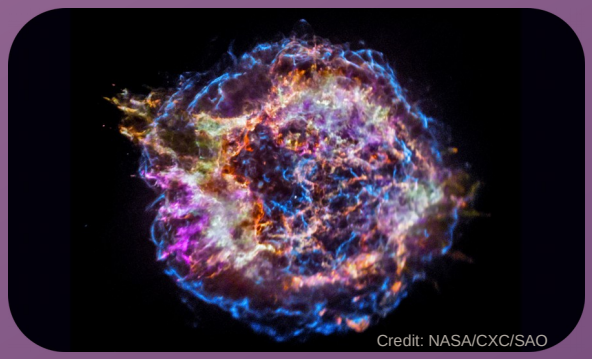
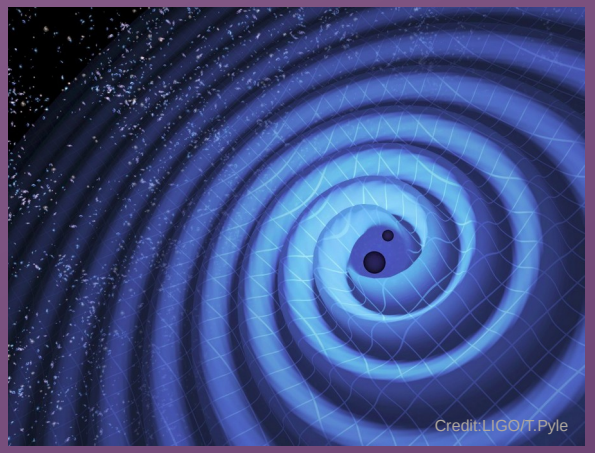
From stripped stars to GWs



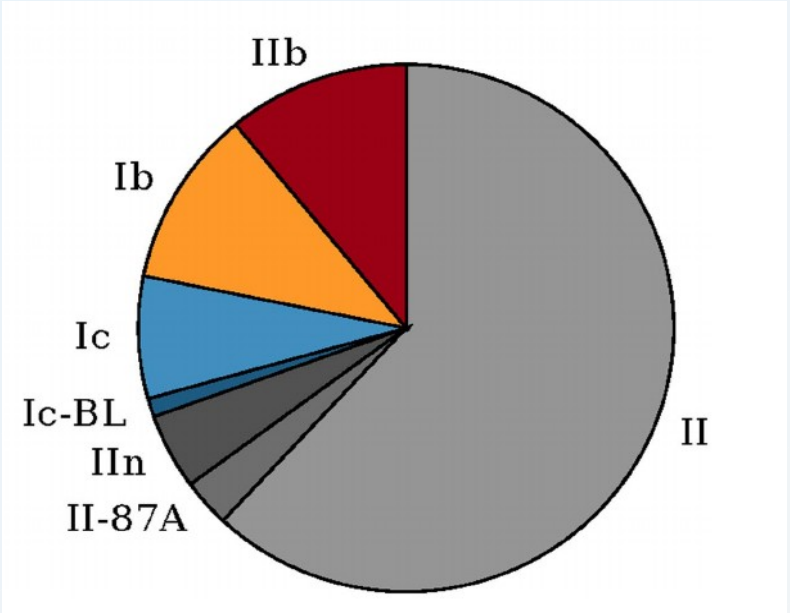


Eva Laplace
Selma de Mink, Stephen Justham
Ylva Götberg, Rob Farmer,
Manos Zapartas, Mathieu Renzo,
Antony Piro, David Vartanyan

FOE conference 2019
Raleigh, NC

Stripped SNe (IIb, Ib/c)

- Common

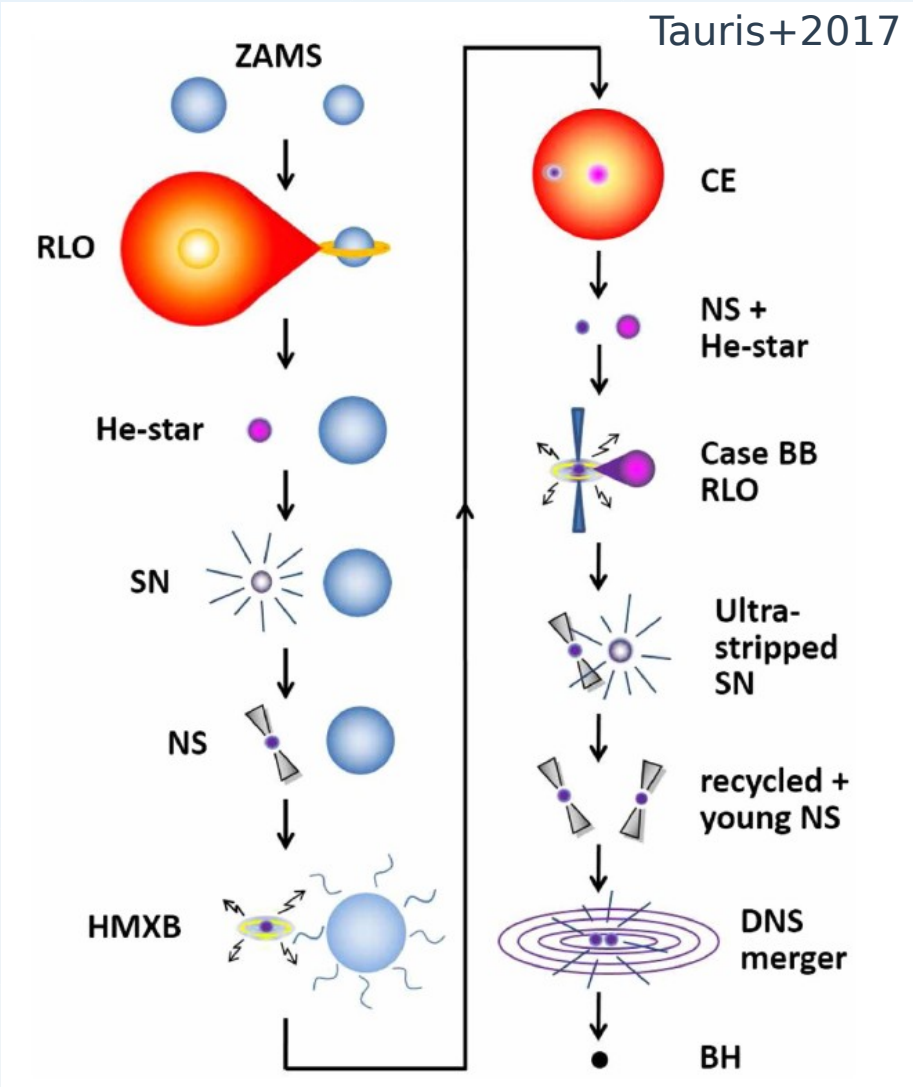


Relative fraction of core-collapse SNe in a volume-limited sample (Shivvers+ 2017)

cf. Nomoto+1984; Dewi&Pols 2001, 2002; Yoon+2010; 2017; Bersten+2011; Li+2011; Eldridge+2013; Moriya+2014; Shivvers+2017; Arcavi+2017; Tauris +2017; Dessart+2018

Stripped SNe

- Common
- Important for gravitational waves (GW) sources



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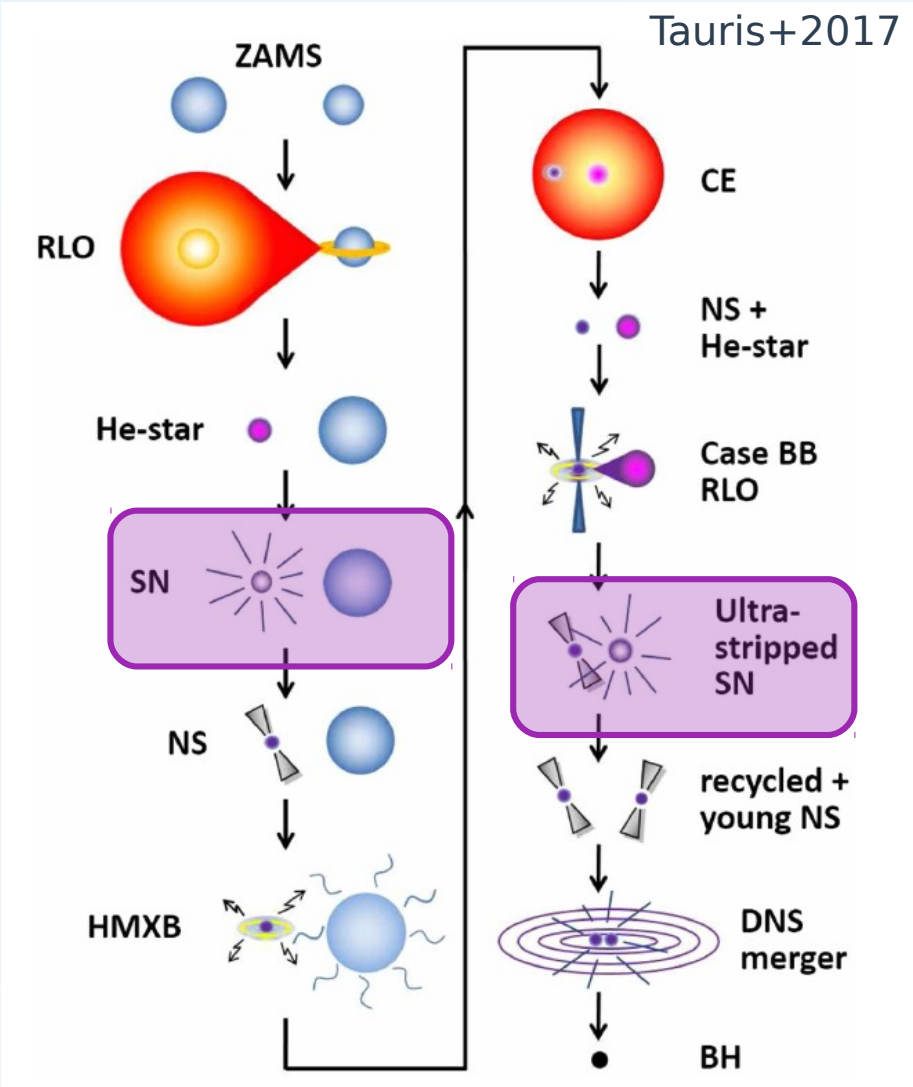

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Project

Stellar evolution

MESA
Modules for Experiments in Stellar Astrophysics

c.f. Paxton+2011,2013,2015, 2018, 2019

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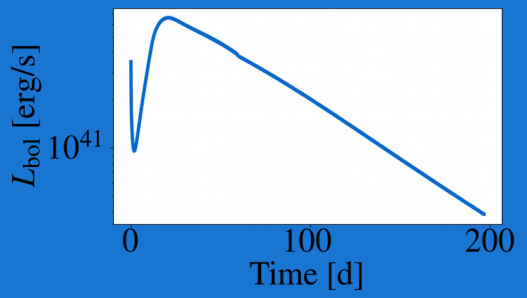
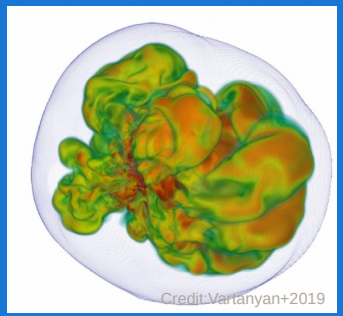


3D SN explosions

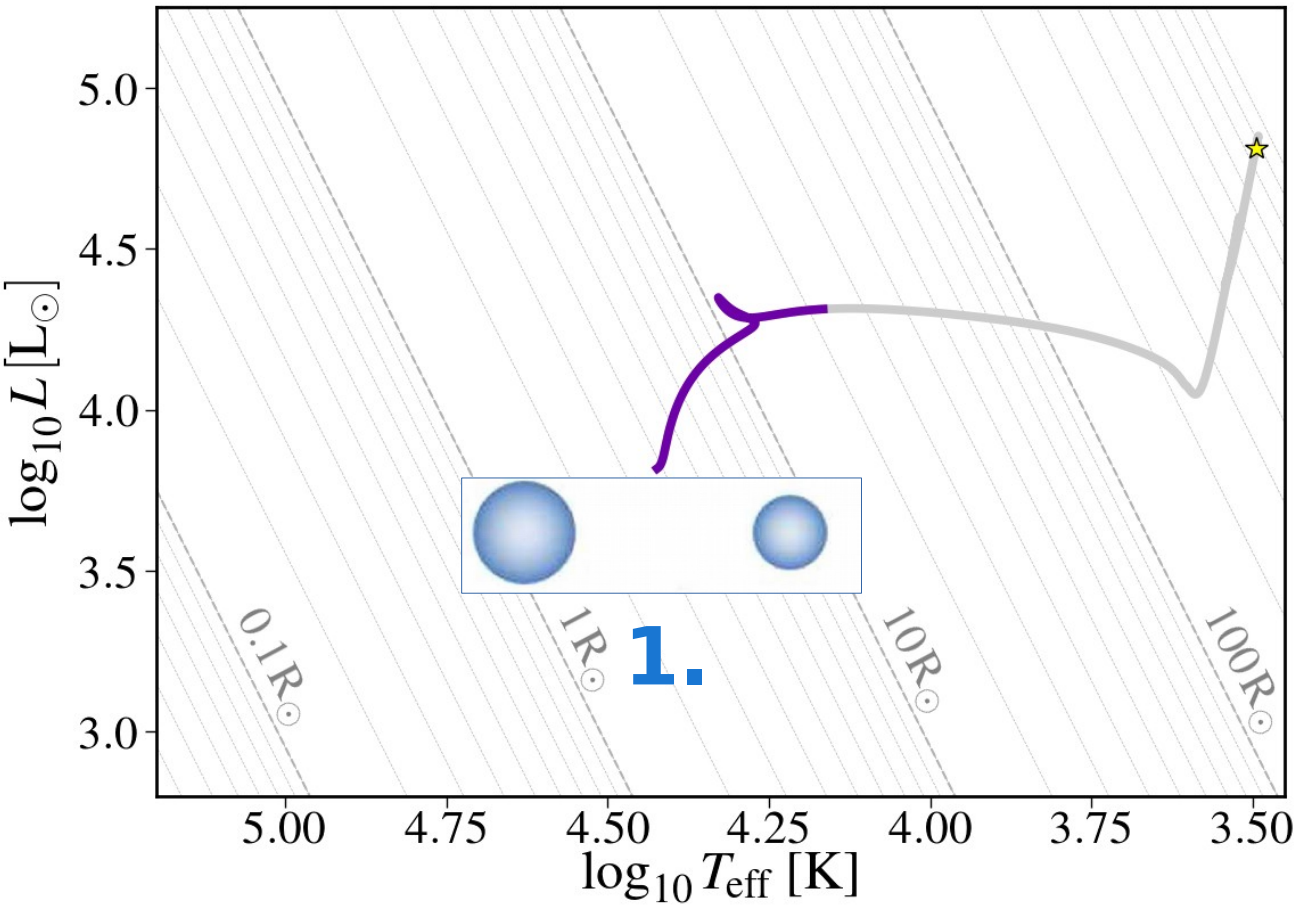


Progenitor evolution

$M_1 = 10.5\ M_{sun}$

$P_{orb} = 25$ d

$q = 0.8$



cf. Kippenhahn & Weigert 1967; Habets+1986; Dewi&Pols 2001, 2002; Yoon+2010, 2015, 2017, 2018; Bersten+2011; Eldridge+2013; Götberg+2017, 2018; Gilkis+2019

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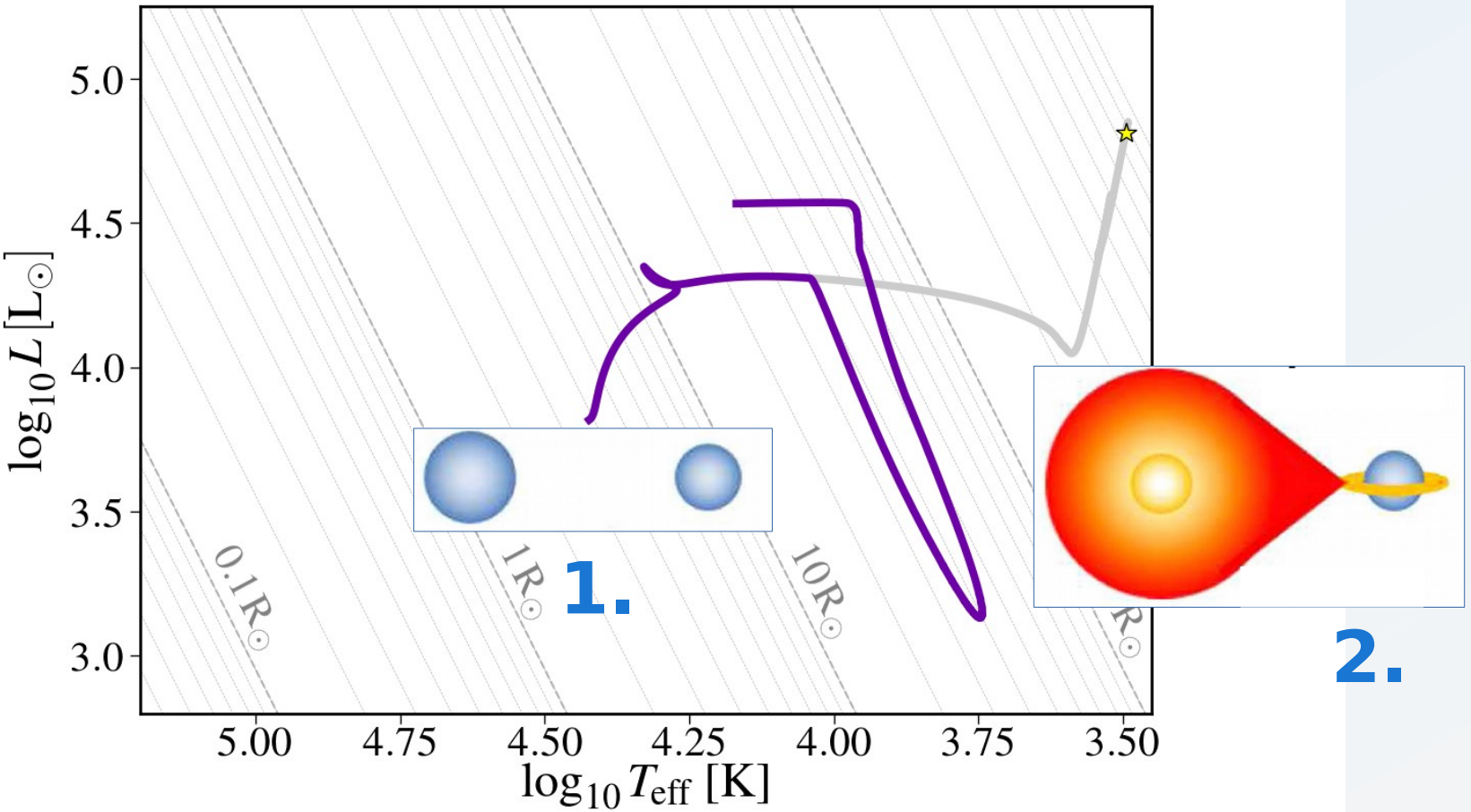

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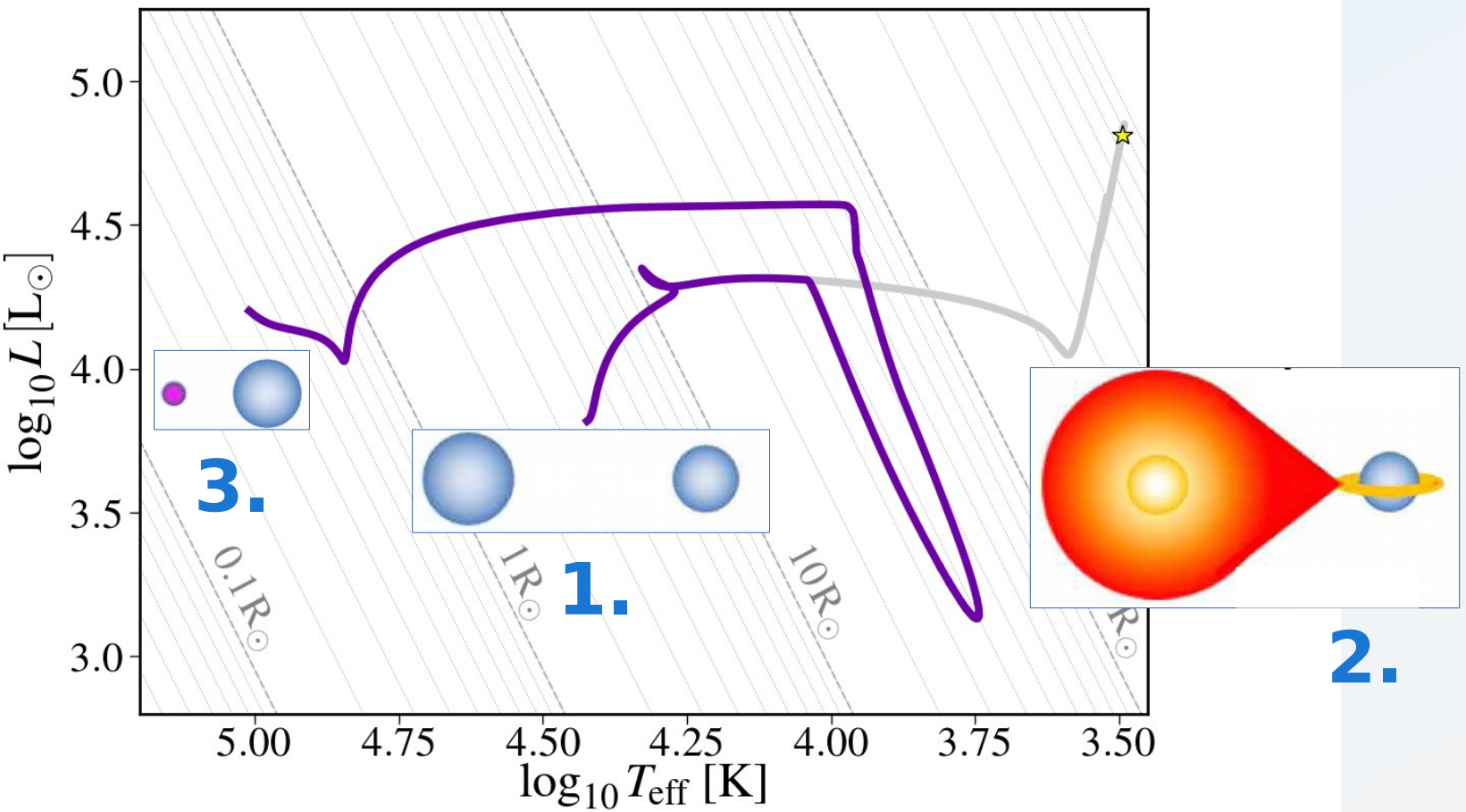

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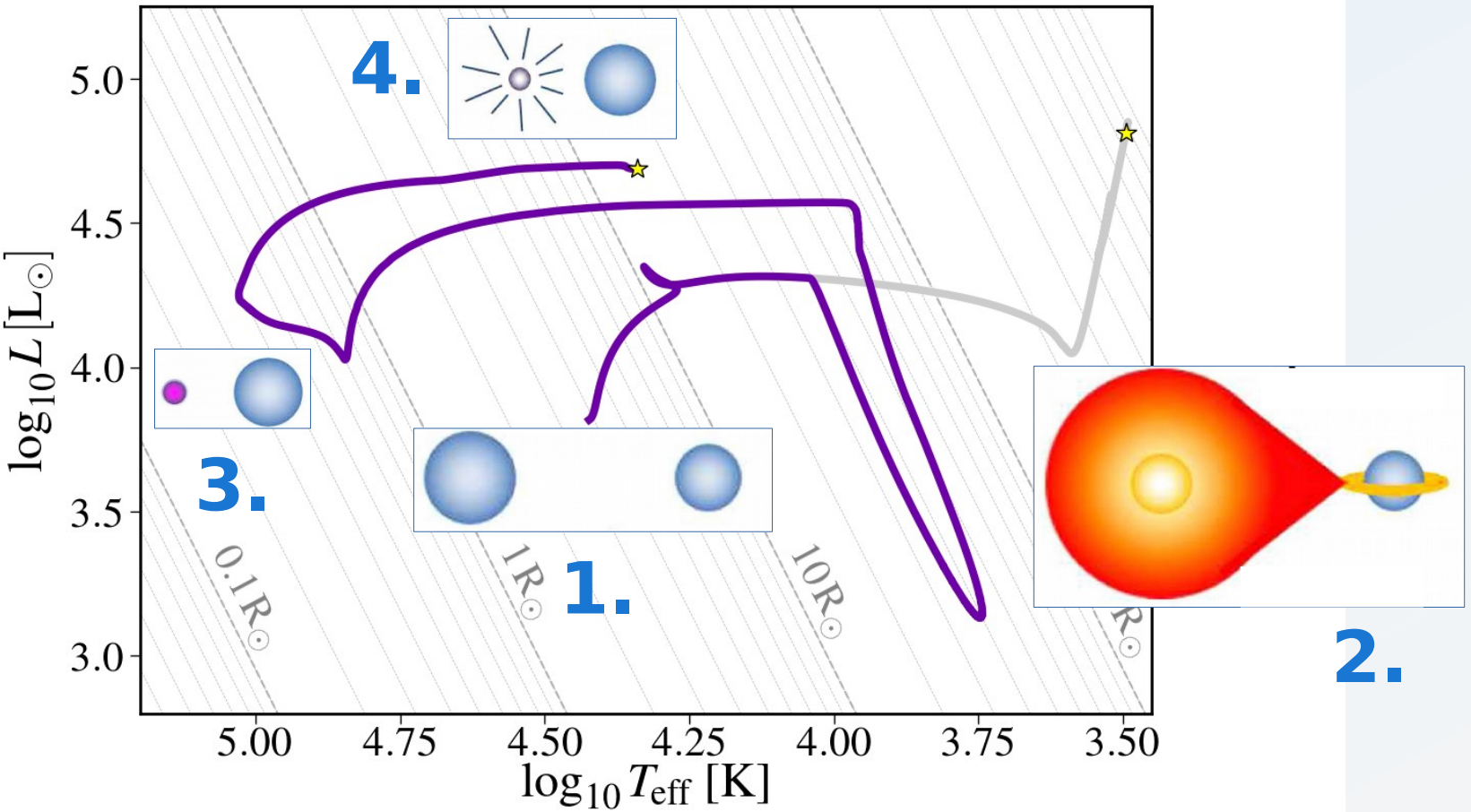

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Grid of stripped stars: solar metallicity

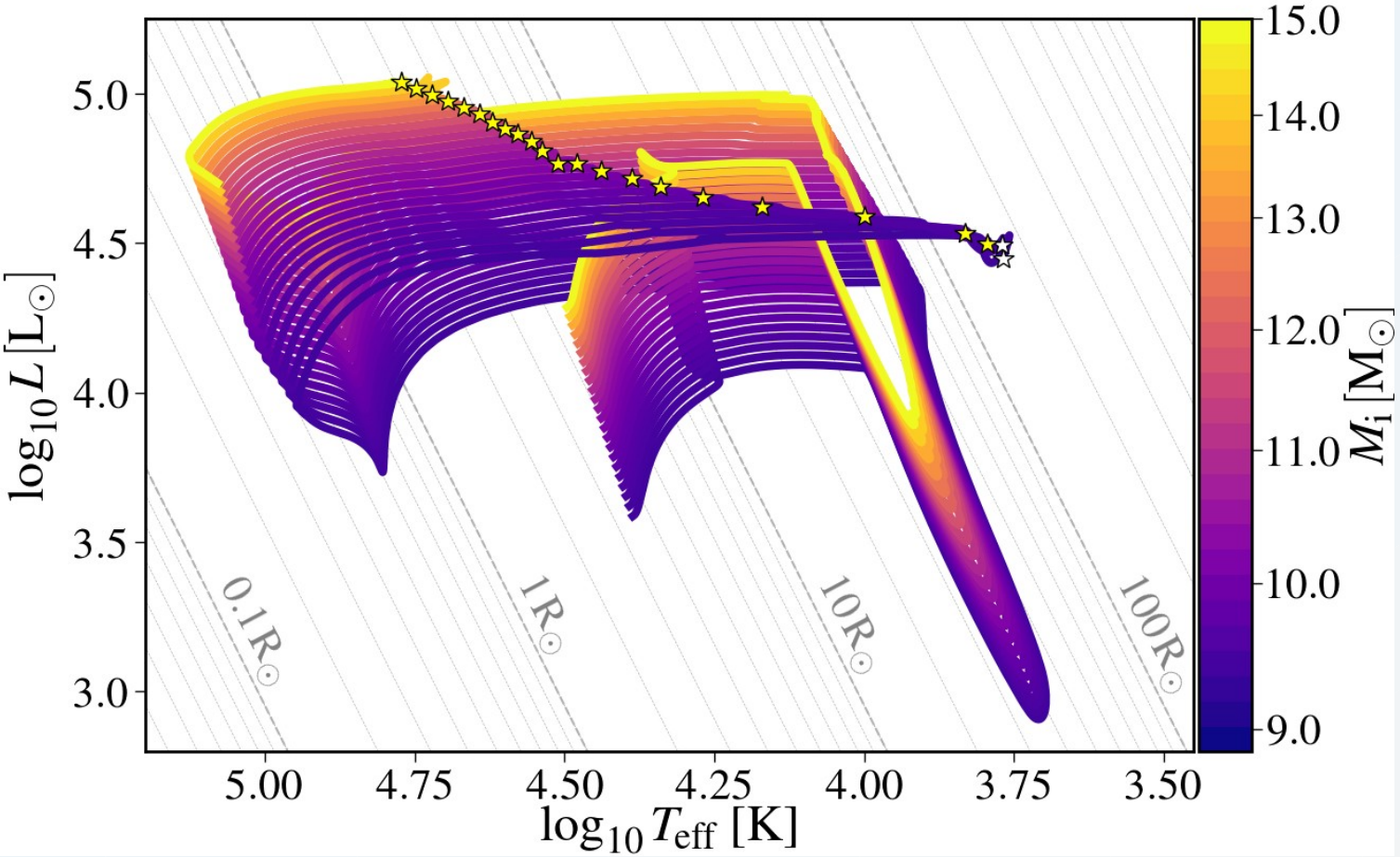
M_1: 8.8 – 15 M_{Sun}

q = 0.8

P_{orb} = 25 d

Z = 0.0142

Laplace et al. in prep.



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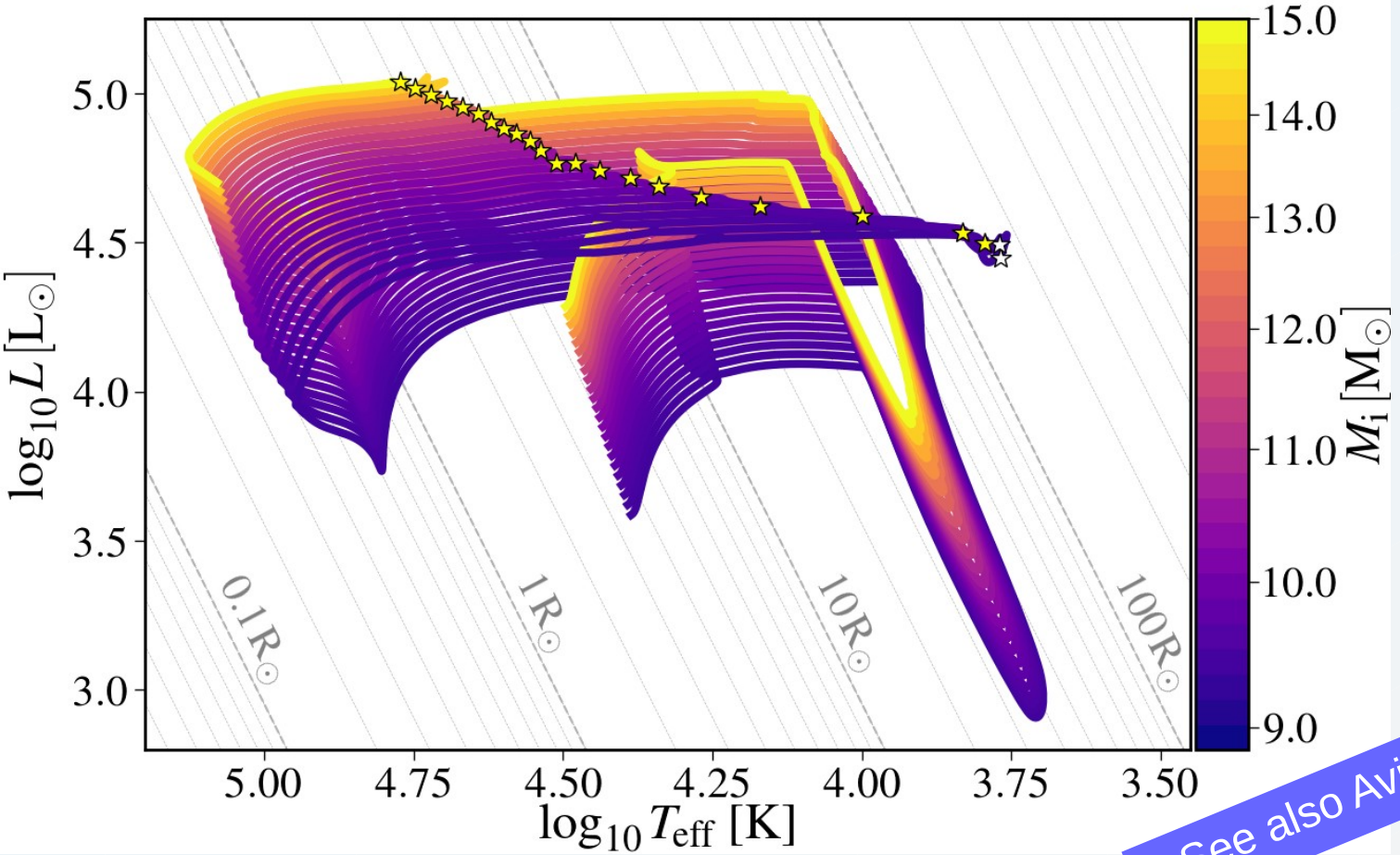

See also Avishai's talk!

cf. Kippenhahn & Weigert 1967; Habets+1986; Dewi&Pols 2001, 2002; Yoon+2010, 2015, 2017, 2018; Bersten+2011; Eldridge+2013; Götberg+2017, 2018; Gilkis+2019

Grid of stripped stars: lower metallicity

M_1: 8.8 – 15 M_{Sun}

q = 0.8

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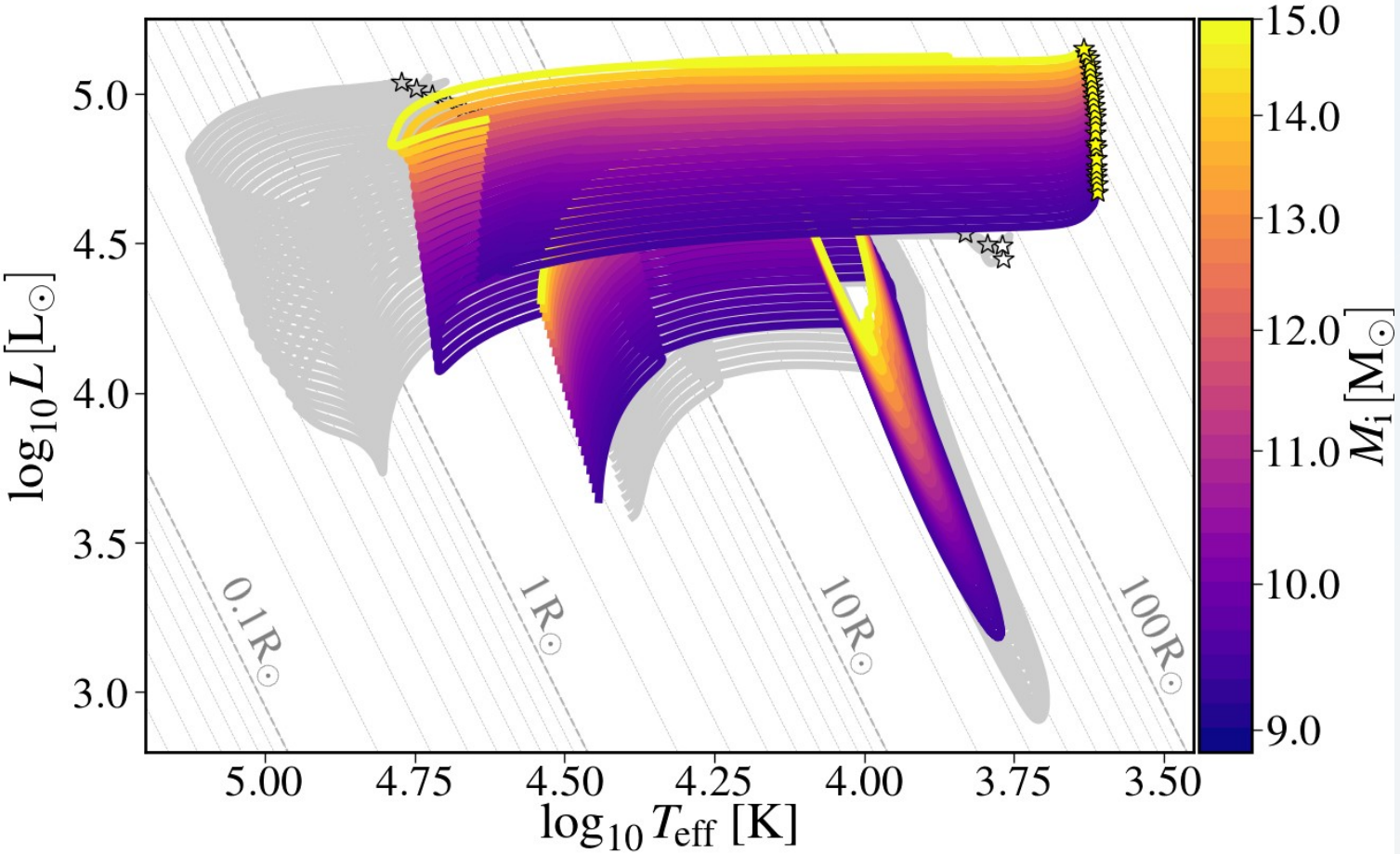
Z = 0.001

Laplace et al. in prep.



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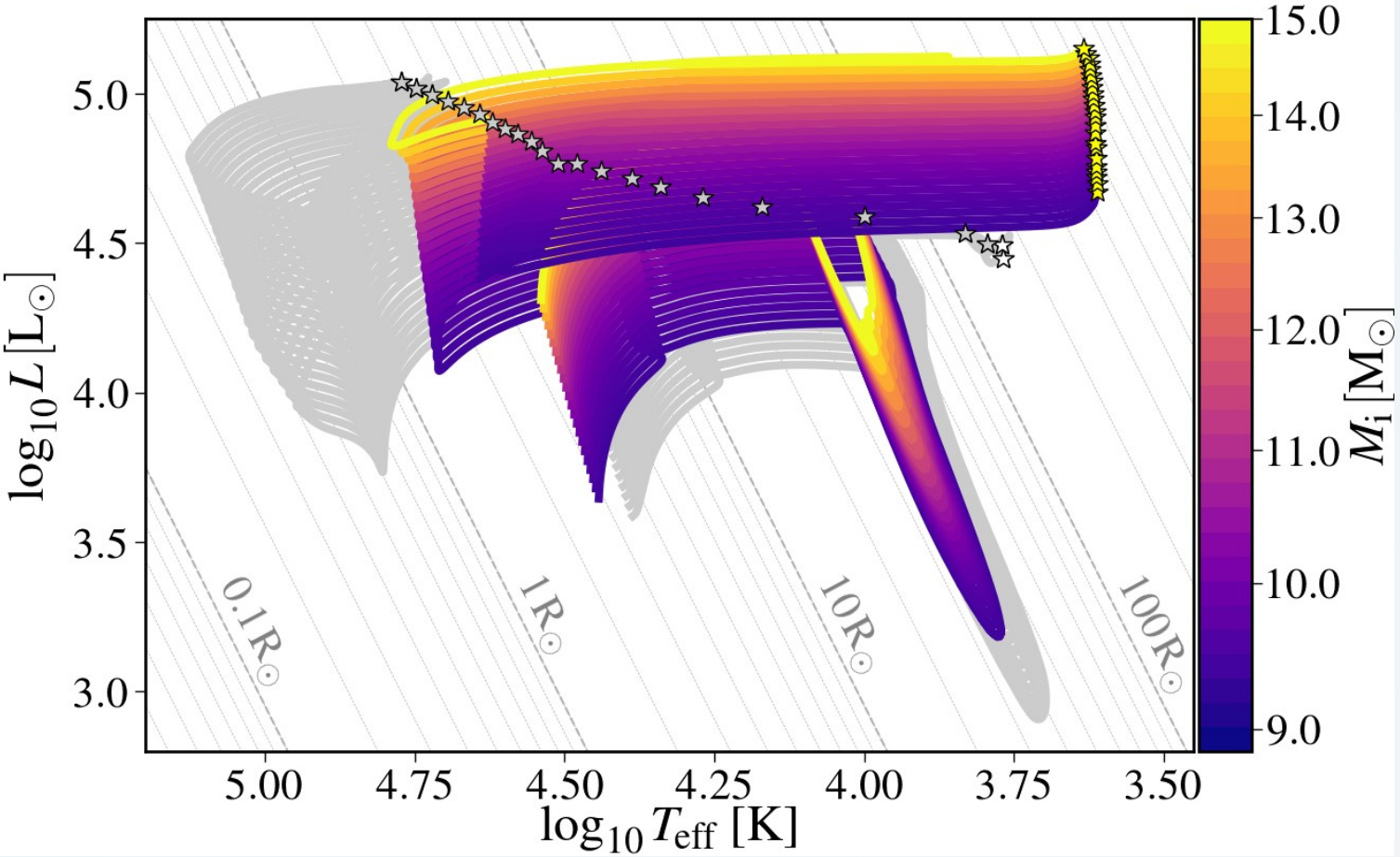

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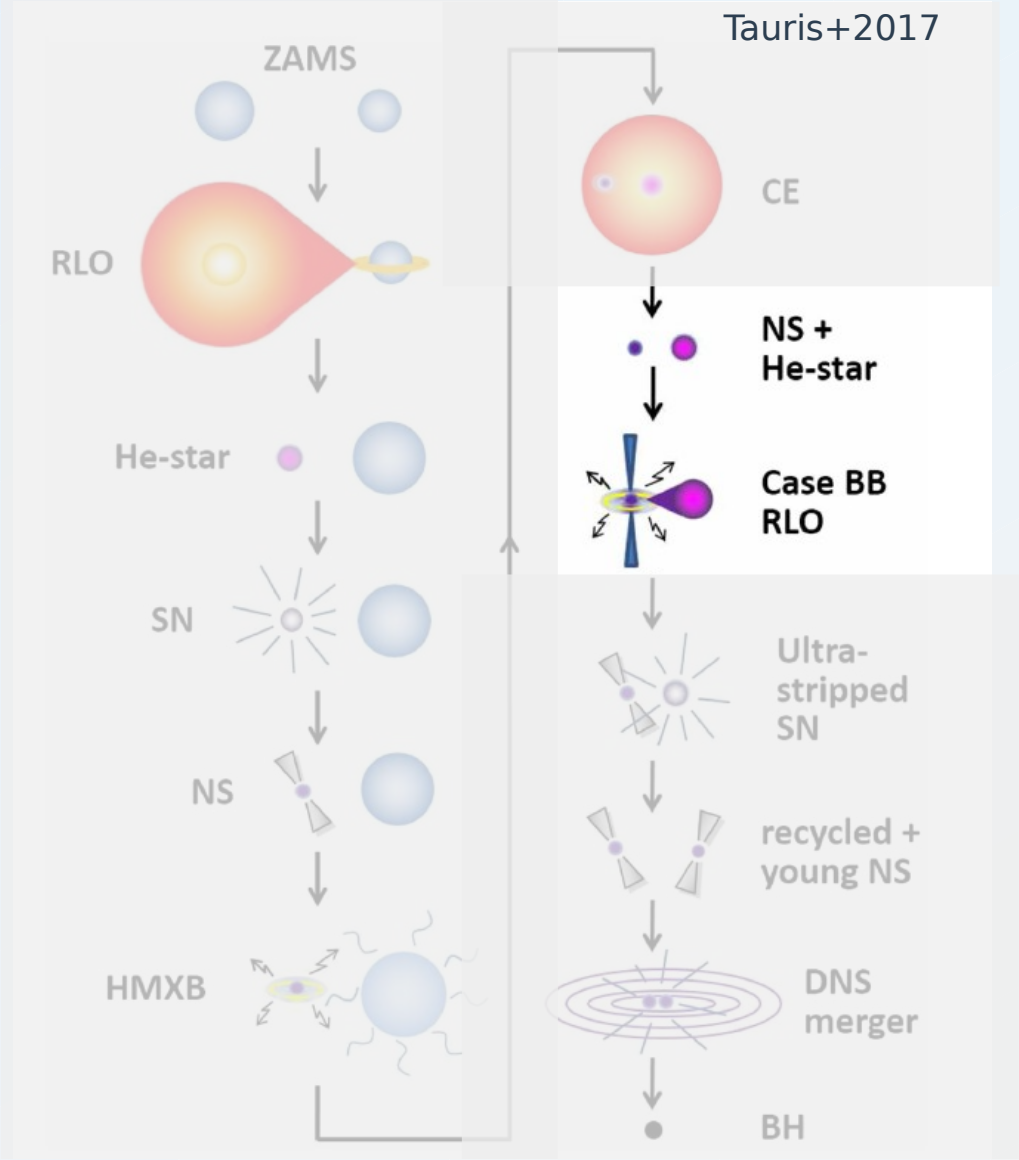
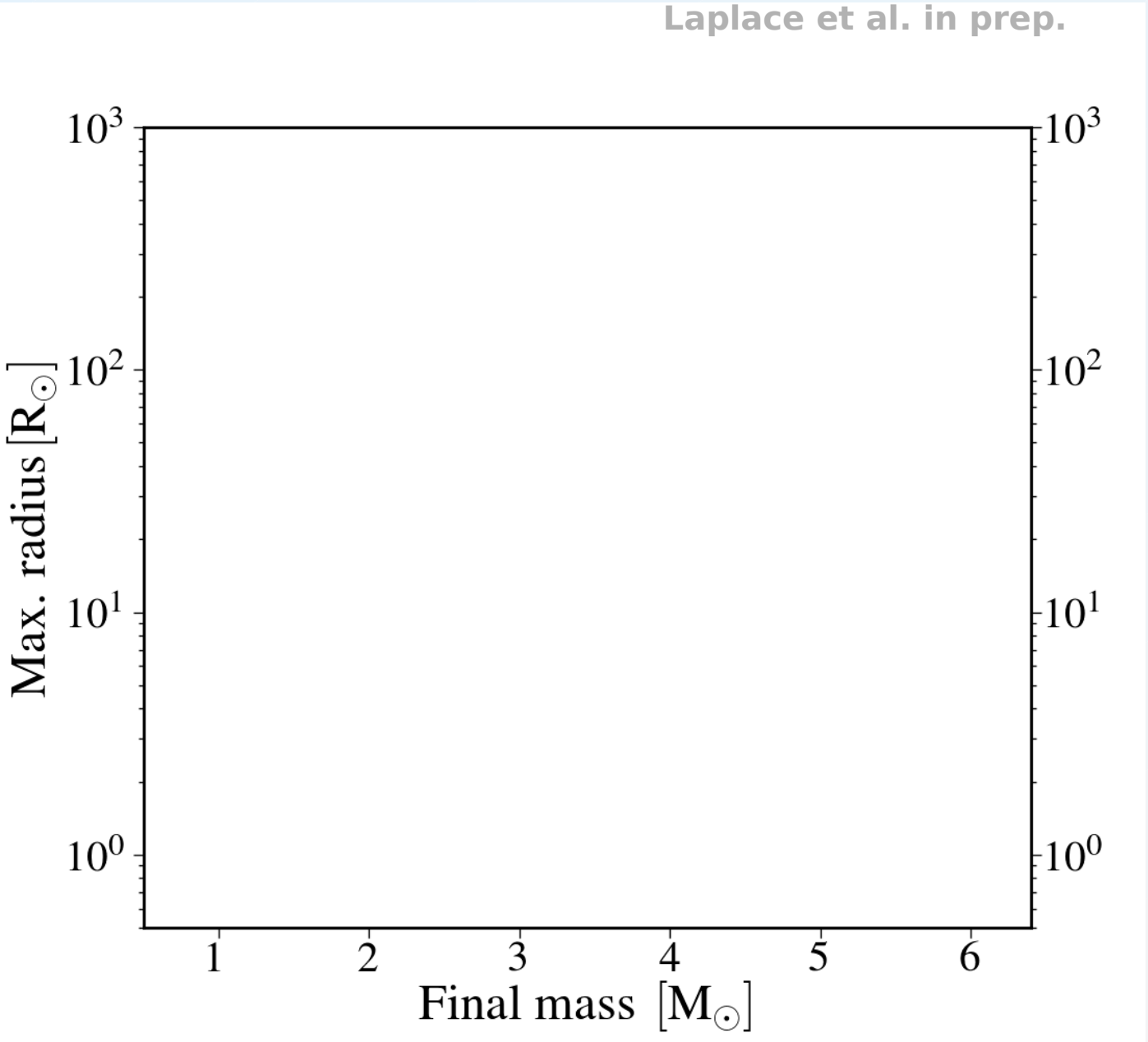
Implications for GWs progenitors



cf. Tauris+2015, 2017; Andrews+2015; Eldridge+2016, 2017; Vigna-Gomez+2018

Maximum radius

Laplace et al. in prep.



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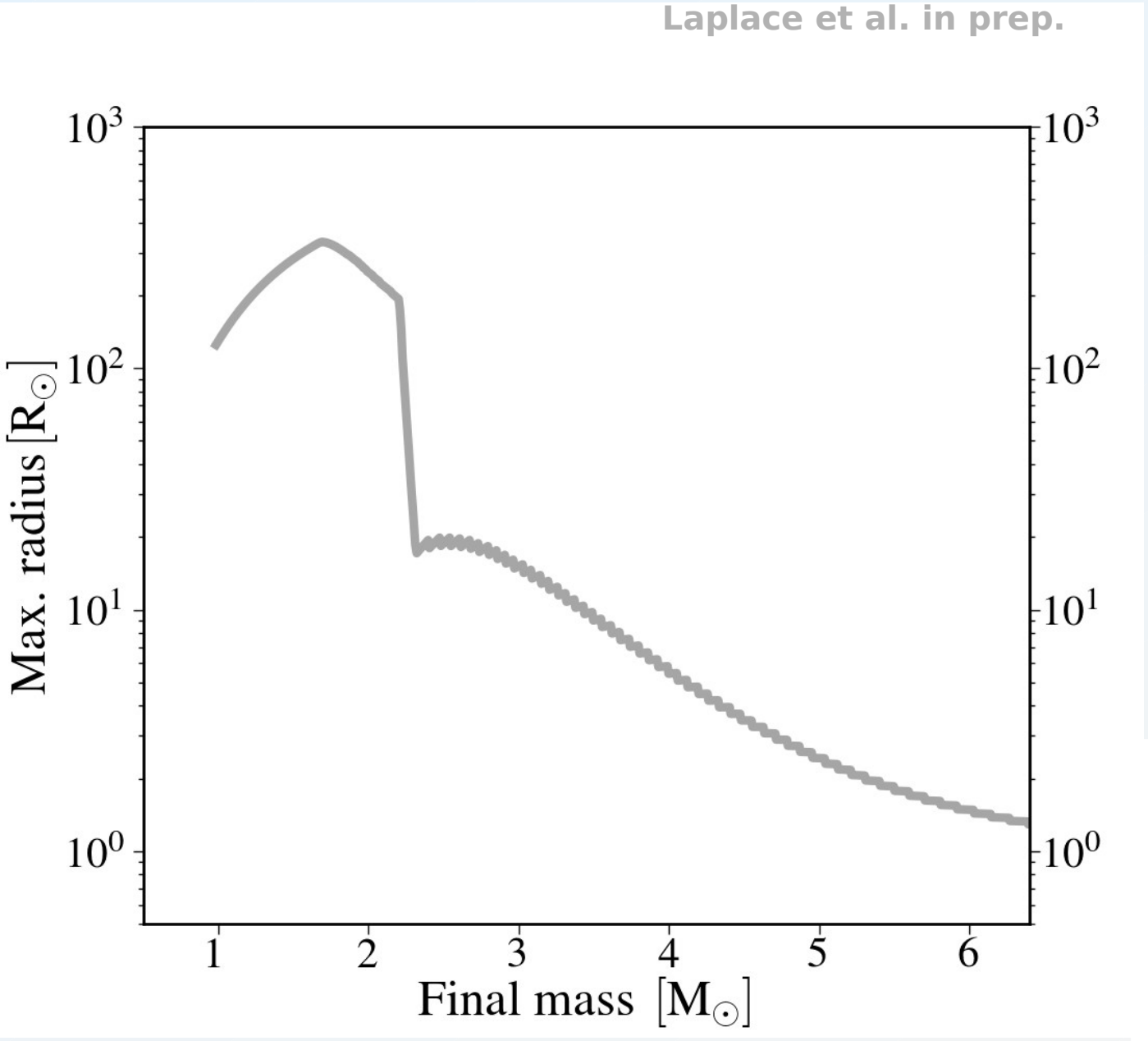

Hurley+2000
Pols+1995

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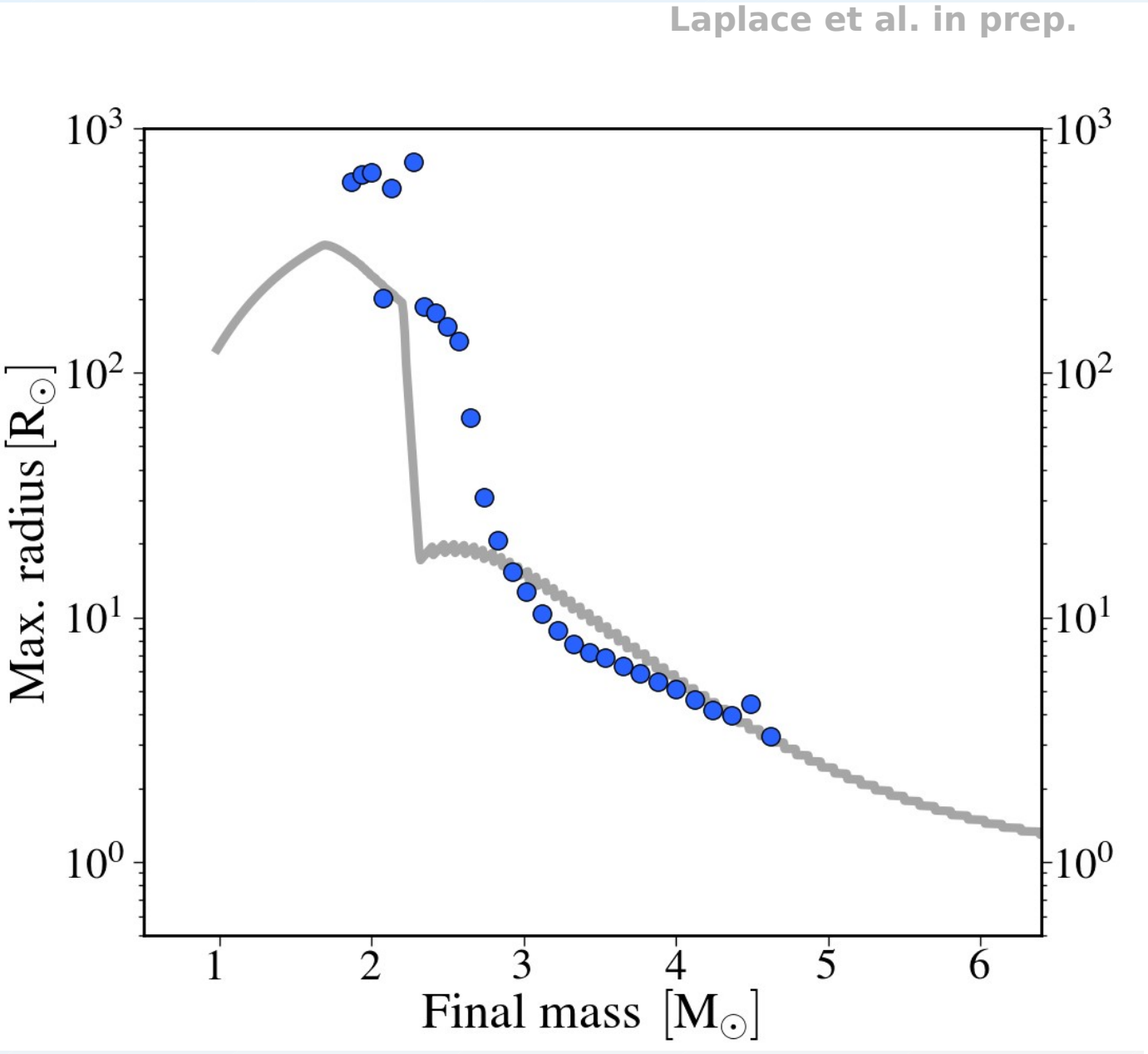

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Z_{sun}=0.0142

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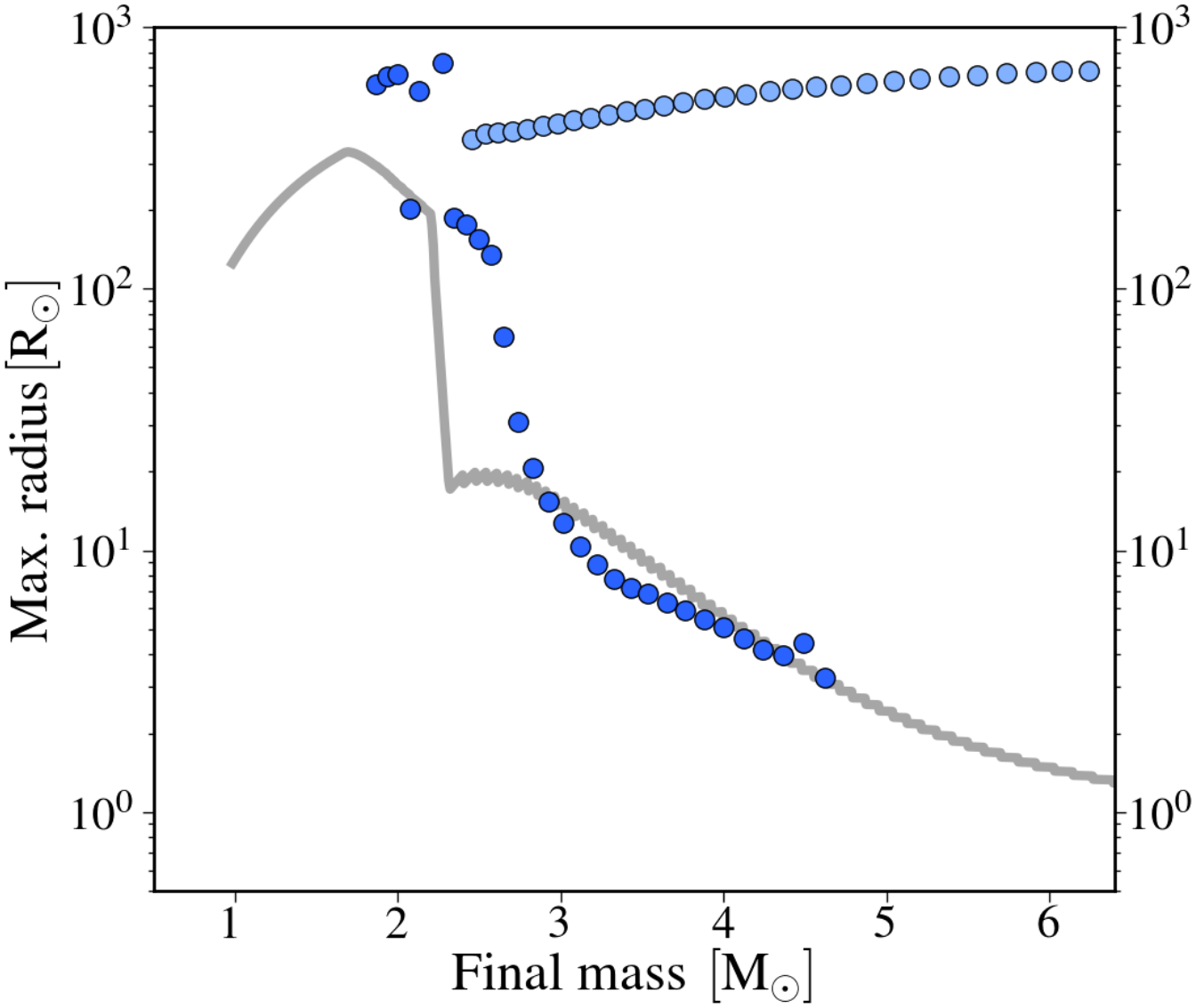


Hurley+2000
Pols+1995

Z_{sun}=0.0142

Z_{low}=0.001

Implications for GW progenitors

How many more interacting systems?

At Z_{sun} → **2 to 3 times more**

At Z_{low} → **10 to 20 times more**

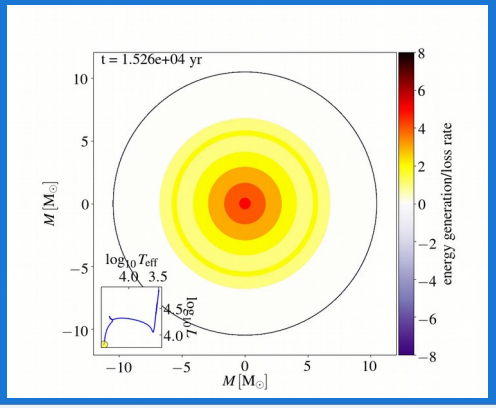
Assuming a distribution flat in log P_{orb}

Future steps

With: Rob Farmer

MESA Modules for Experiments in Stellar Astrophysics

Movies package



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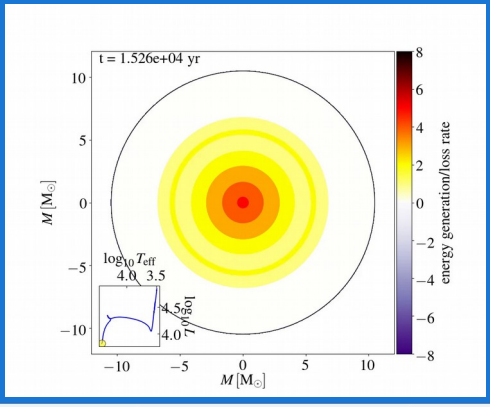

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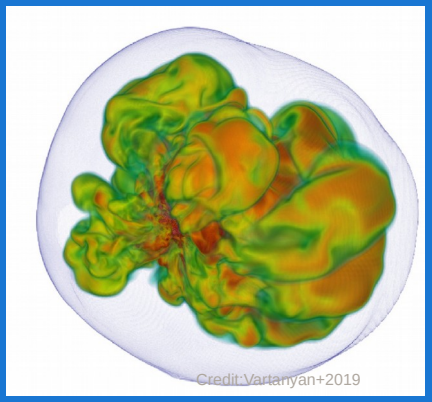

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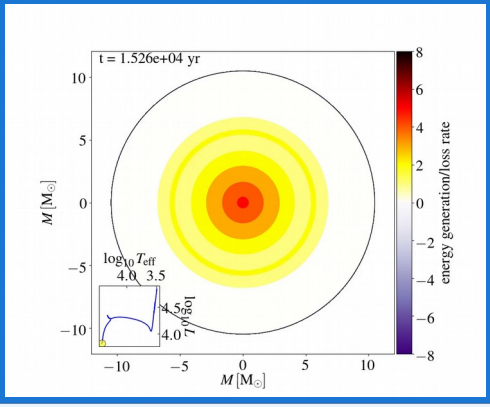

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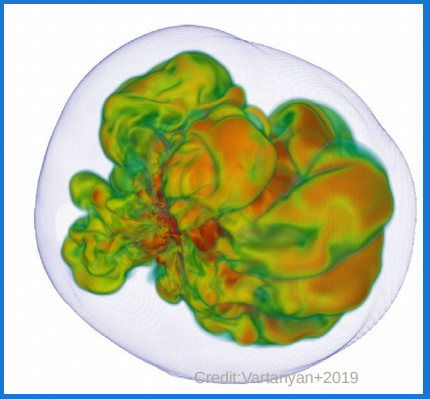
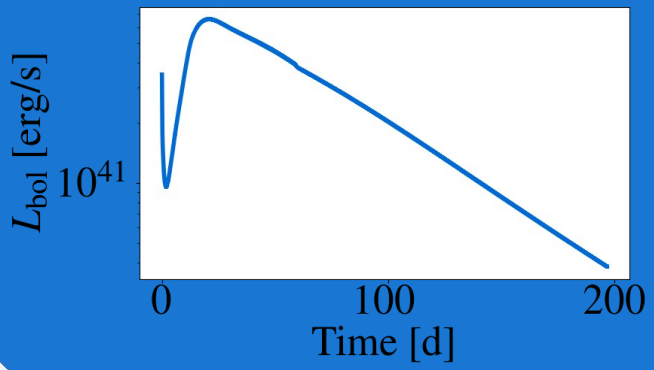


With: Takashi Moriya, Antony Piro, Mariam Modjaz, Thomas Dodds

SN light-curves



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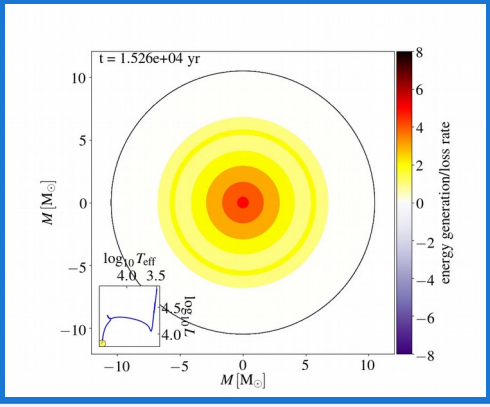

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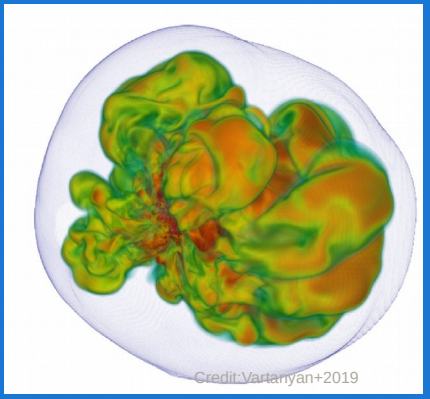

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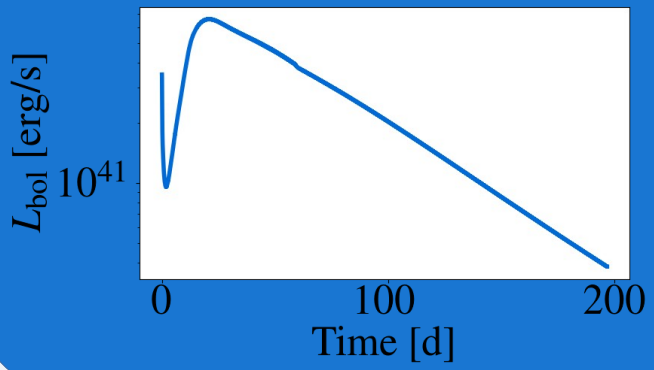
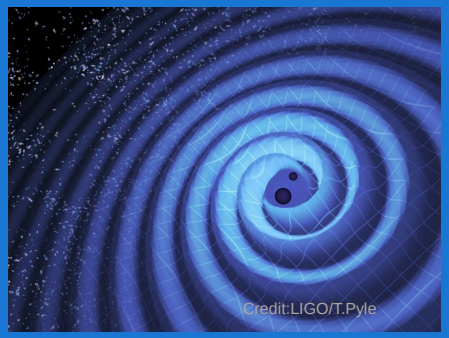


With: Stephen Justham, Lieke van Son, Javier Morán, Floor Broekgaarden

Population synthesis calculations



Conclusion

- Stars stripped in binaries can swell up to giant sizes

- Depending on how much hydrogen they retain, their maximal sizes are
  → 10 – 100 R_{sun} at Z_{sun}
  → > 400 R_{sun} at Z_{low}

- This implies many more systems that will interact again
  → 2 – 3 x more at Z_{sun}
  → 10 – 20 x more at Z_{low}

- Our results has potentially large implications for GW progenitors