Accretion-Induced Collapse and its Progenitors

with L. Bildsten, J. Brooks, E. Quataert, & others

Josiah Schwab

Hubble Fellow, UC Santa Cruz

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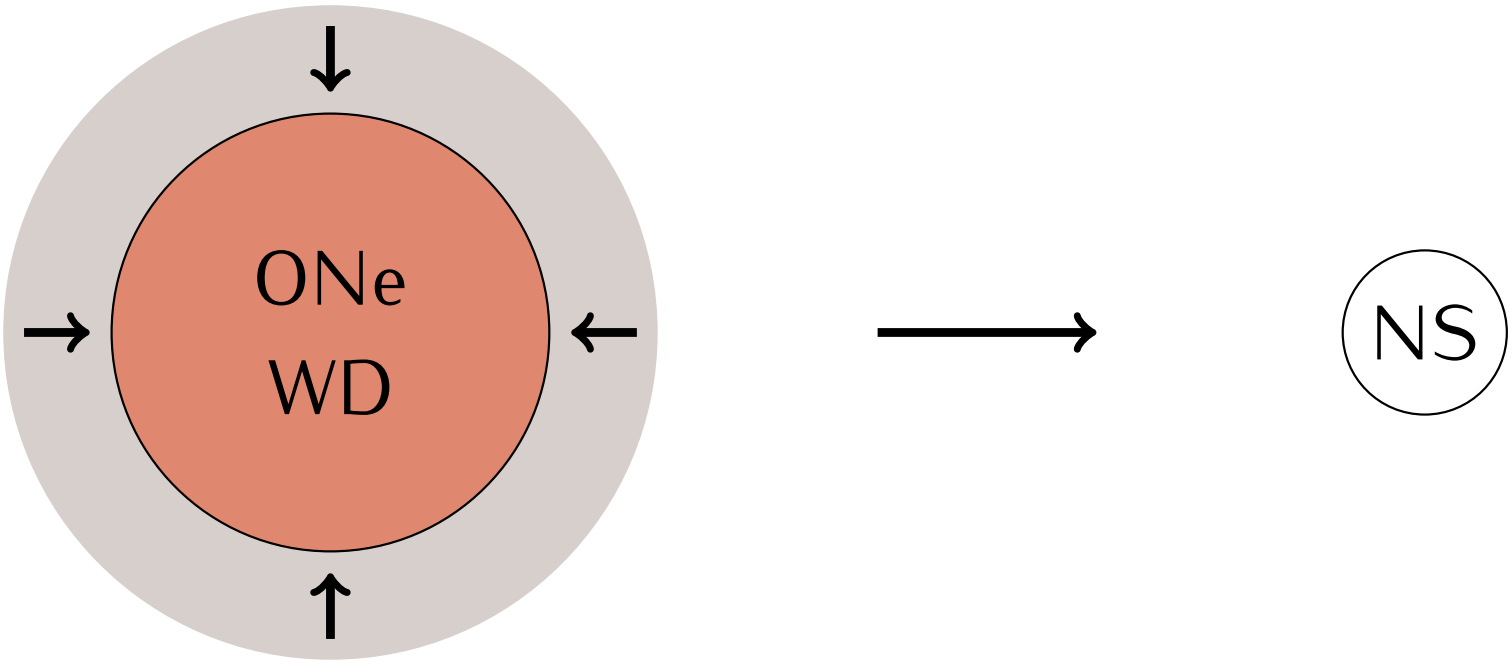
Accretion-induced collapse (AIC) occurs when an O/Ne WD reaches a critical mass.



No direct observations of AIC have yet been made.

- Models of the collapse of a massive WD to form a neutron star (NS) produce a weak explosion and $\sim 10^{-3}\,M_\odot$ of Ni-rich ejecta.

  Woosley & Baron (1992); Dessart et al. (2006)

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- Other radio, optical, and X-ray signatures have been predicted, but depend on whether
  - the progenitor systems have surrounding material
  - other aspects of the evolution synthesize Ni-56
  - the newly formed NS is a magnetar

  e.g. Piro & Kulkarni (2013), Metzger & Bower (2014)

The strongest (indirect) evidence for AIC is the presence of young NSs in GCs.

Globular clusters have:

- old stellar populations ($\sim$ 10 Gyr)
- low escape velocities ($<$ 50 km/s)
- some young NSs (P ~ 300 ms, B ~ 10^{11} G)

Lyne et al. (1996); Boyles et al. (2011)

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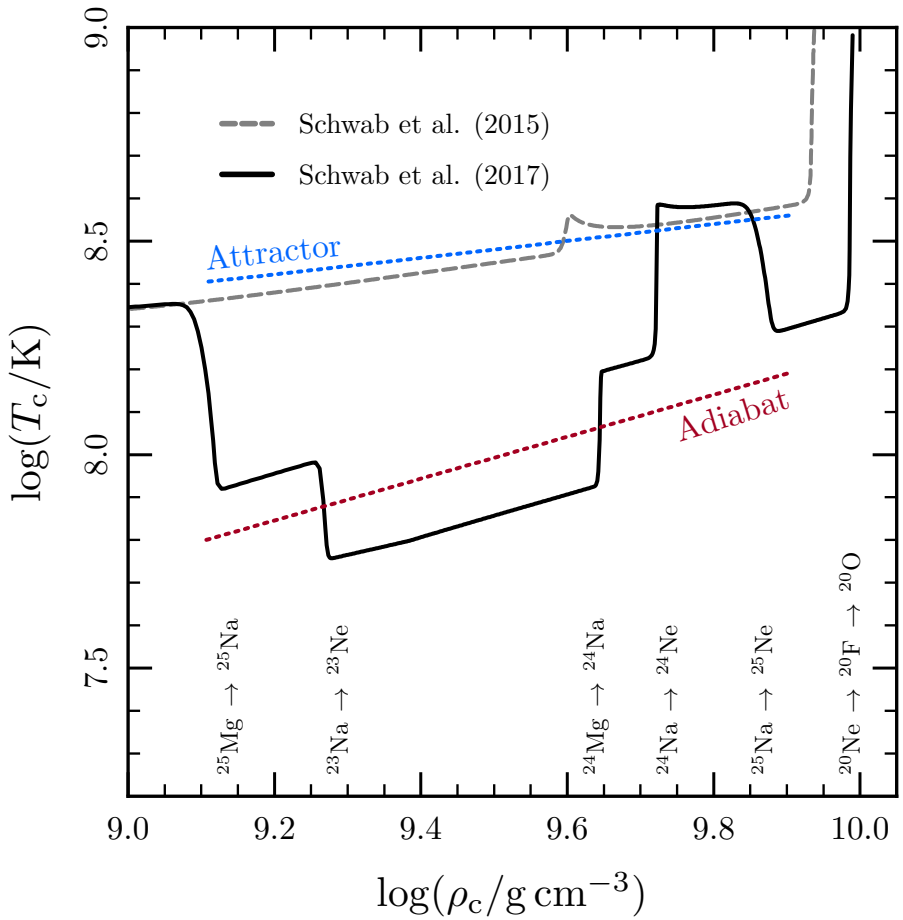
AIC:

- takes a long time
- produces NSs with low natal kicks

Accurate weak reaction rates and high (space & time) resolution are necessary.



JS et al. (2015, 2017)

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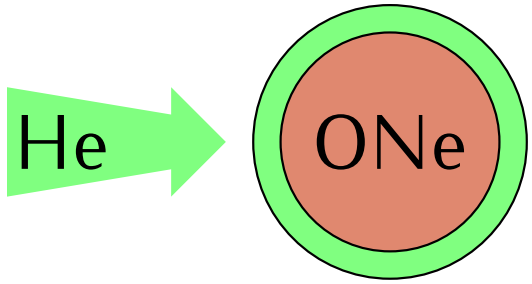
...but they're a significant step forward.

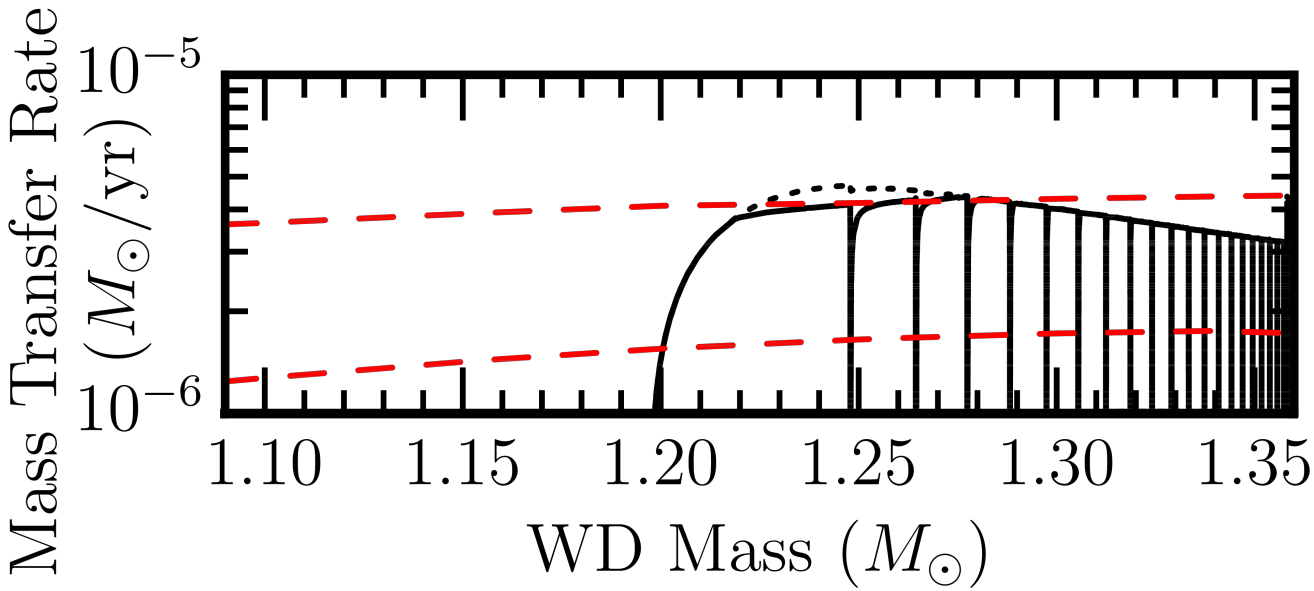
- Models have long been on the edge between explosion and collapse. Need good initial conditions for multi-D explosion sims.

Nomoto & Kondo (1991); Jones et al. (2016)

Mass transfer after core He-burning gives $\dot{M}$ in the regime for stable He burning on the WD.

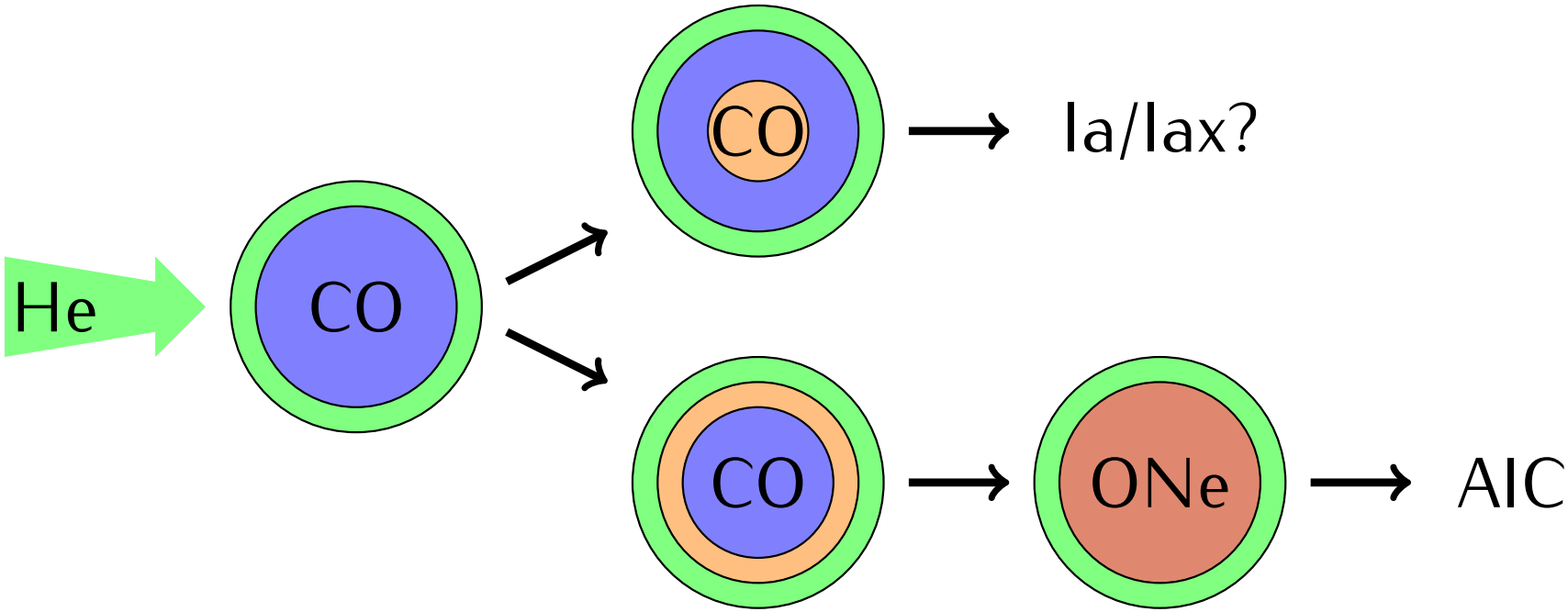


$\longrightarrow$ AIC



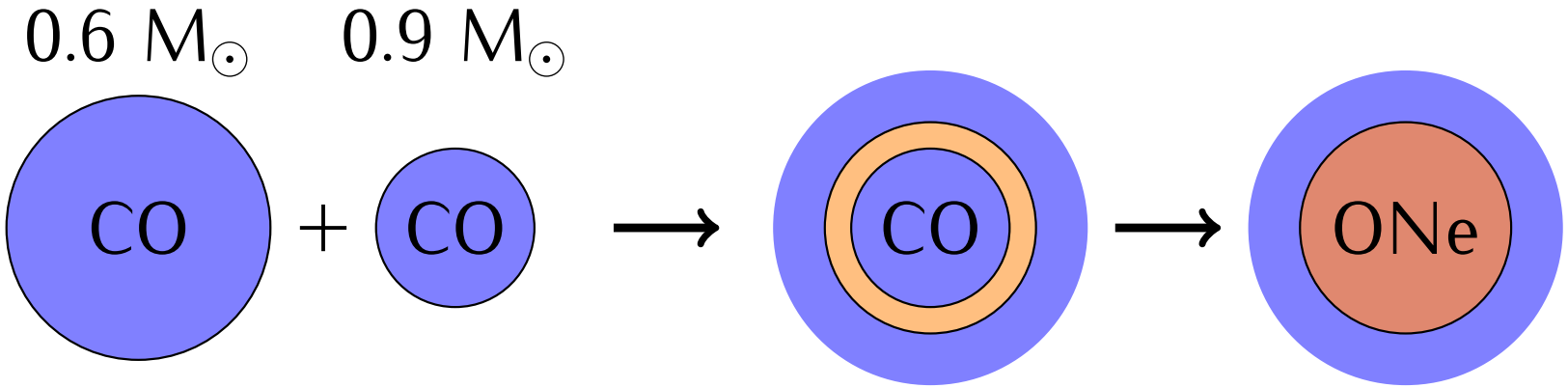
Yoon & Langer (2003); Brooks, JS, et al. (2016, 2017a)

Not only do He + O/Ne WD models reach AIC, but some He + C/O WD models should too.



Brooks, JS, et al. (2017a)

The merger of two CO WDs with a super-Chandra total mass can collapse to an NS.



Nomoto & Iben; Saio & Nomoto (1985), JS et al. (2016)

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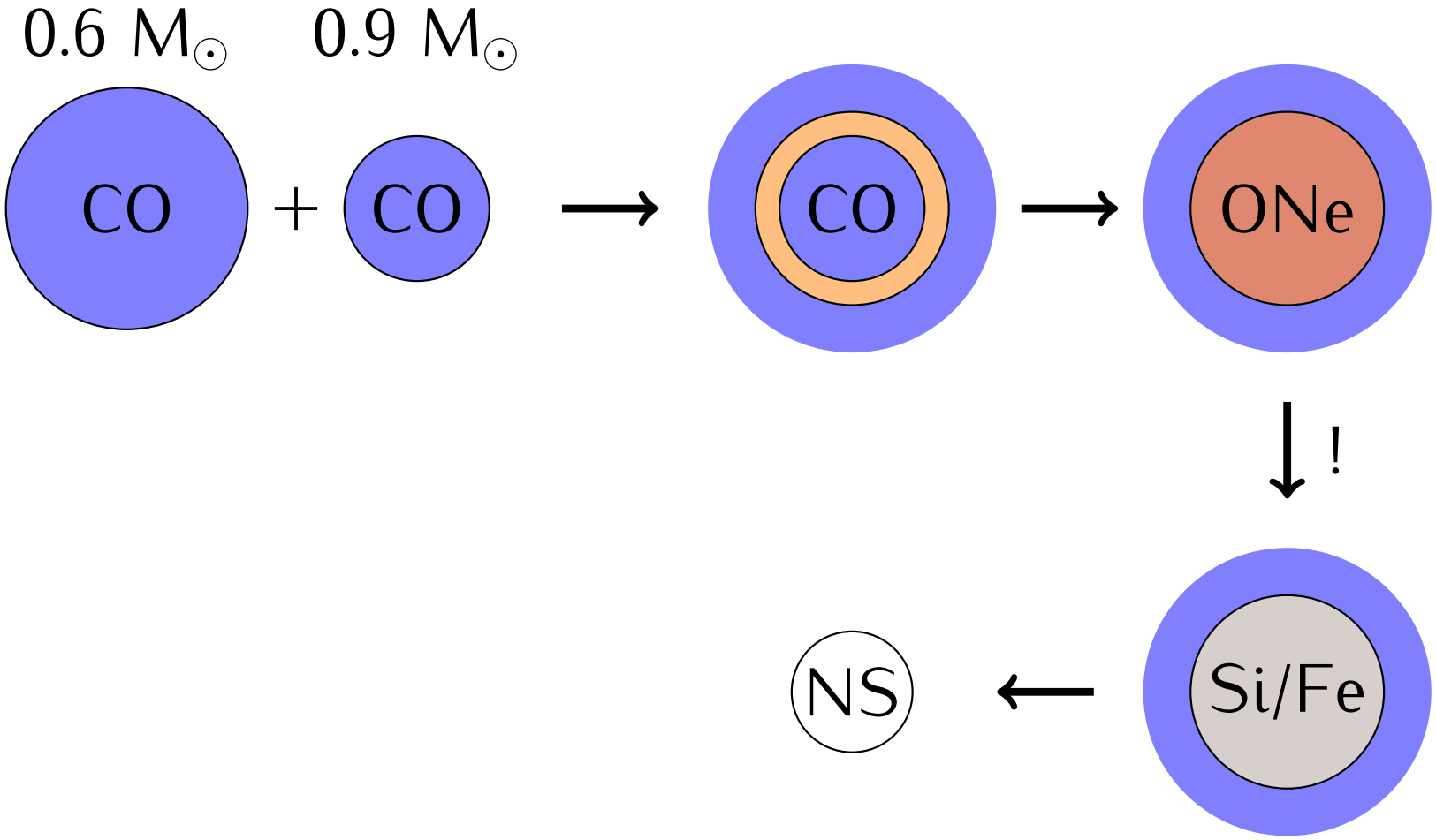

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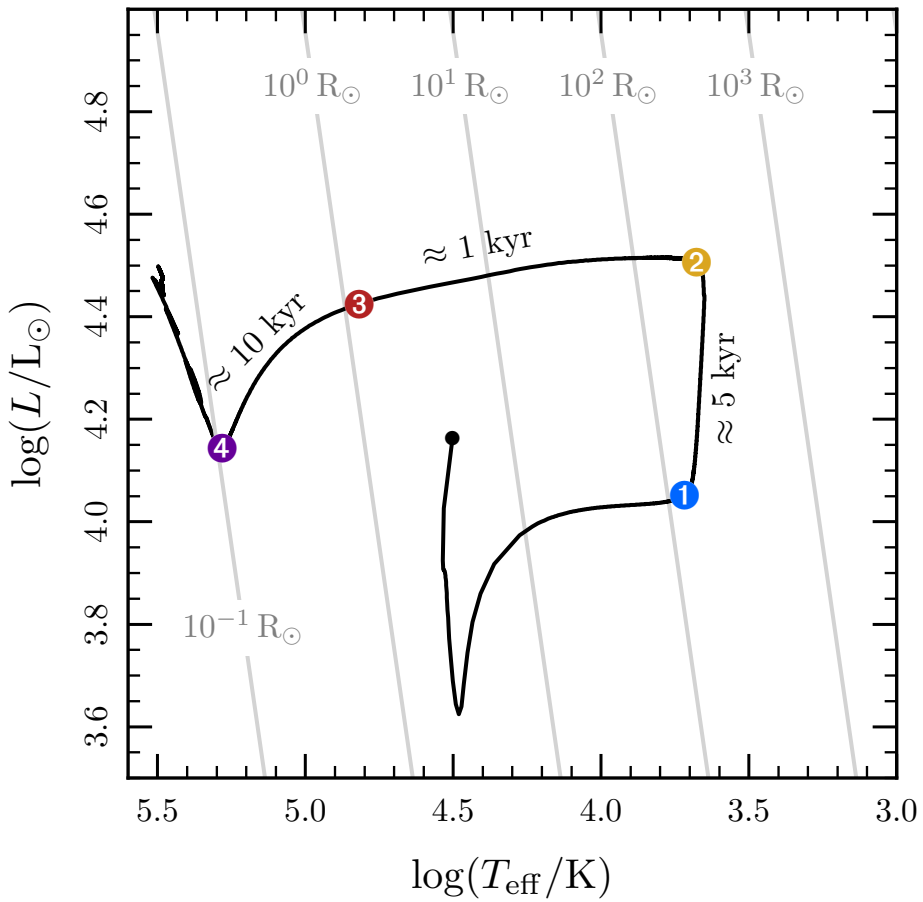
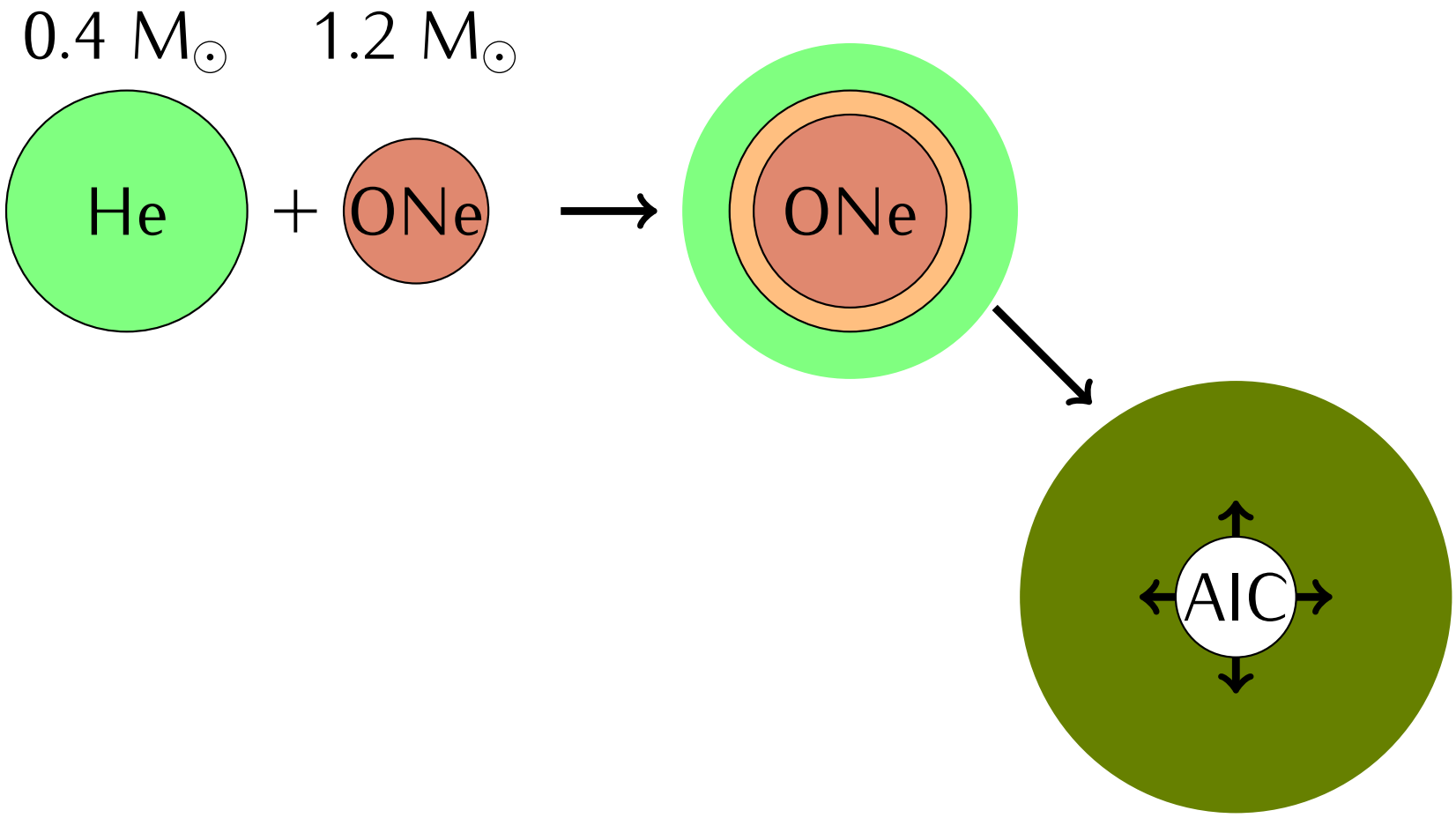
It takes ≈ 20 kyr from merger to collapse;
our models predict the appearance in this phase.



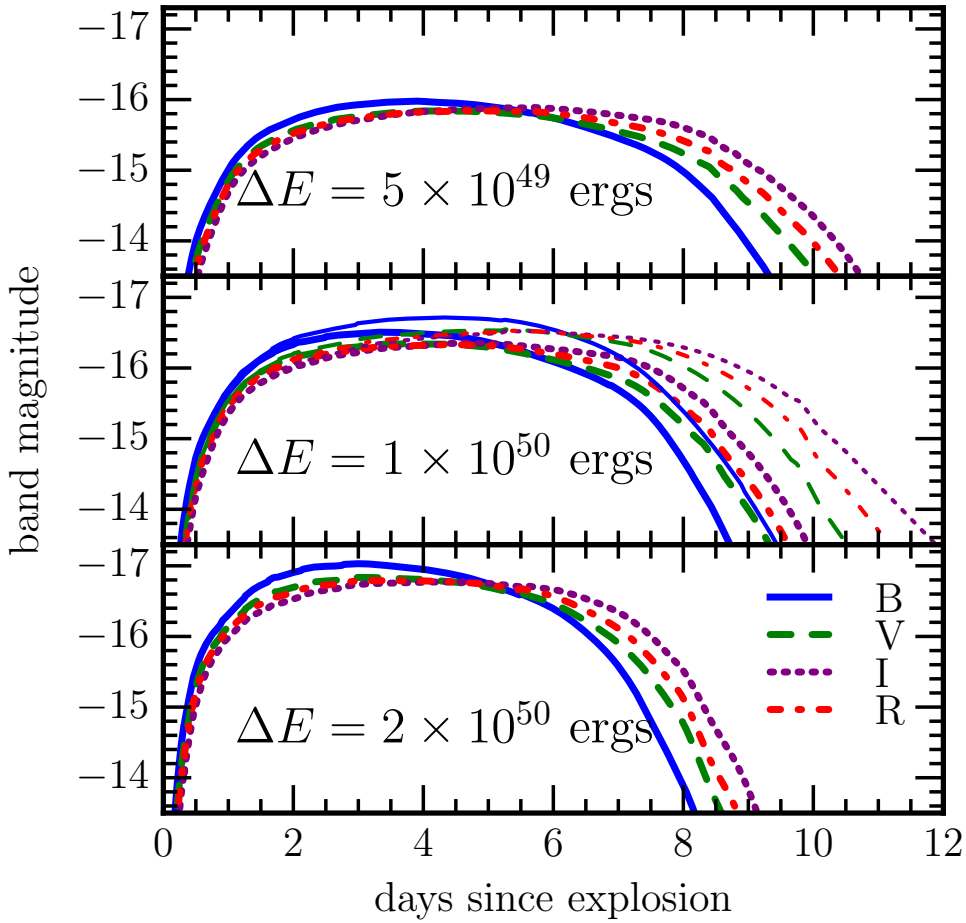
JS et al. (2016)

The merger of He WD & ONe WD with a super-Chandra total mass can collapse to an NS.



Brooks, JS et al. (2017b)

We predict the properties of these events.



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- Our work provides initial models necessary for multi-D work that can probe the collapse/explosion and make predictions for the signatures of the AIC event itself.
- A better understanding of the systems that undergo AIC can predict signatures useful for finding a Galactic AIC progenitor system.