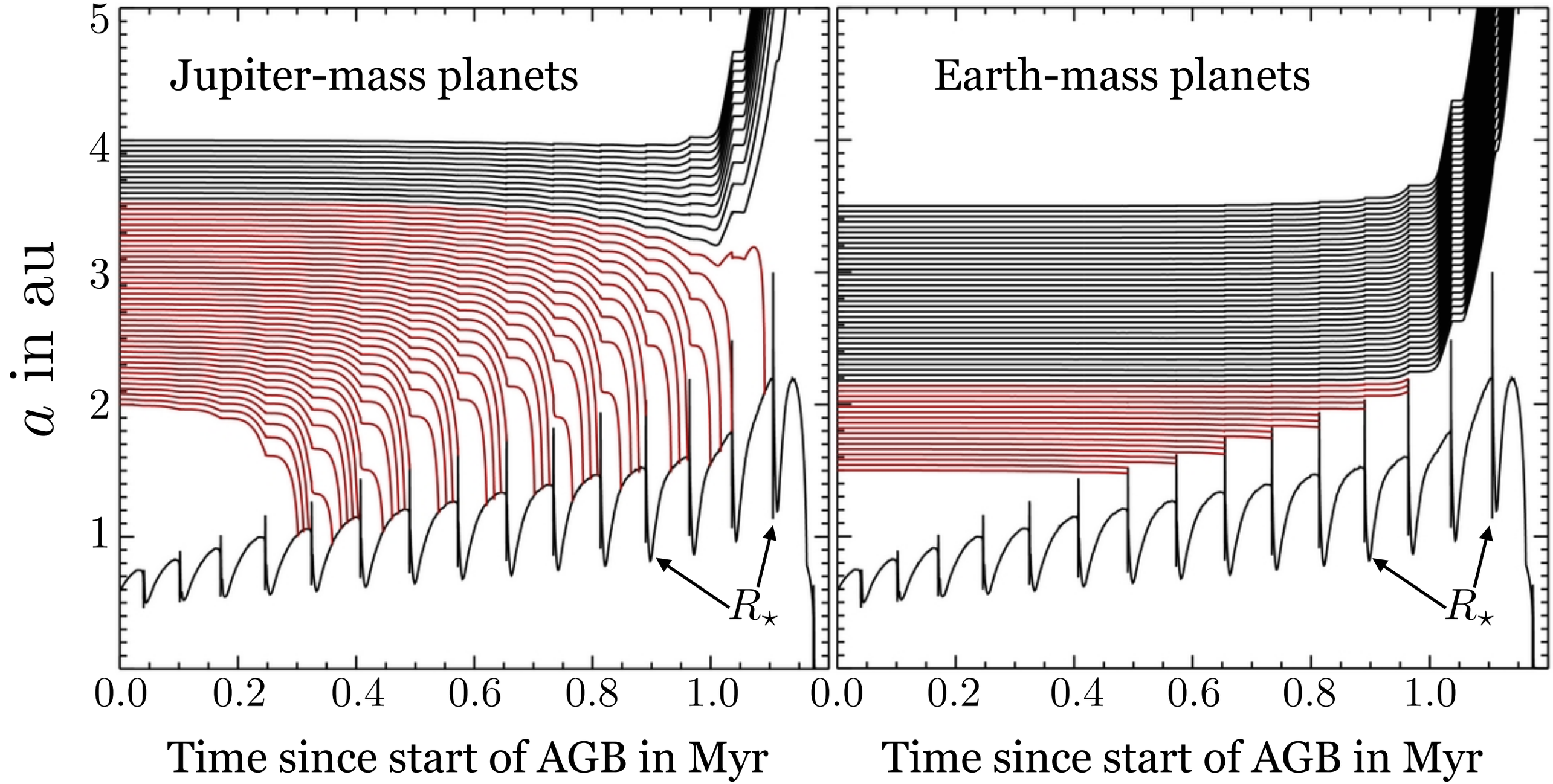
Villaver et al. (2014)



$\mathbf{1.5}M_\odot$

Fate of planetary systems: asymptotic giant branch

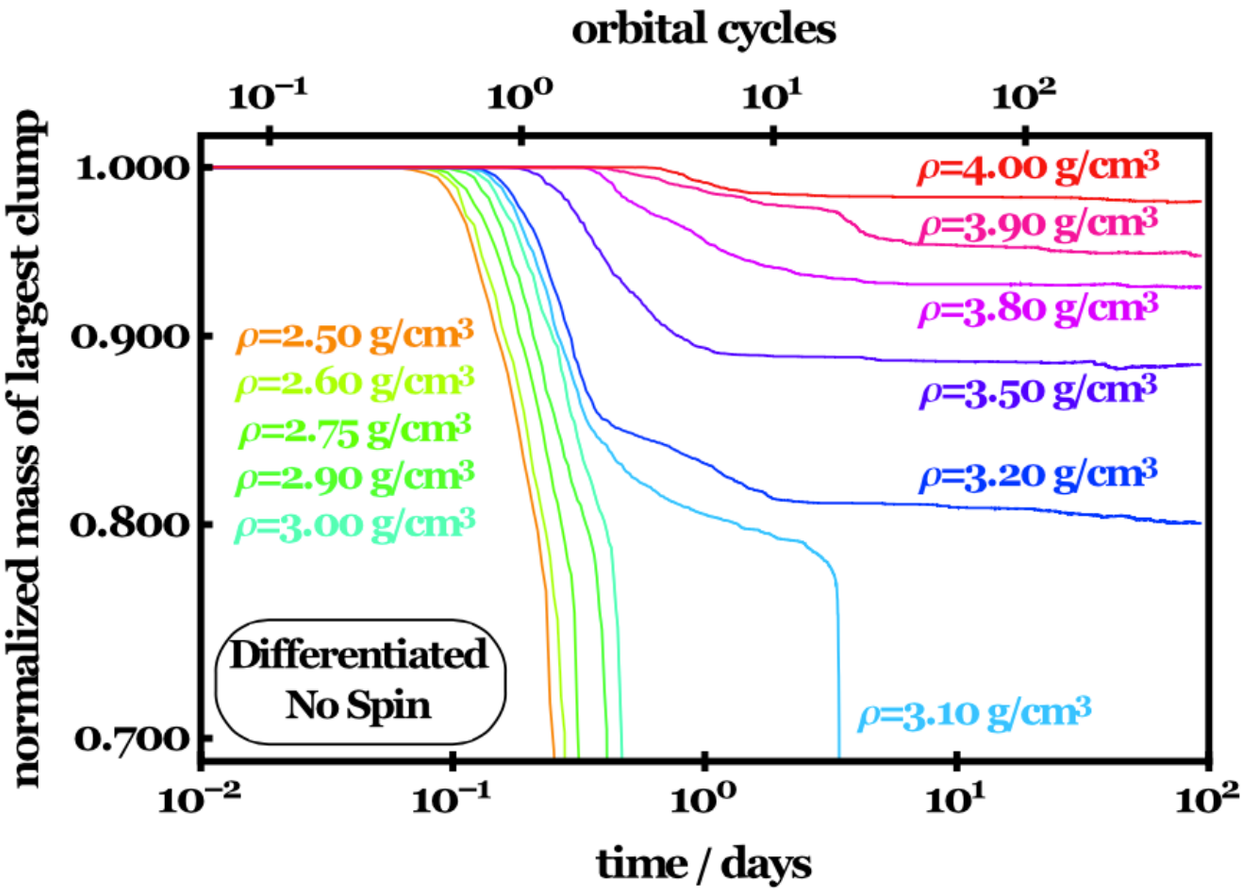
Mustill & Villaver (2012)

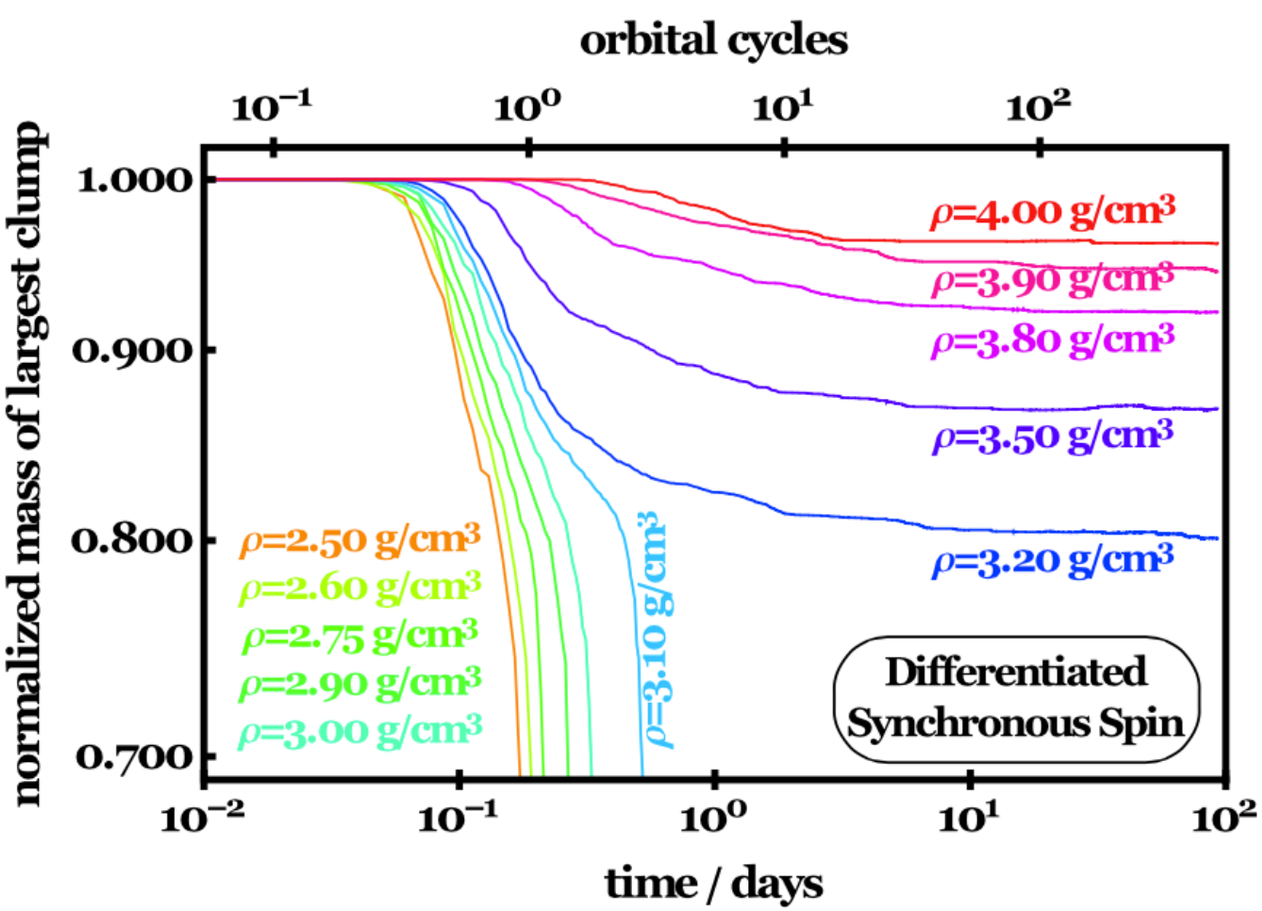


$\mathbf{2.0}M_\odot$

Partial disruption characteristics

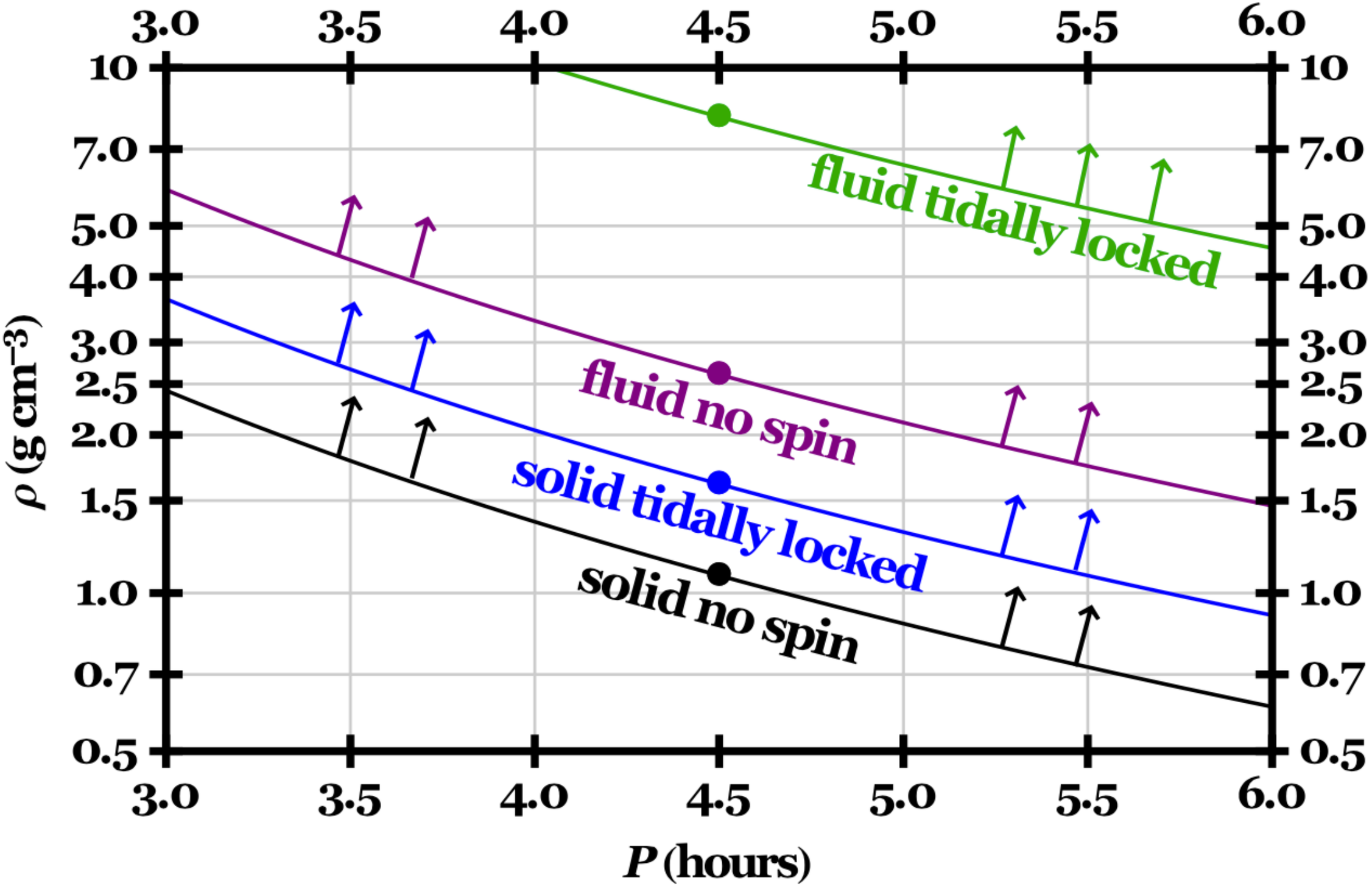
Veras et al. (2017, MNRAS, 465, 1008)





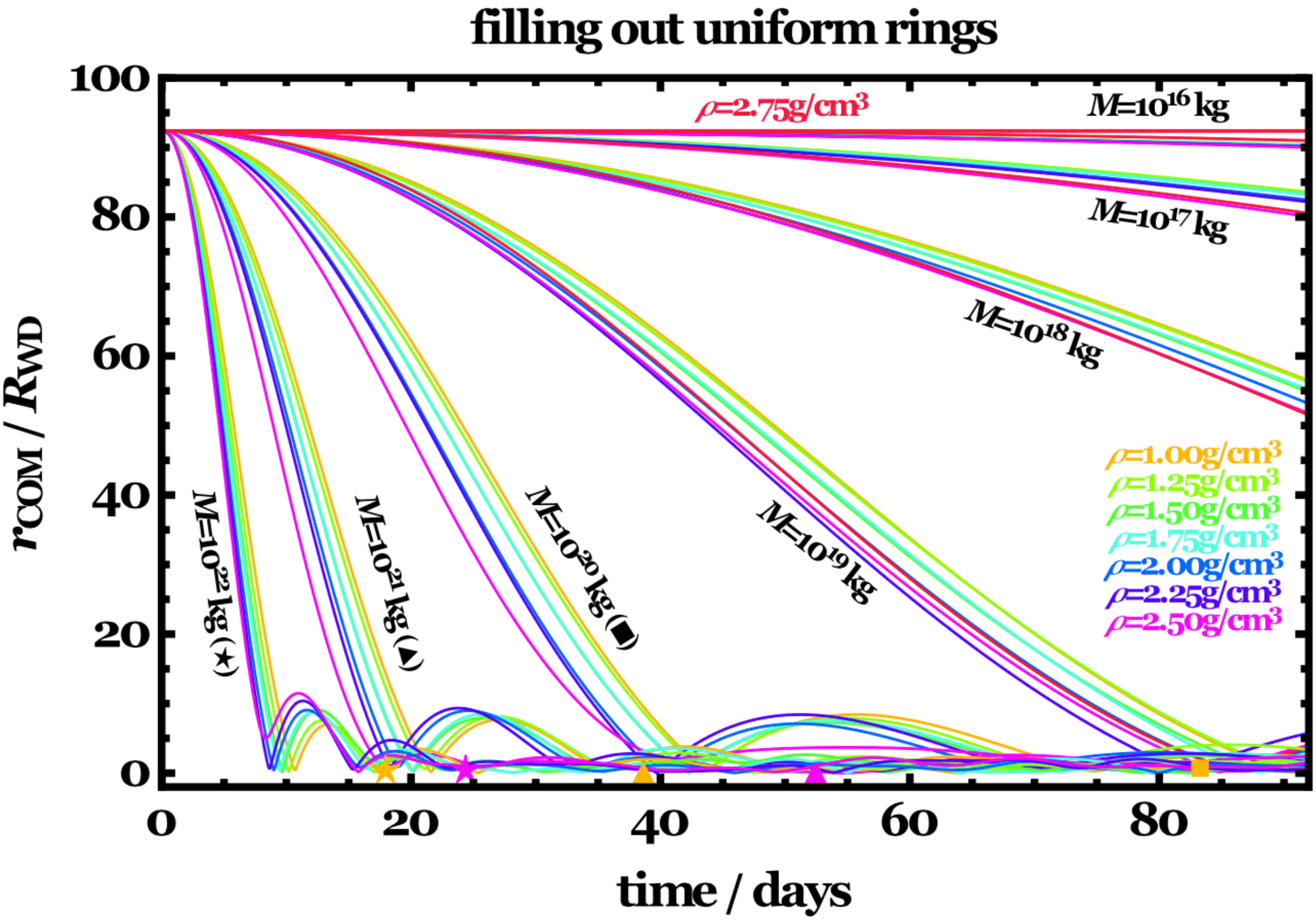
Stable to disruption

Veras et al. (2017, MNRAS, 465, 1008)



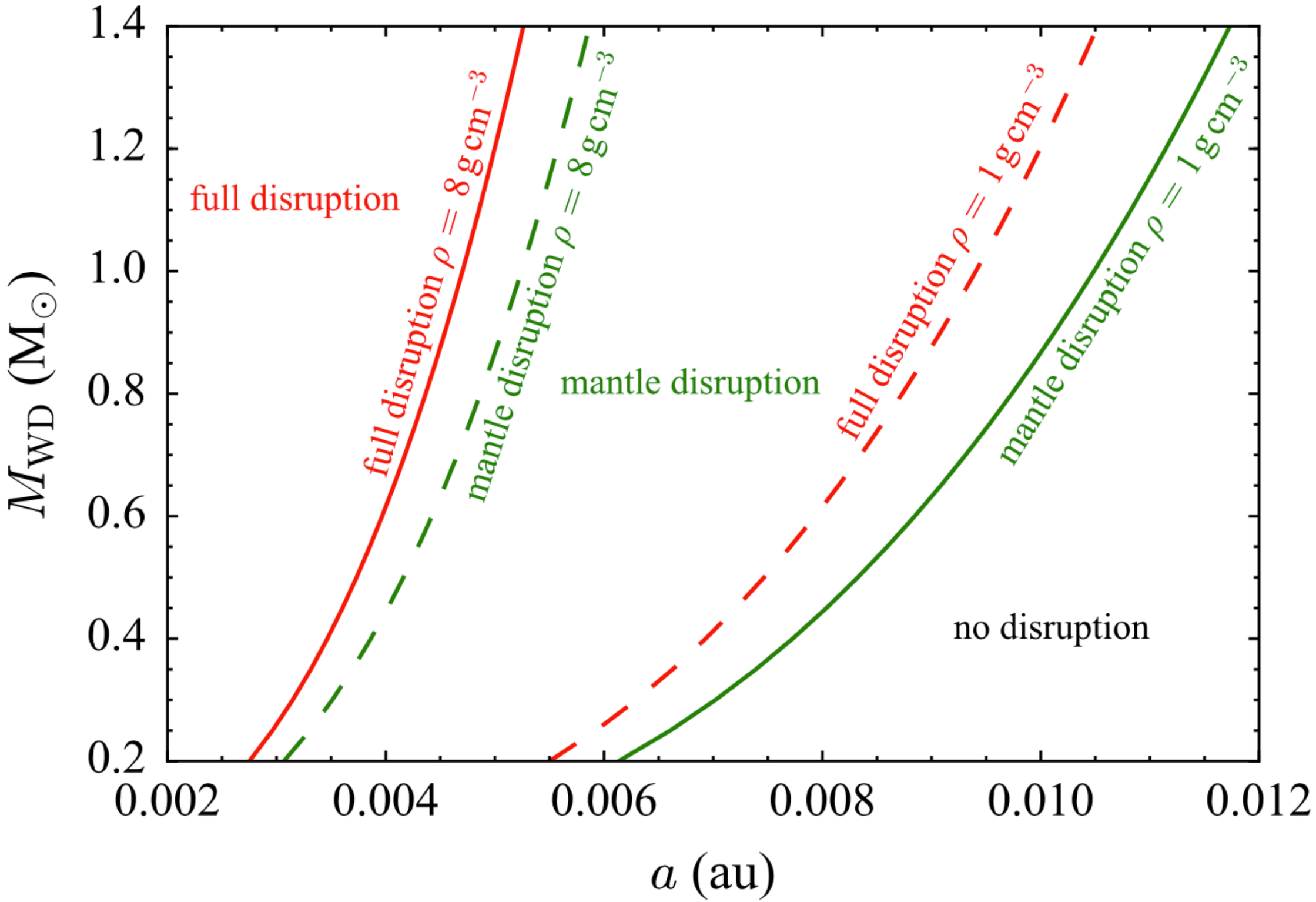
Ring / disc formation timescales

Veras et al. (2017, MNRAS, 465, 1008)



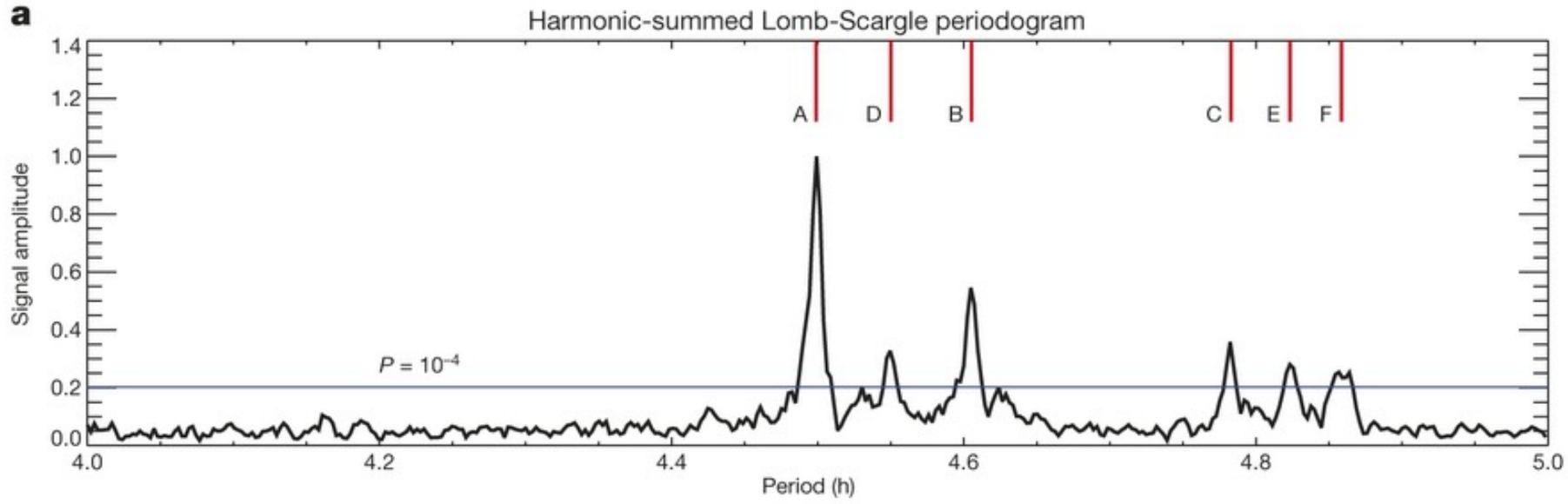
Useful for other white dwarfs

Veras et al. (2017, MNRAS, 465, 1008)



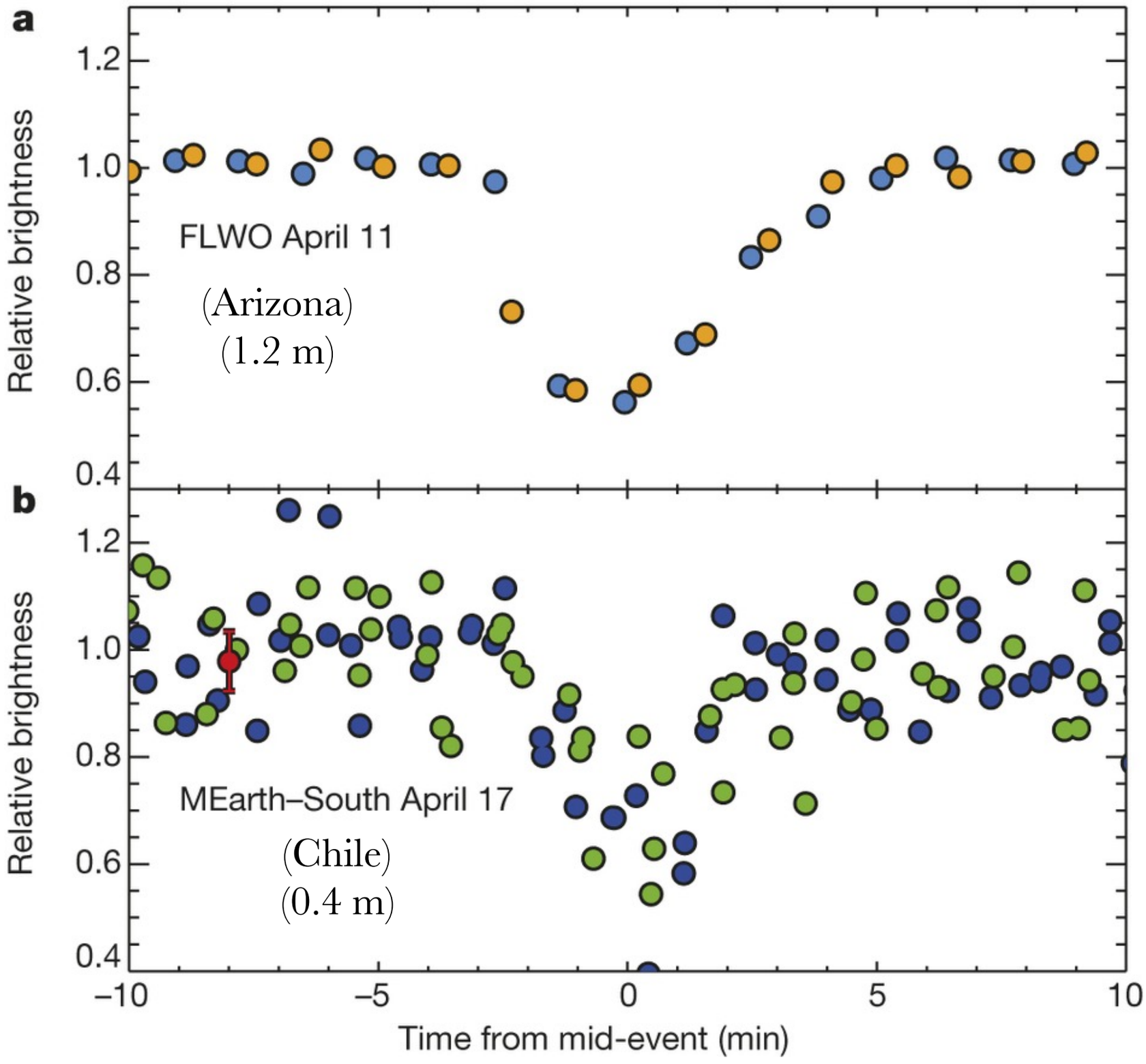
Basic observational background

Vanderburg et al. (2015, Nature, 526, 546-549)



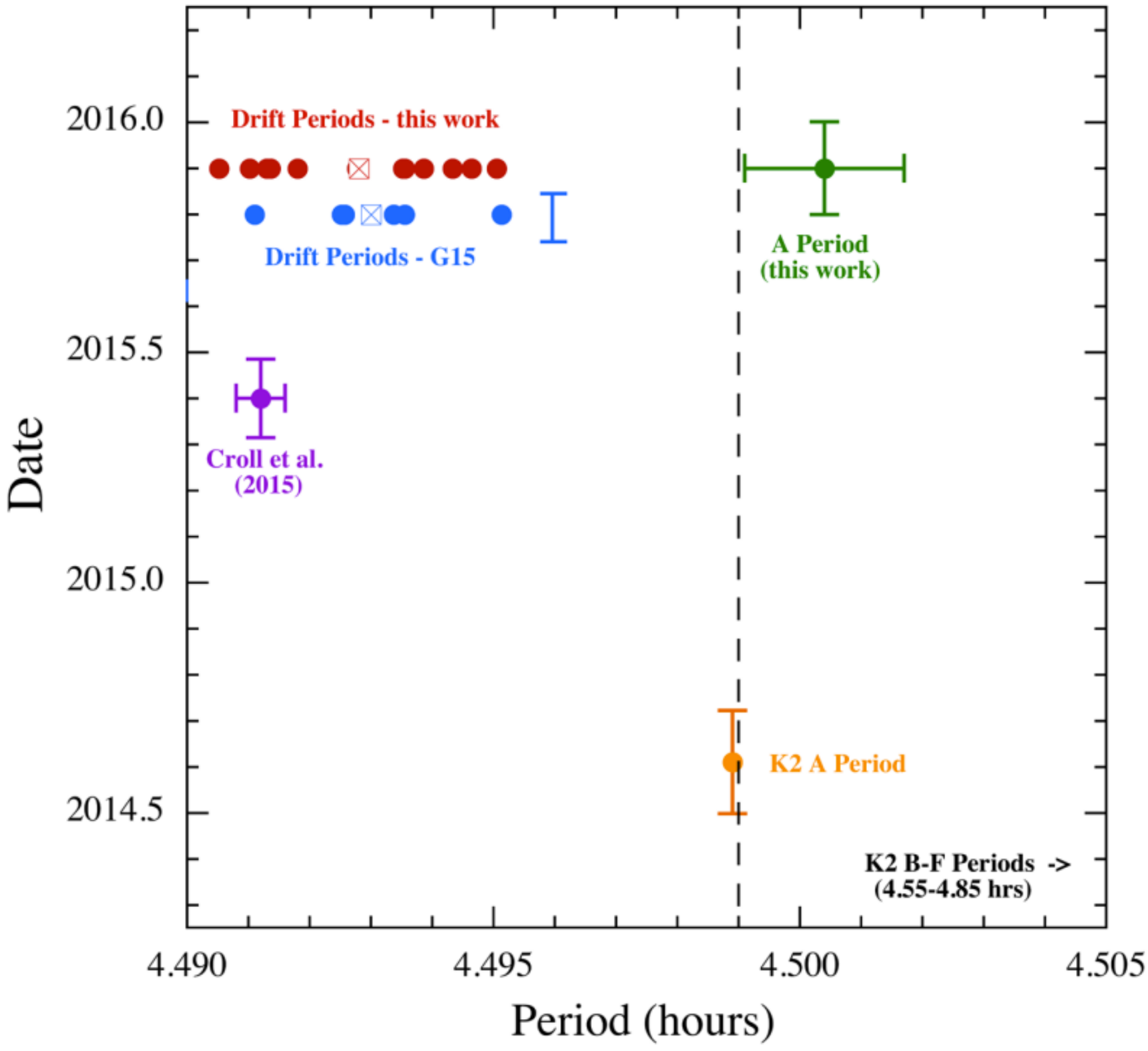
Basic observational background

Vanderburg et al. (2015, Nature, 526, 546-549)



Use other repeating features

Rappaport et al. (2016, MNRAS, 458, 3904)



Constraining mass

Gurri et al. (2017, MNRAS, 464, 321)