Mind the gap: The PPISN/PISN boundary

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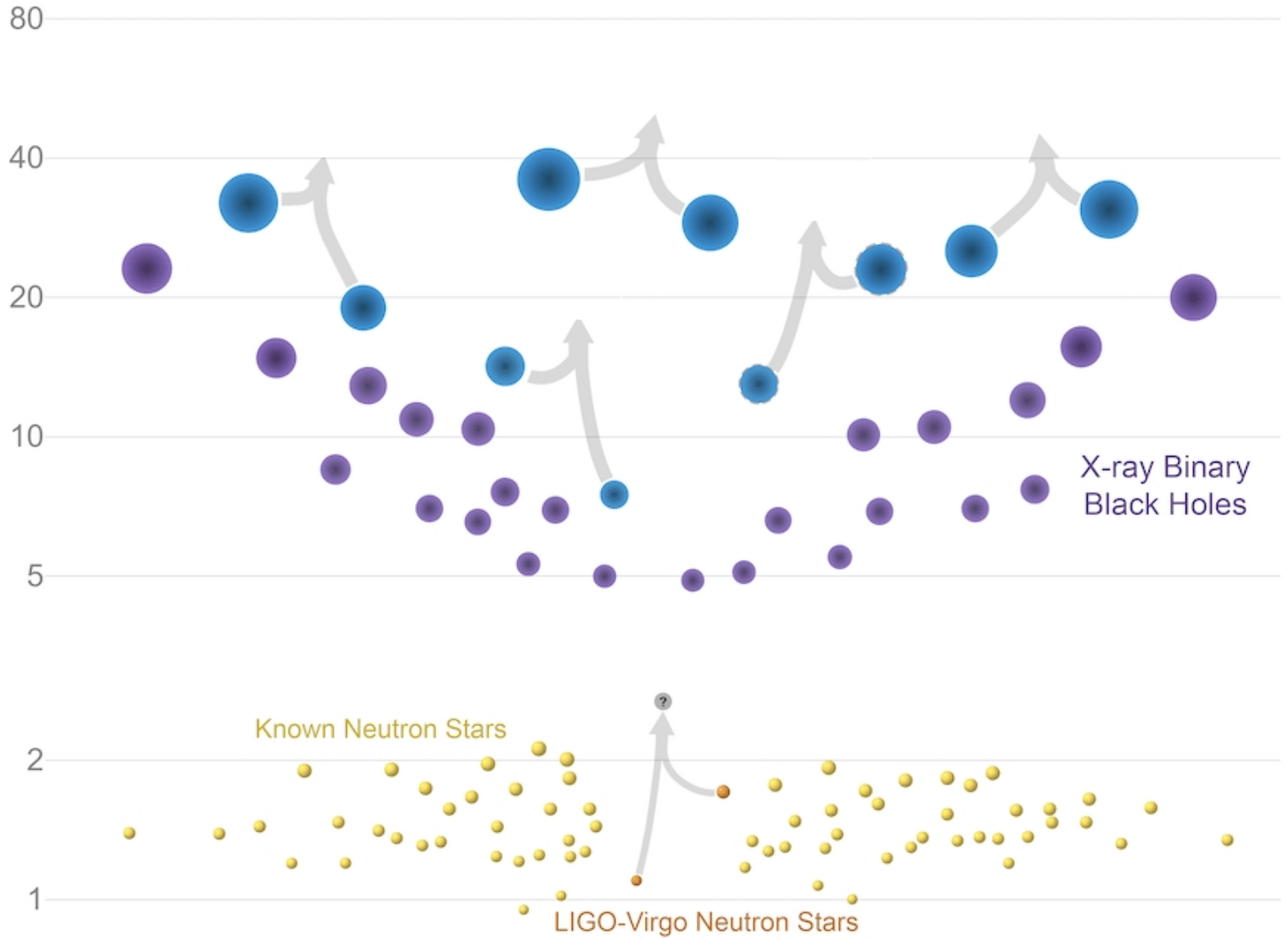
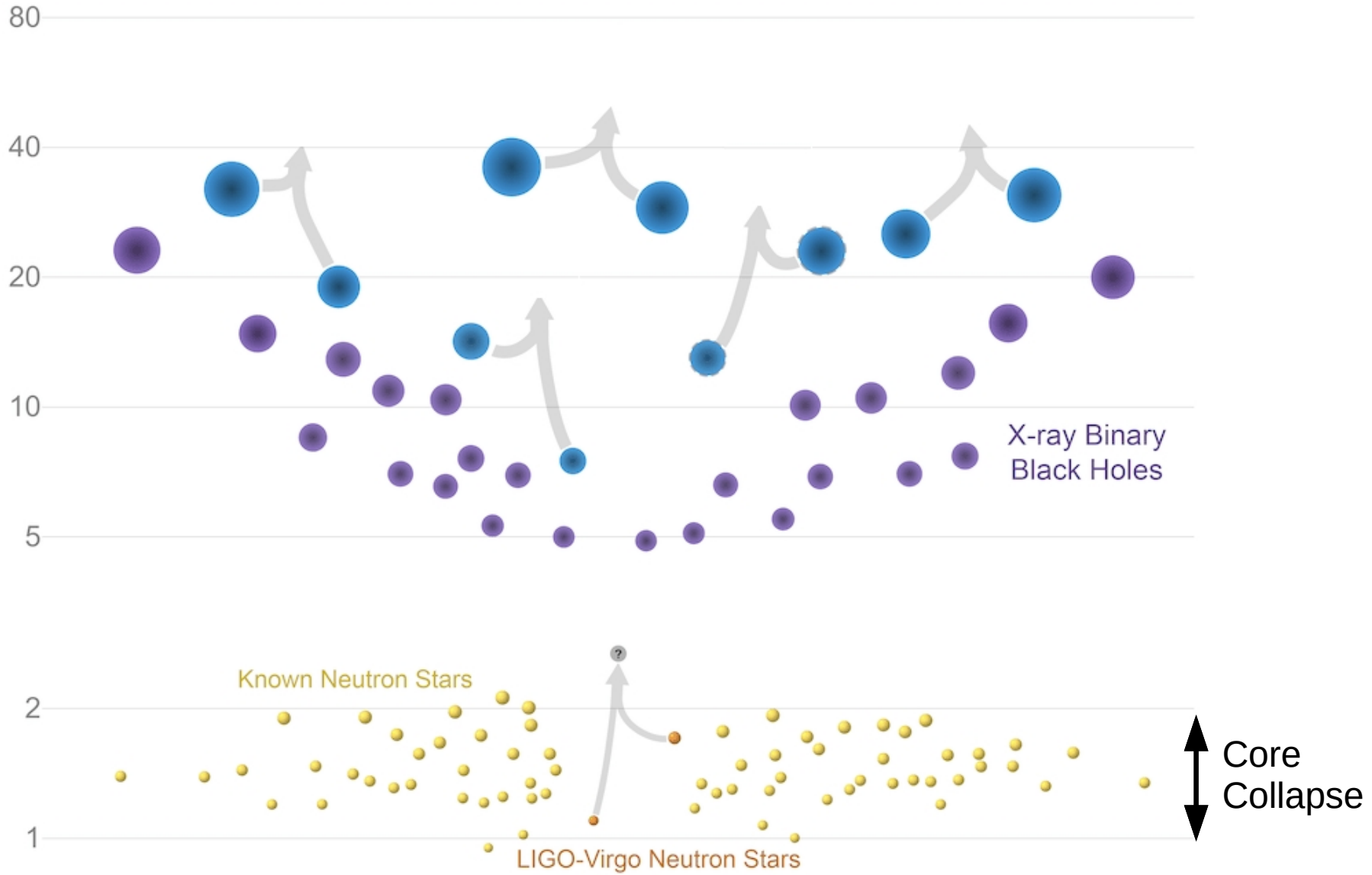
Collaborators:
Mathieu Renzo, Selma de Mink, Stephen Justham,
Pablo Marchant, Eva Laplace, Javier Fraile, Mirron van der Kolk

Black hole formation



Credit LIGO/Virgo/Northwestern/Frank Elavsky

Black hole formation



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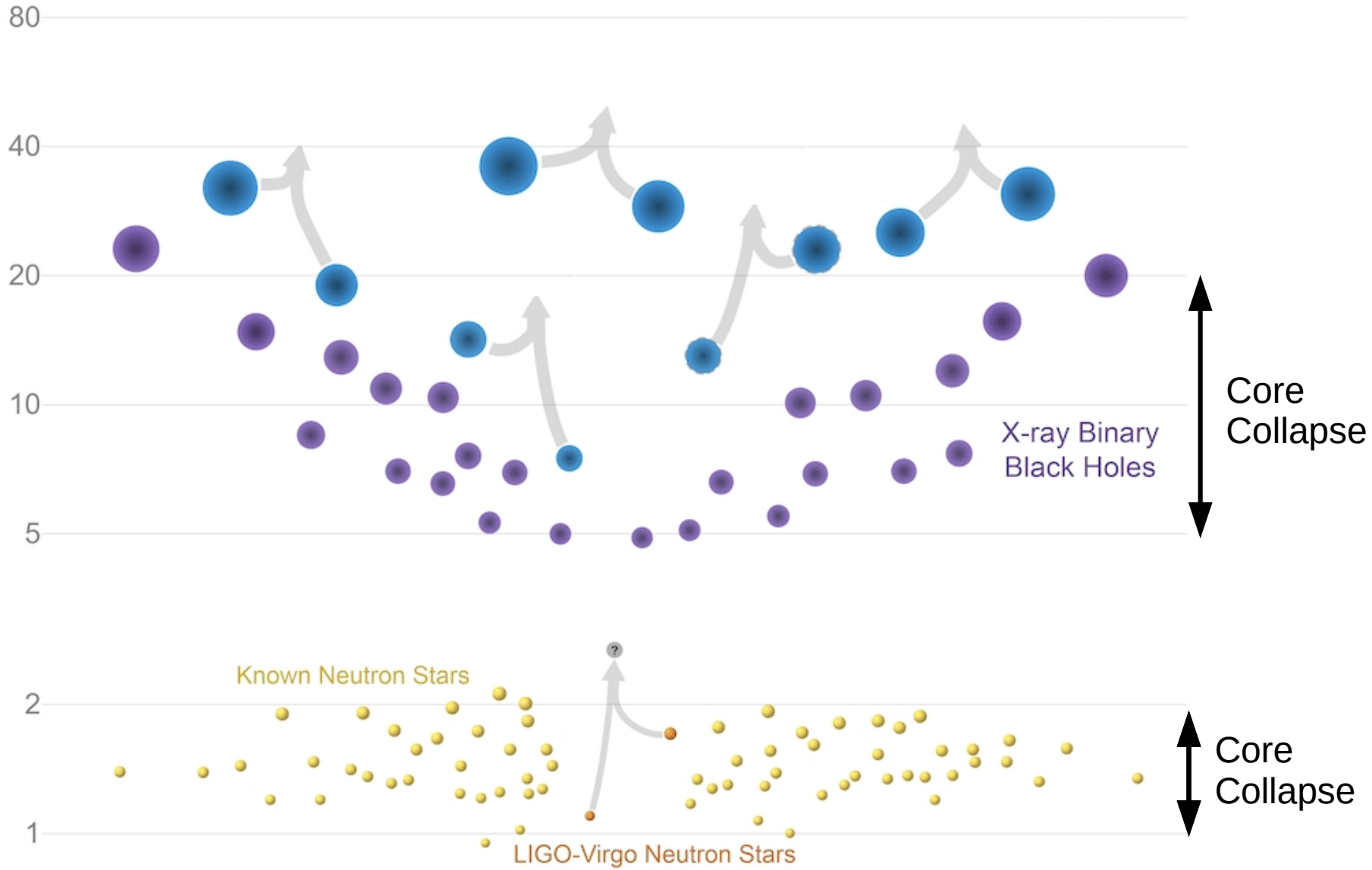

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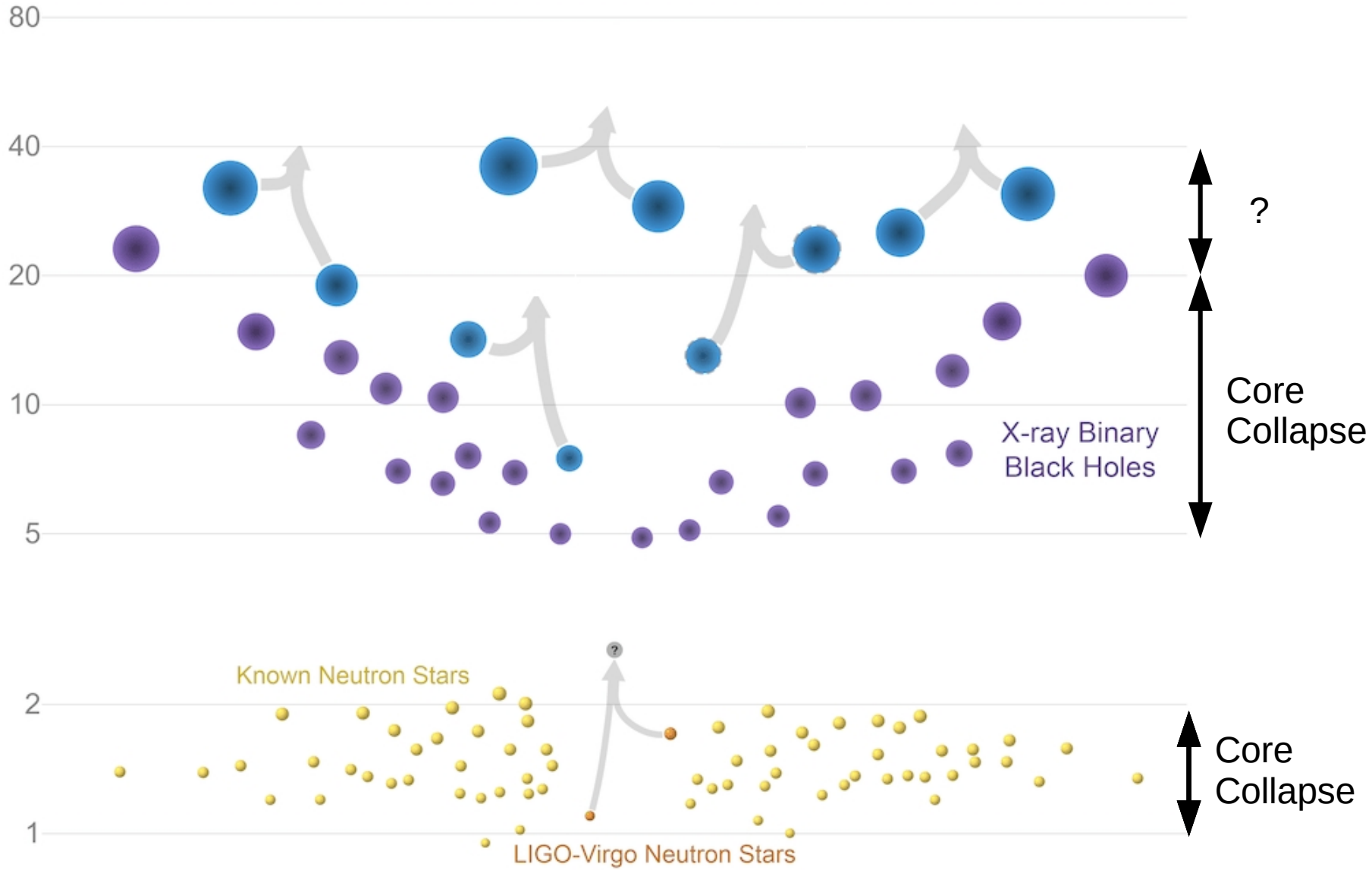

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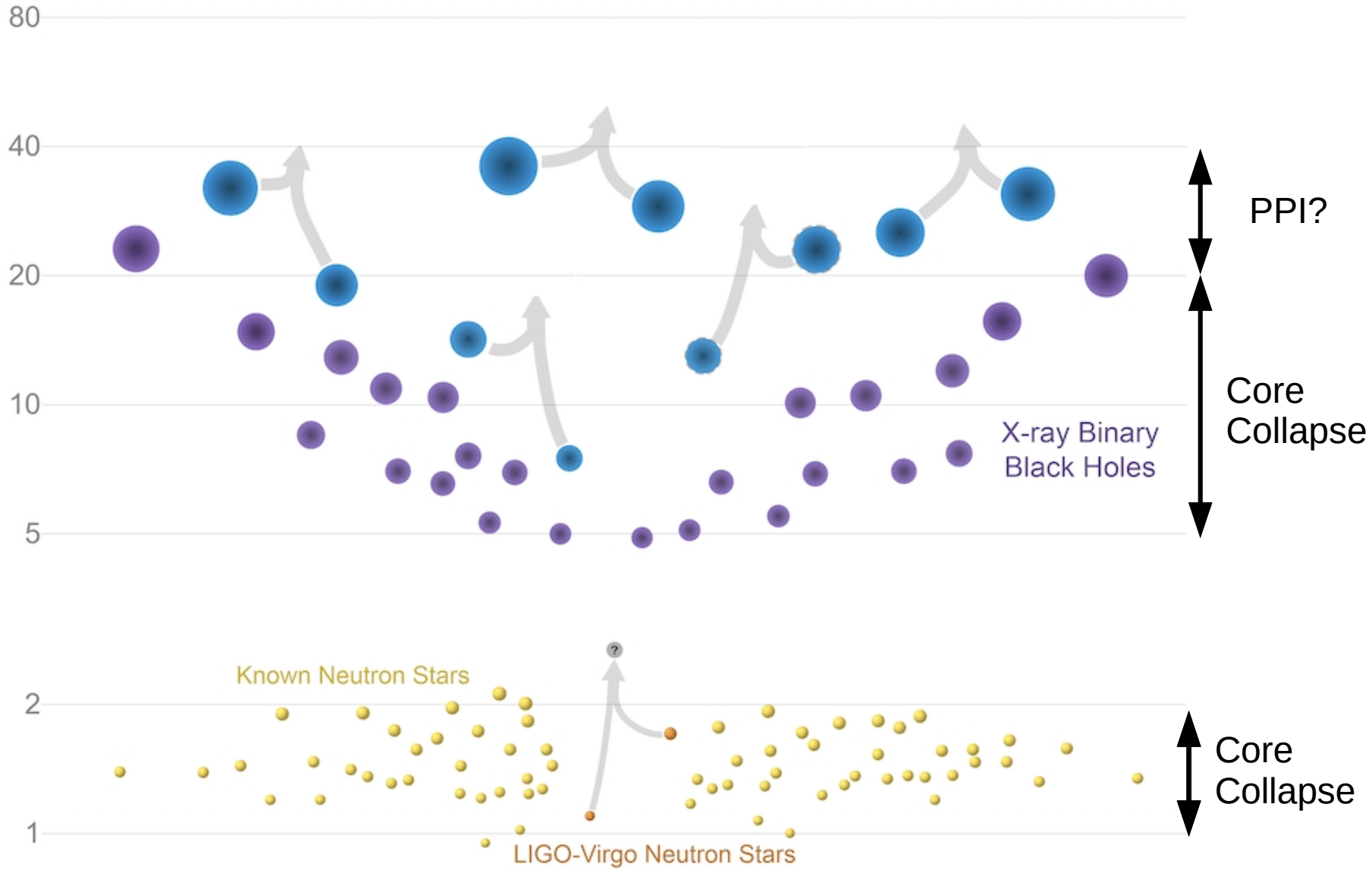

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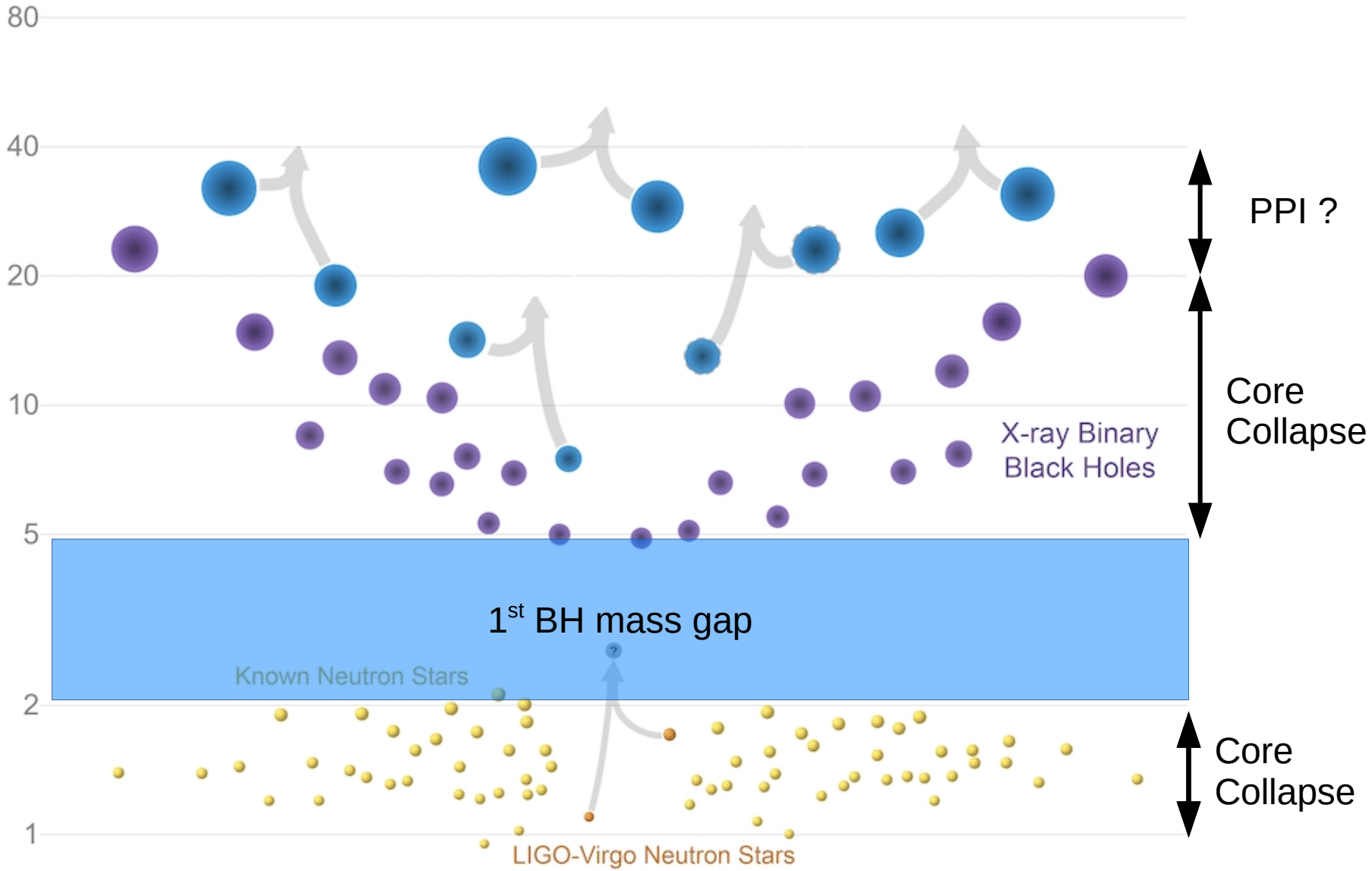

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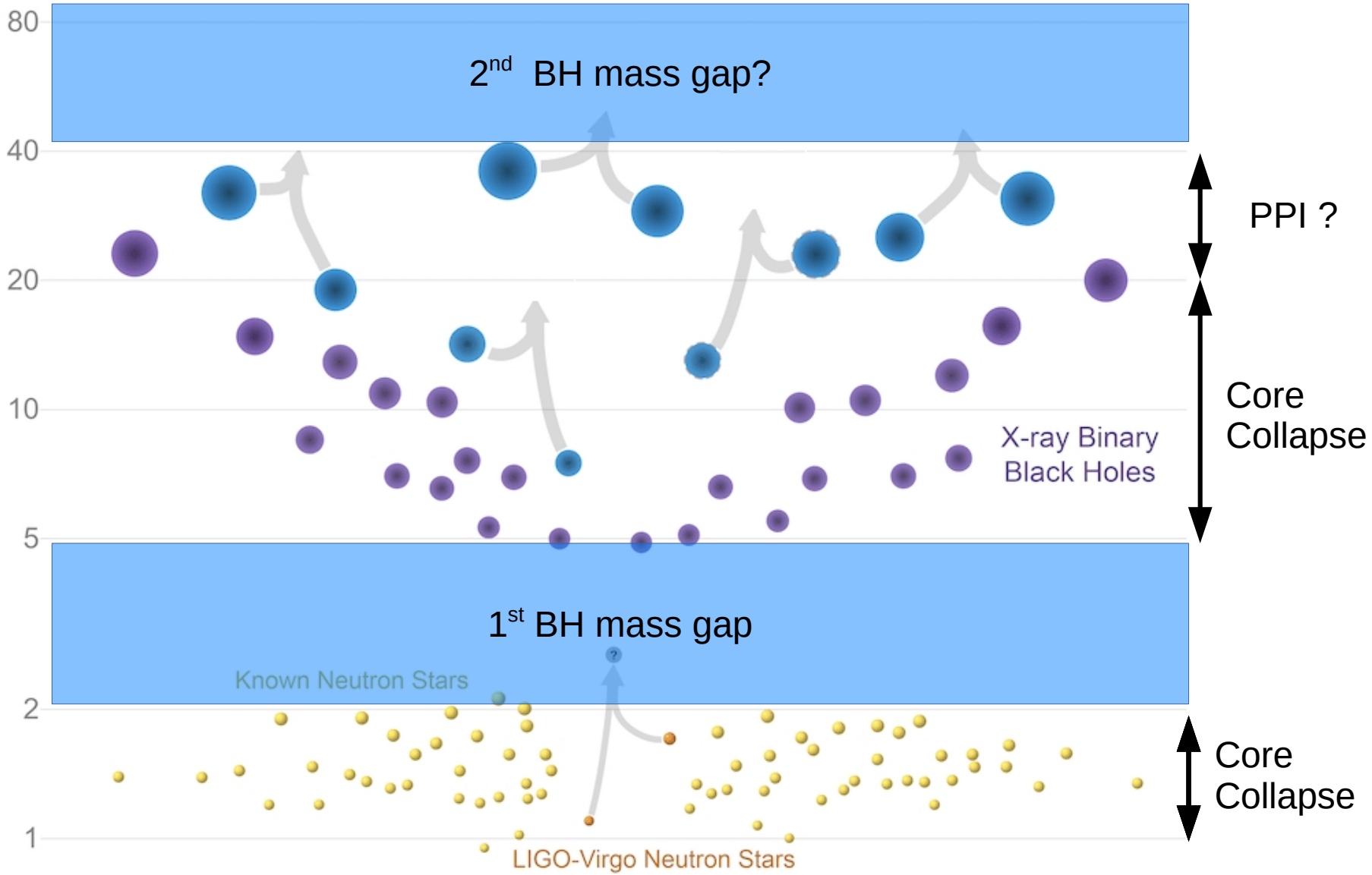

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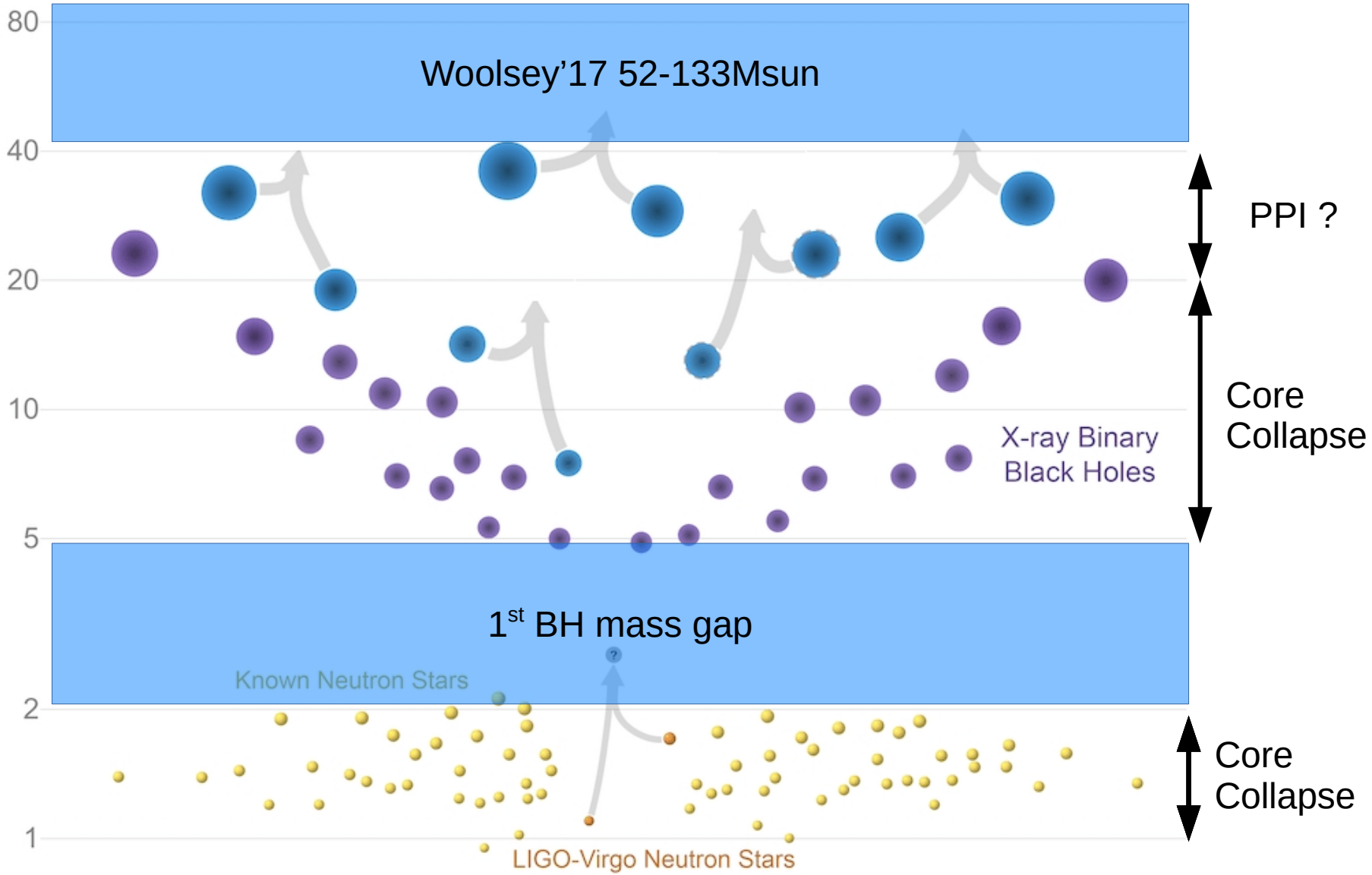

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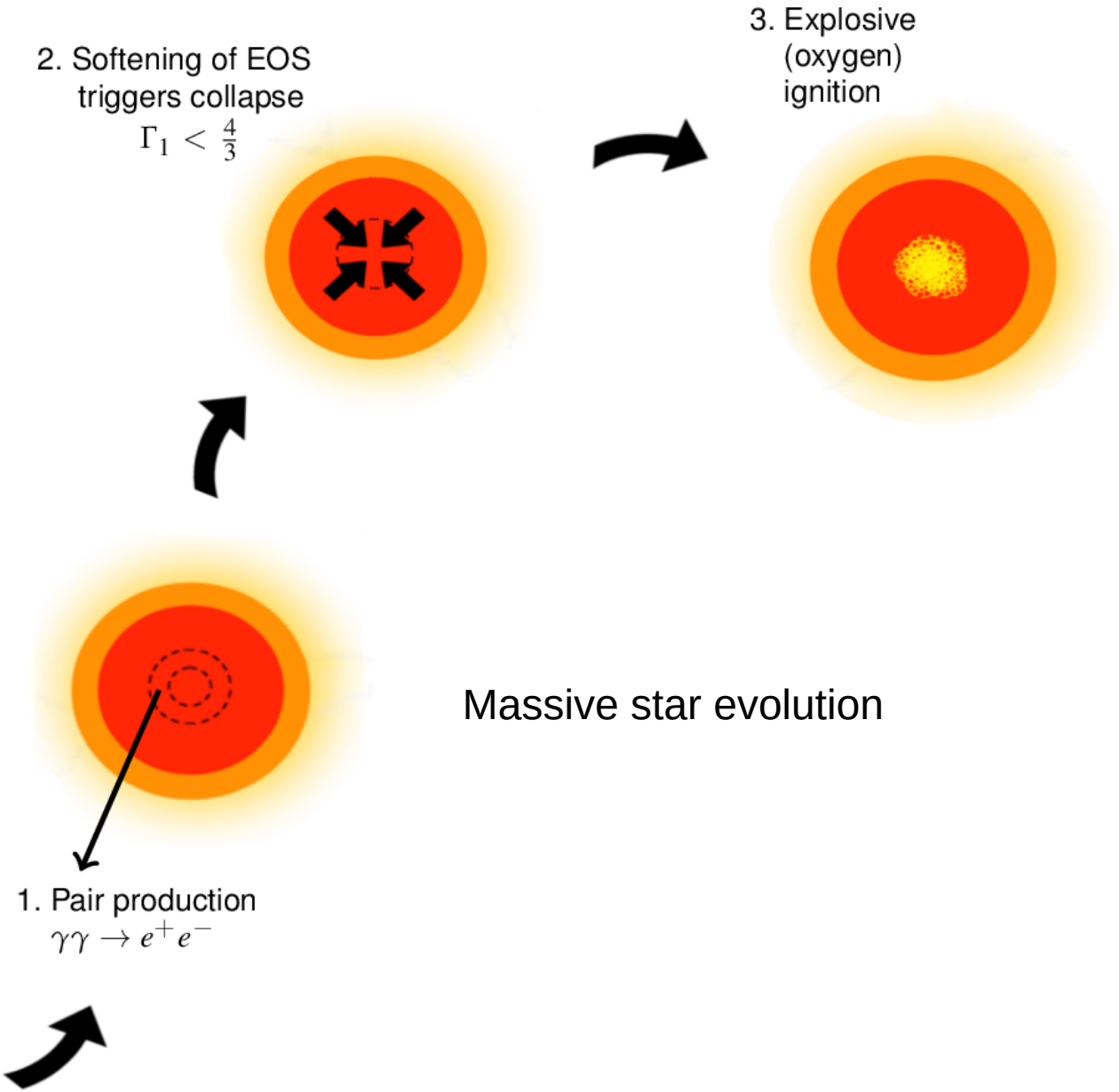
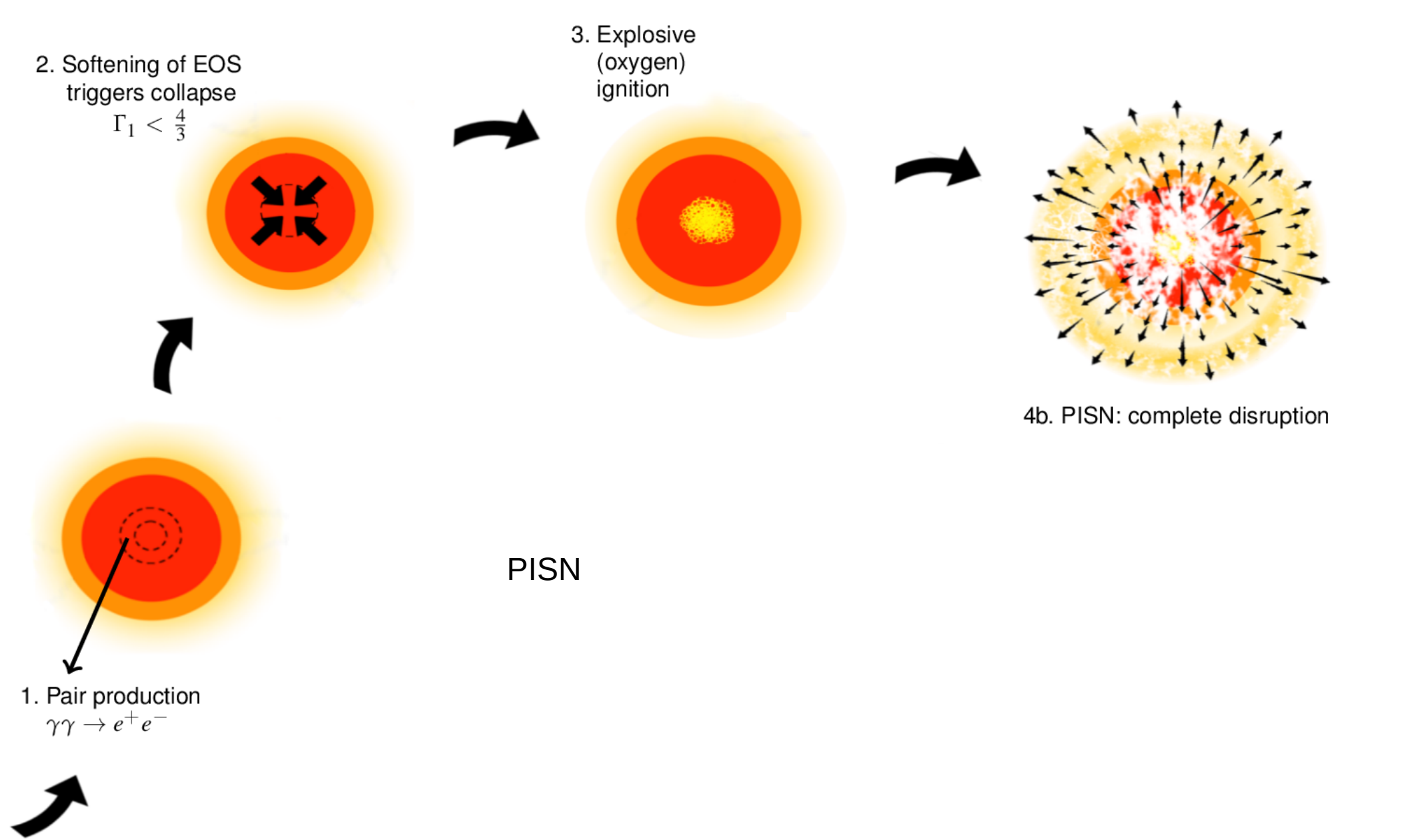


Massive star evolution

See also Rakavy+ 67, Fraley 68, Heger+ 02, Chatzopoulos+12, Woolsey 17, Marchant+18



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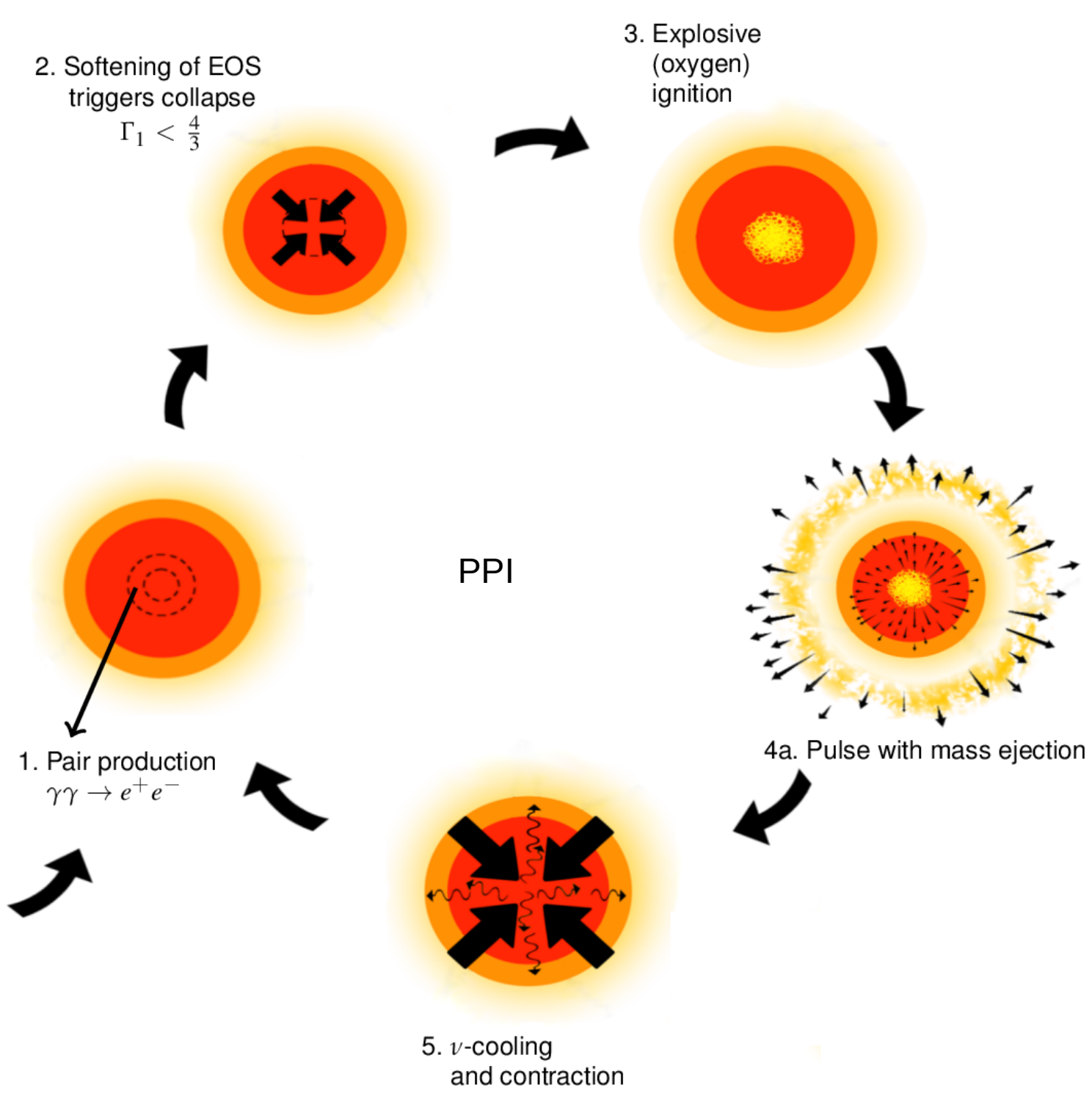

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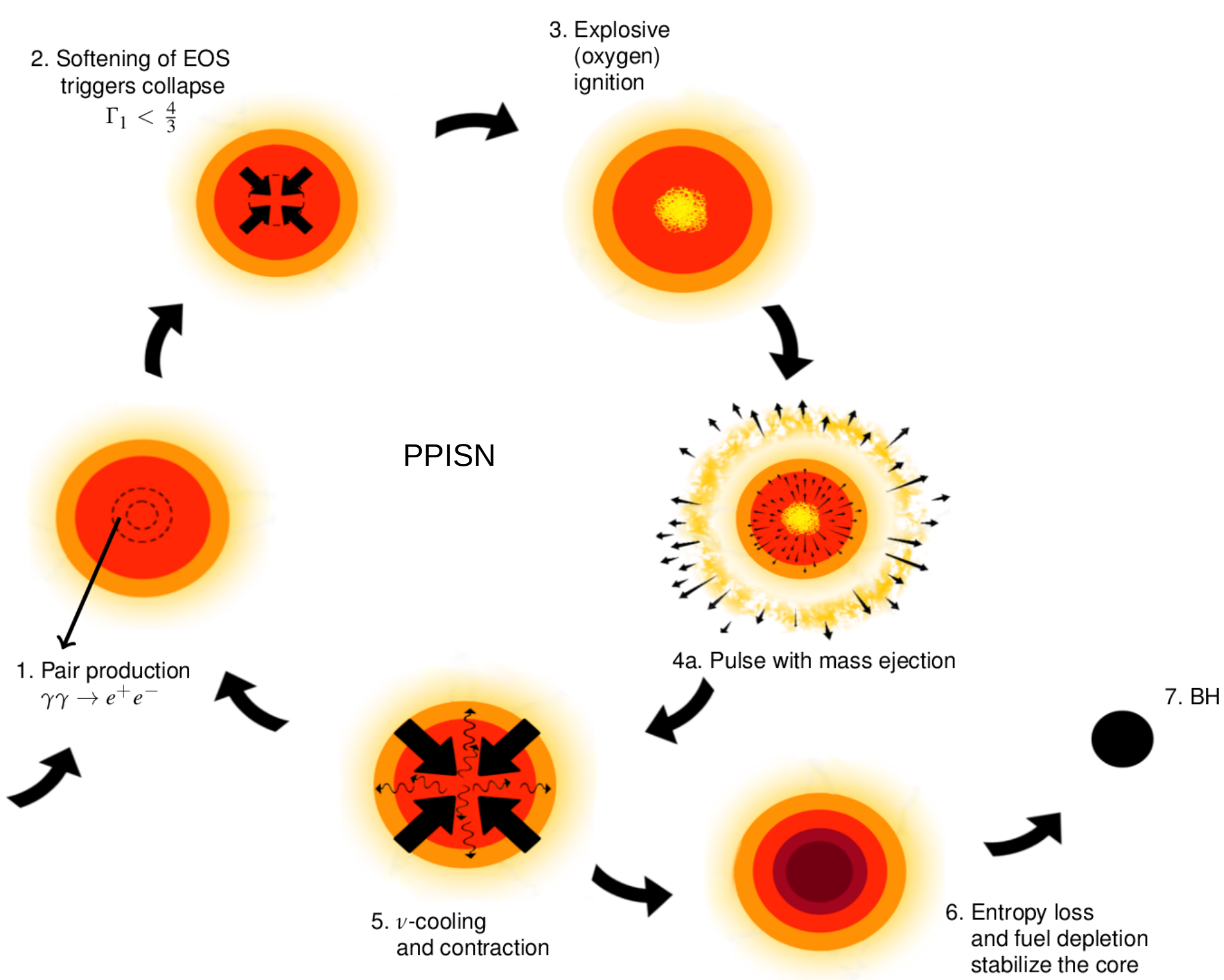

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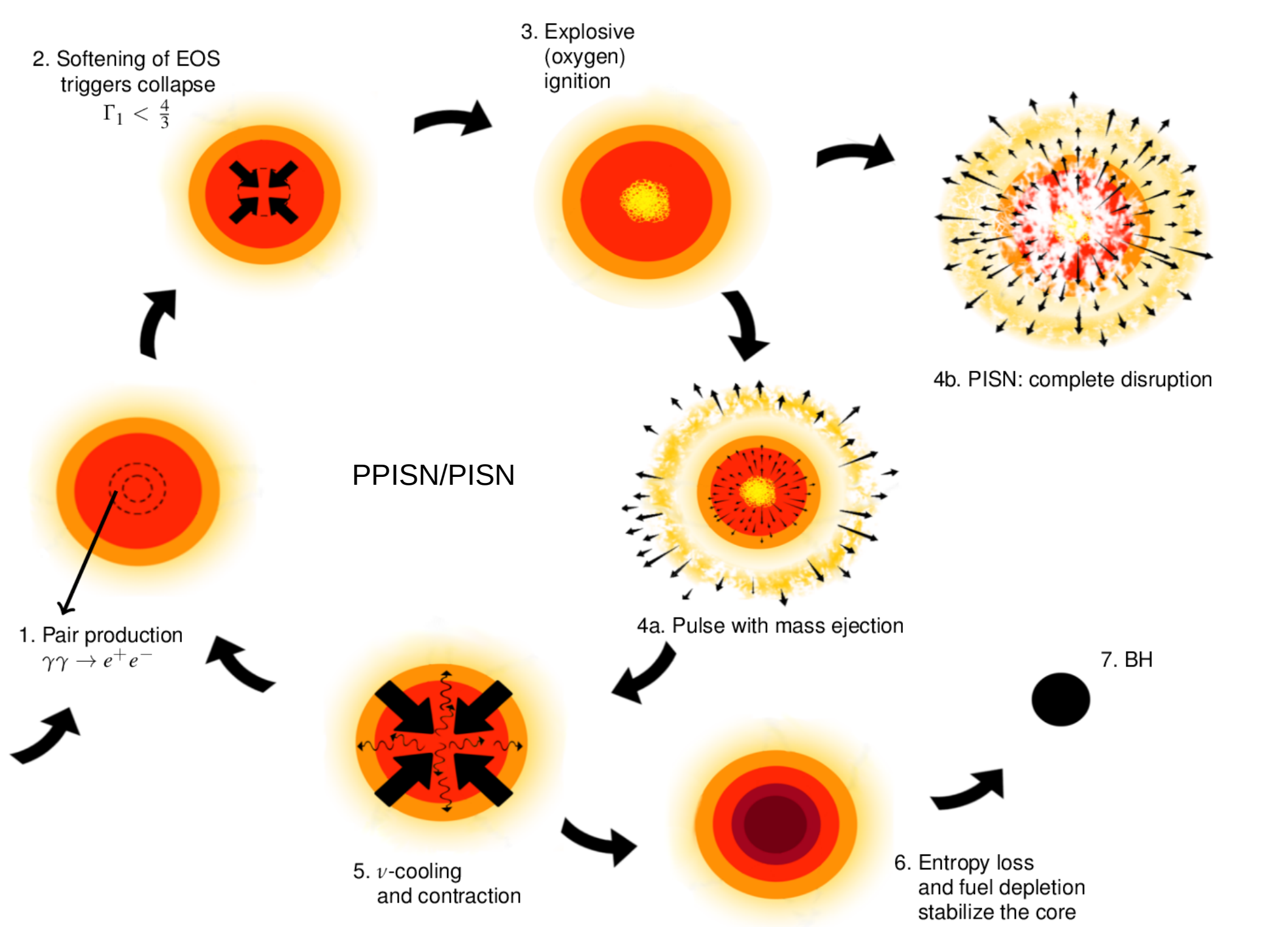

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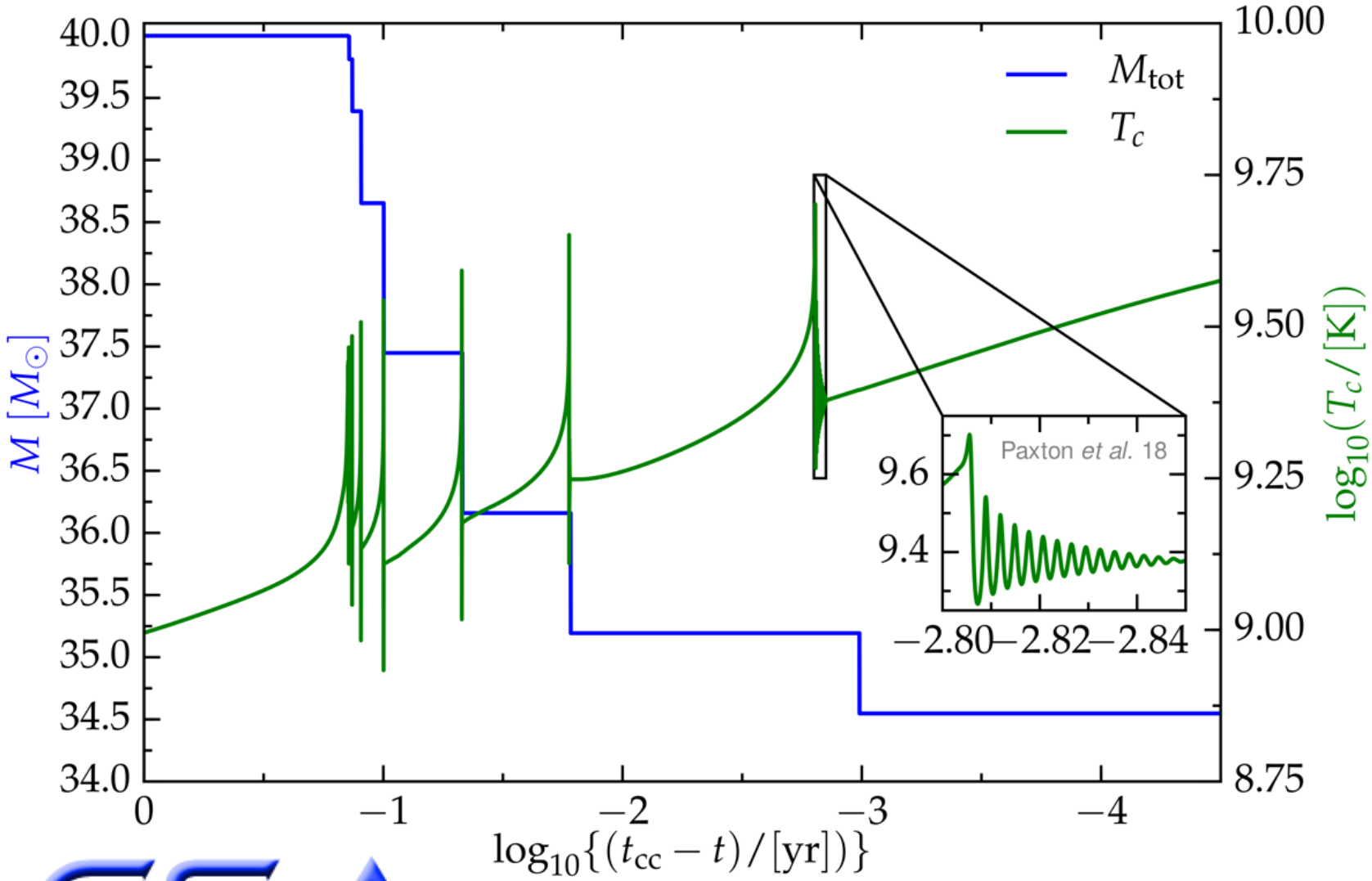
How to make a PPI



MESA

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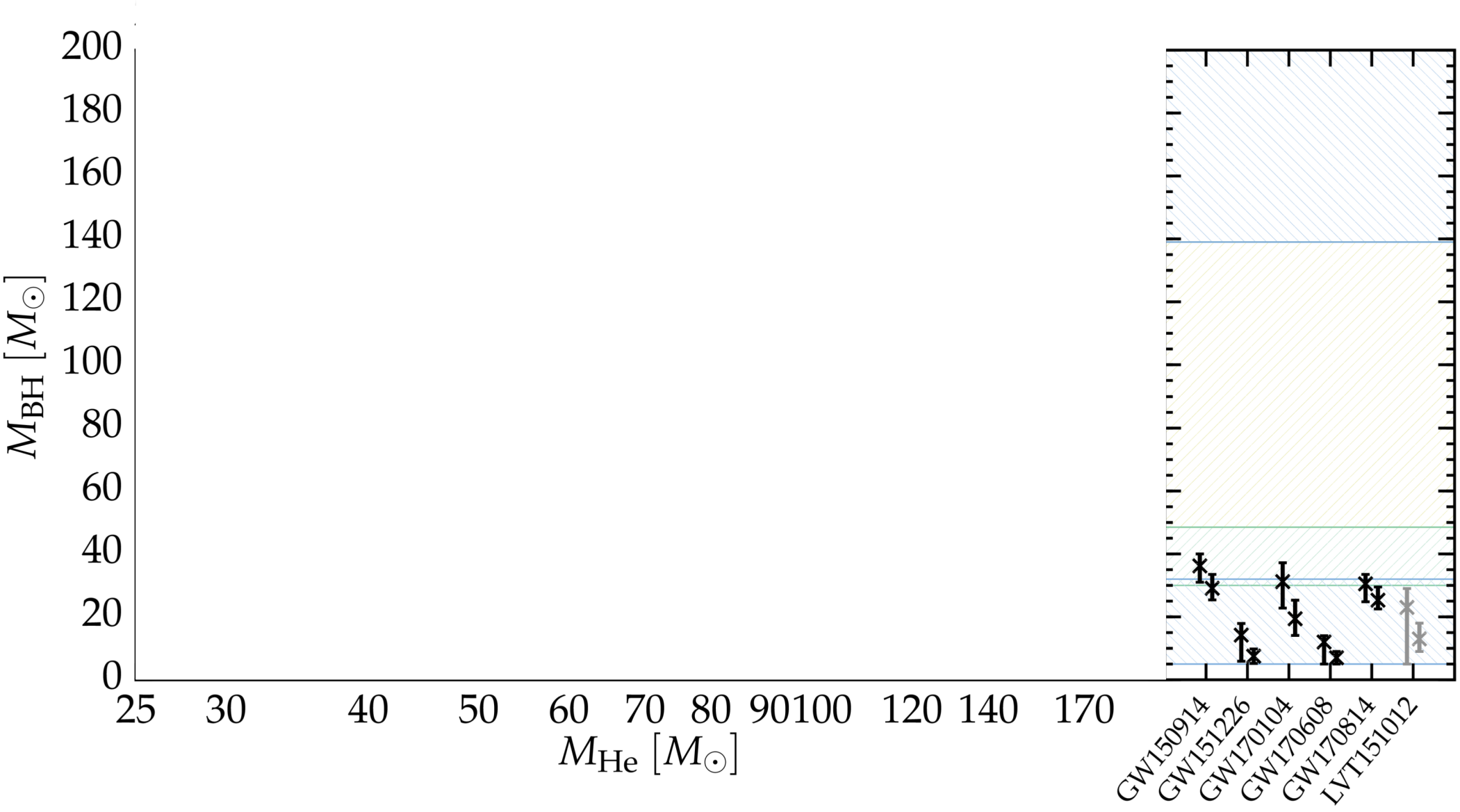
What makes a BH?



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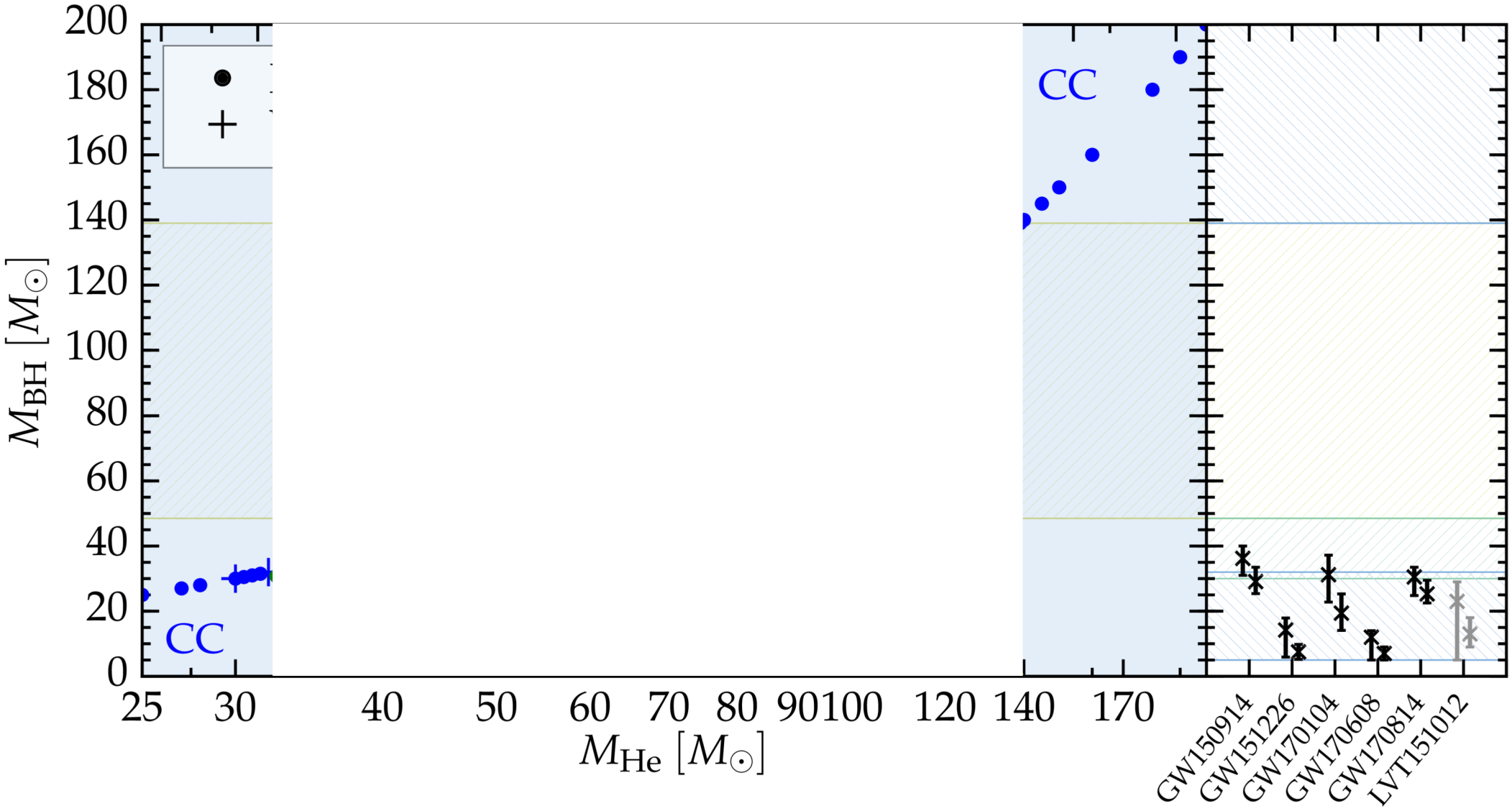

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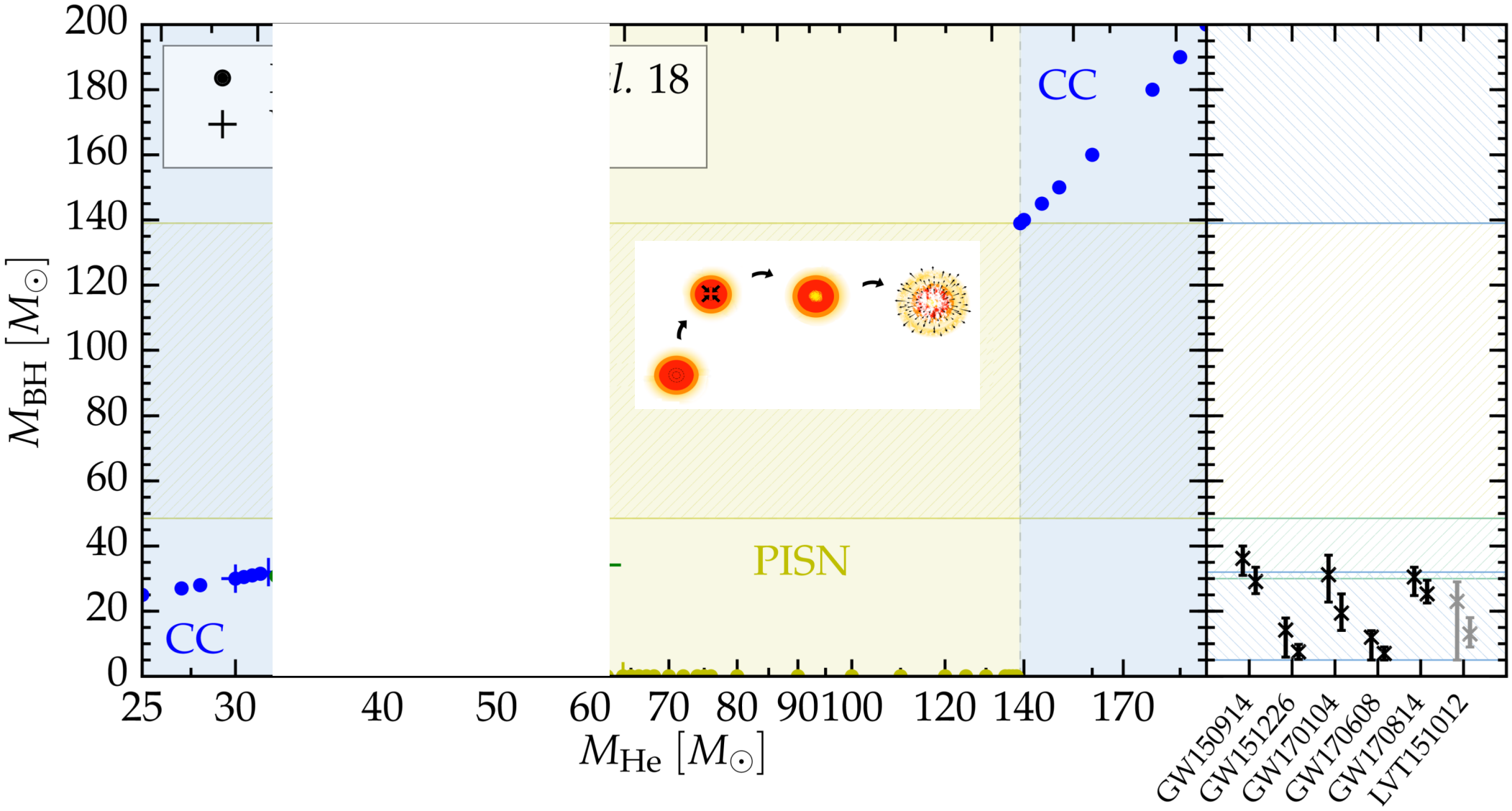

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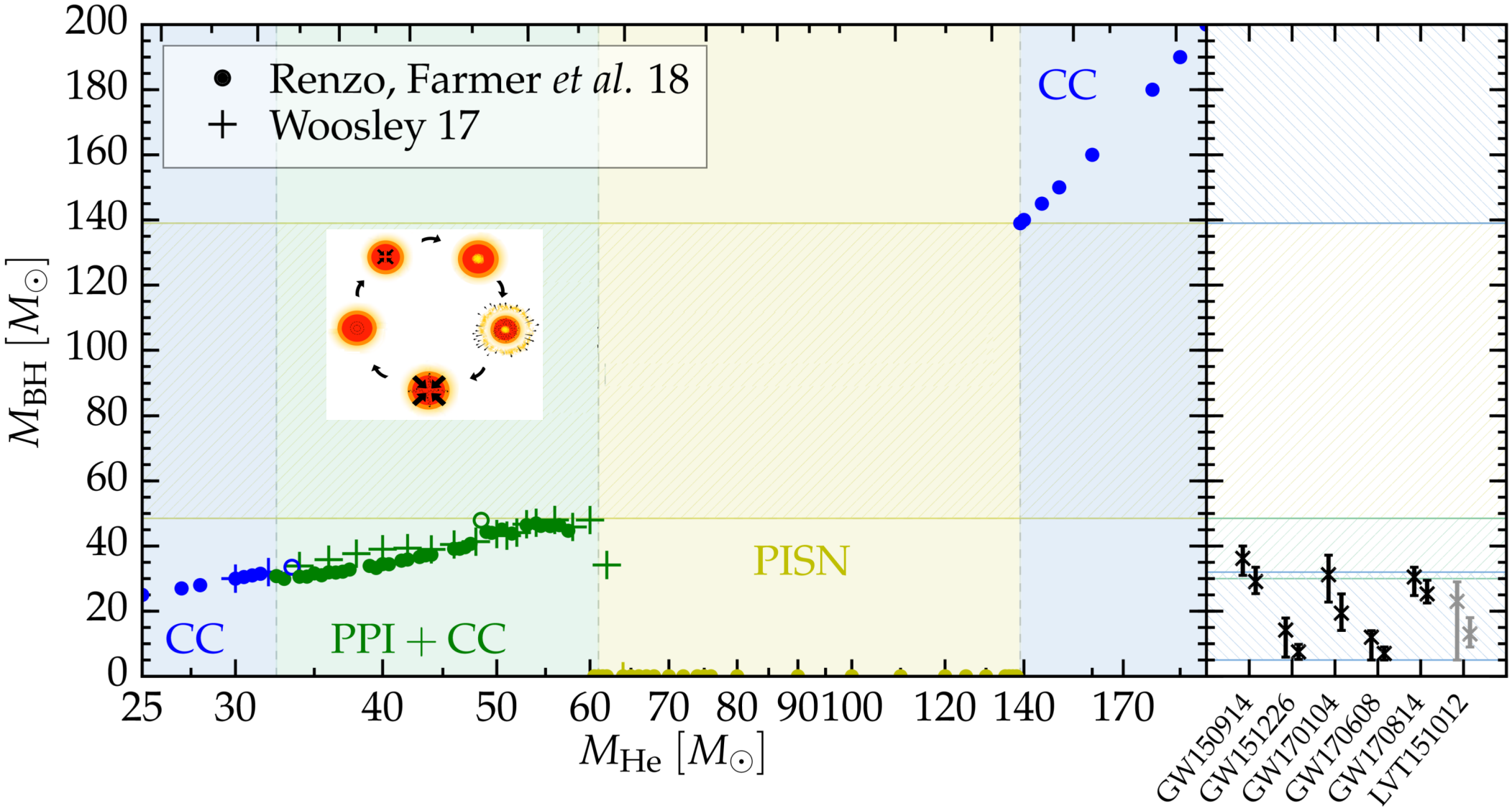

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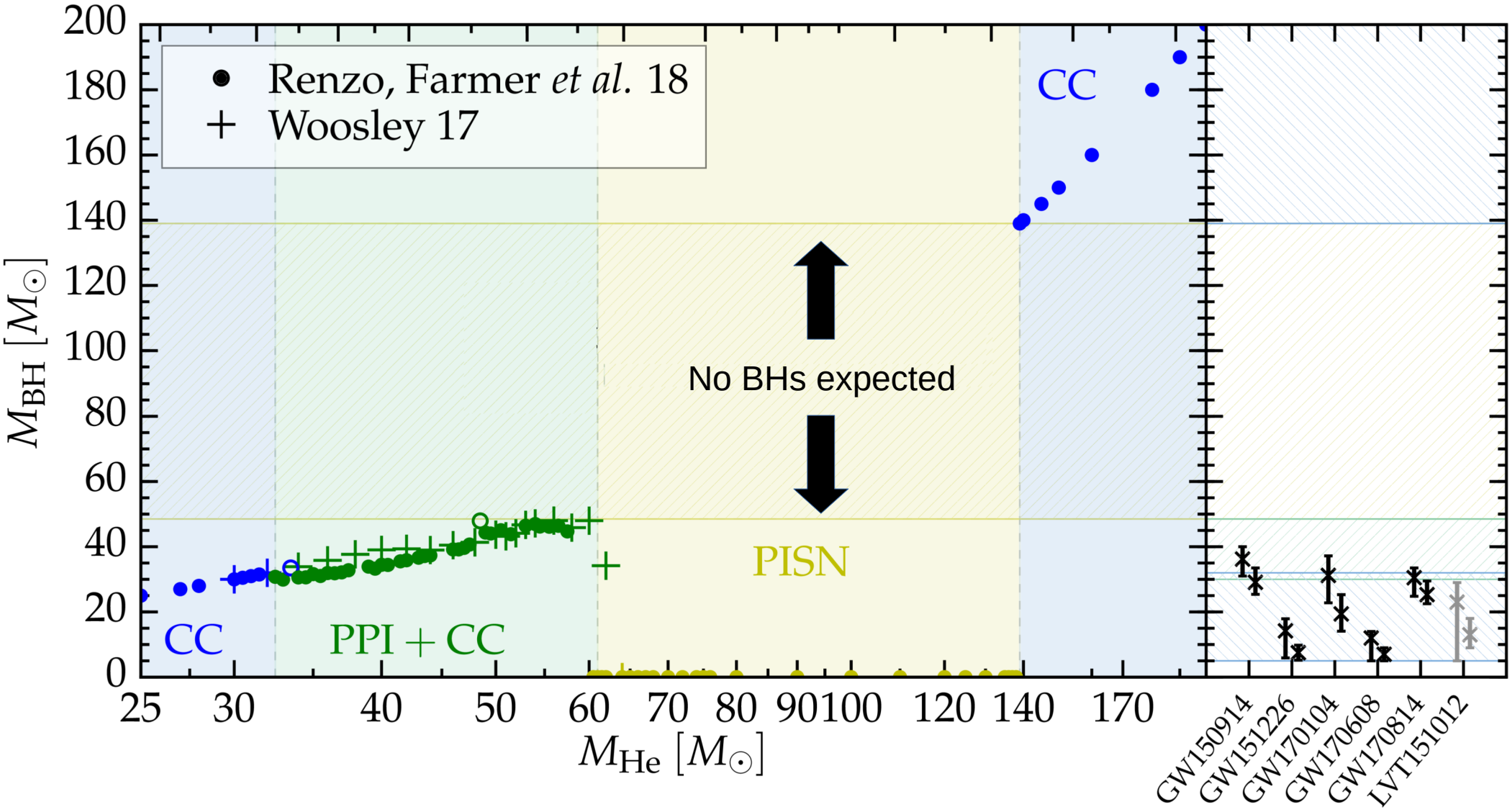

Fishbach&Holz17, Belczynski+16, Abbott+16

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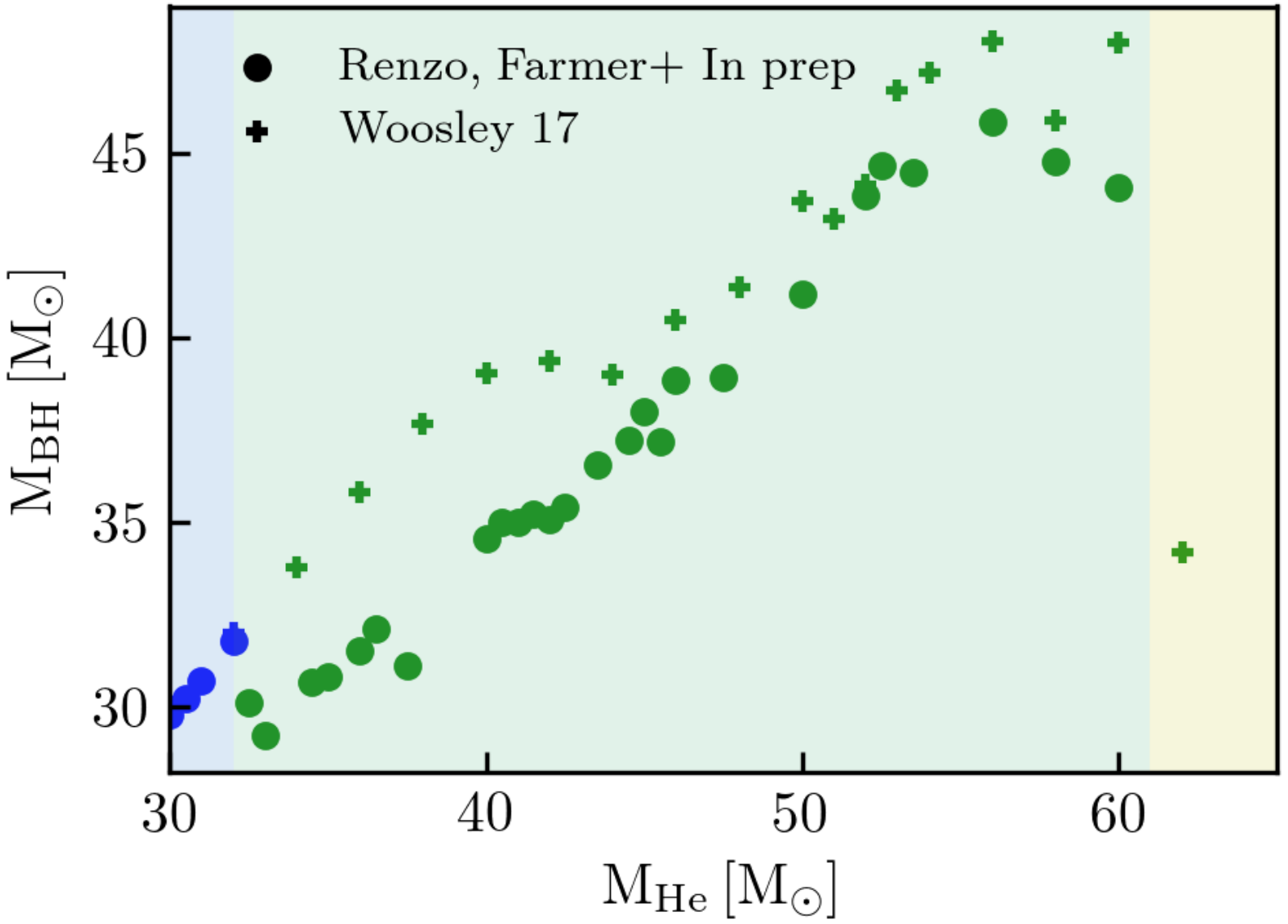
What makes the largest BH*?



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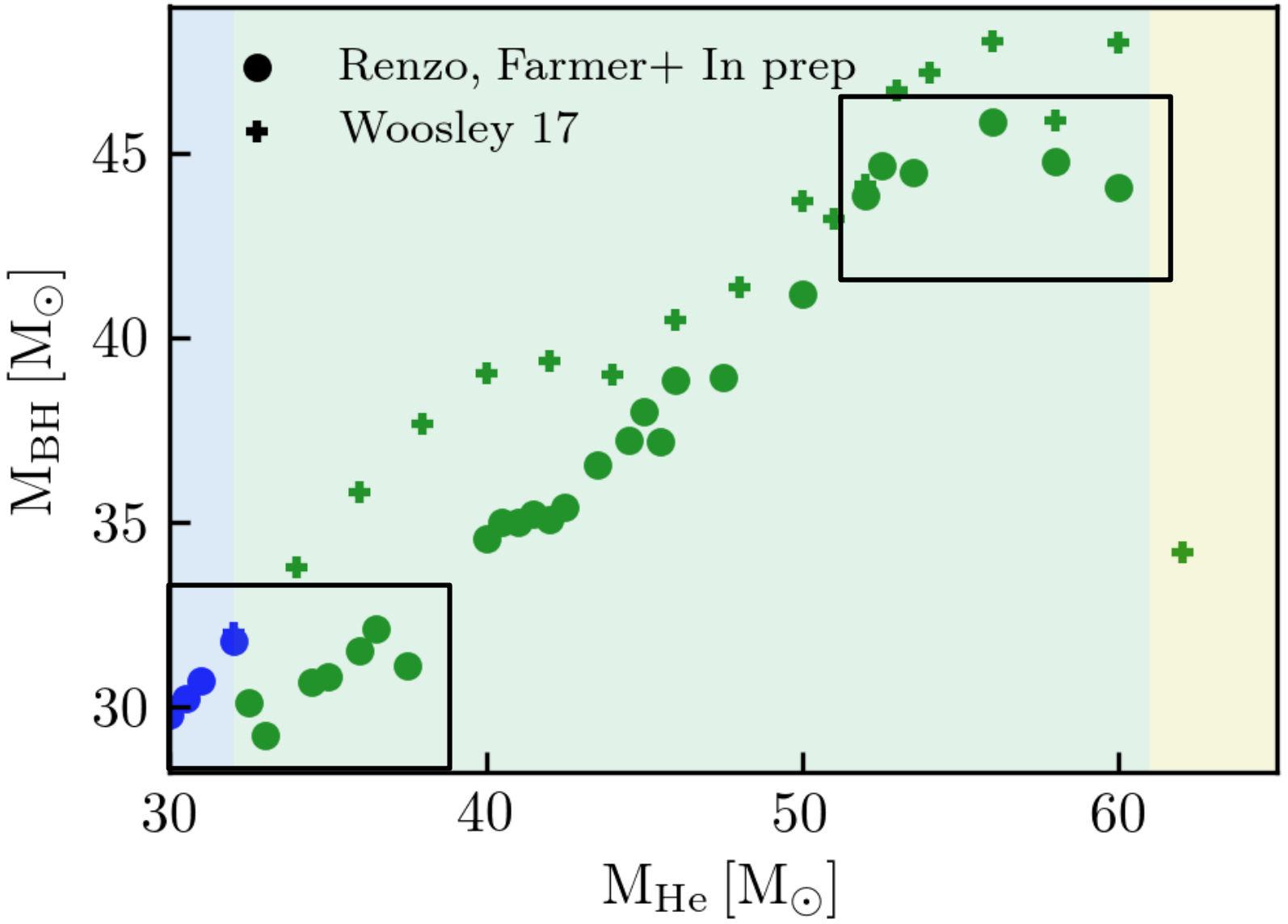
* From single(-ish) stars, non-dynamical mergers

What makes the largest BH?



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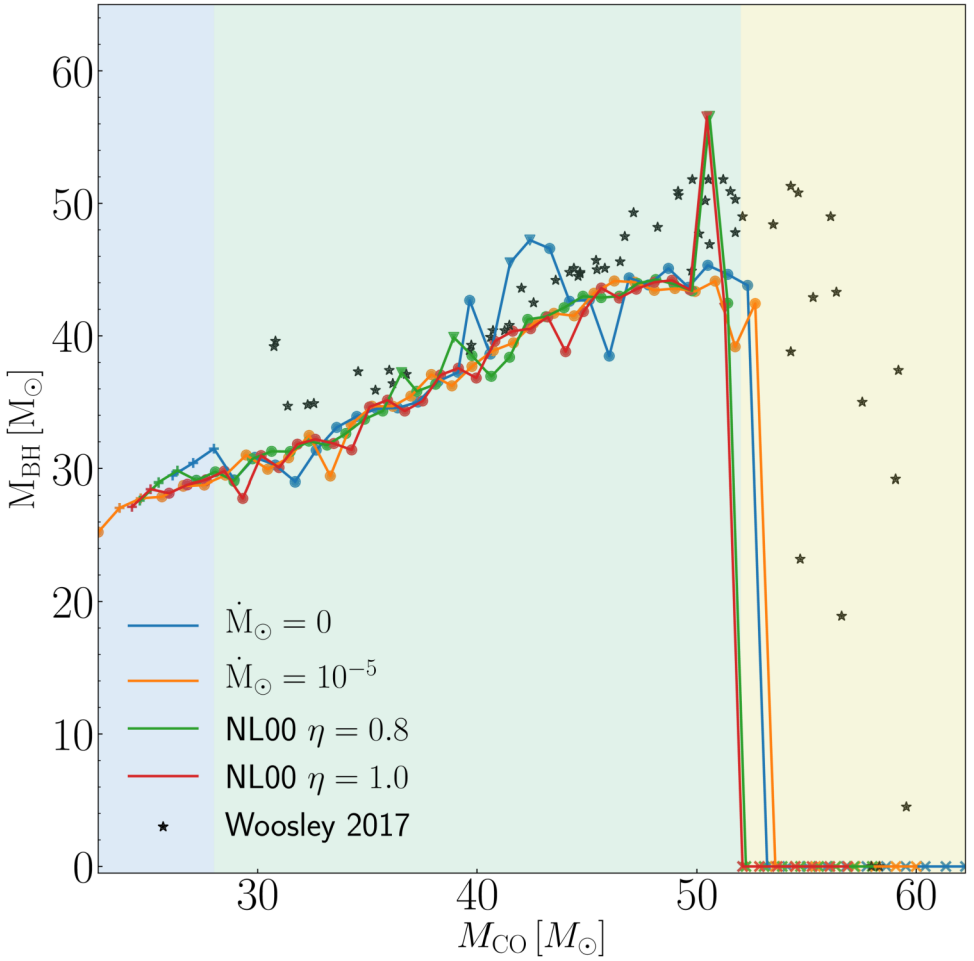
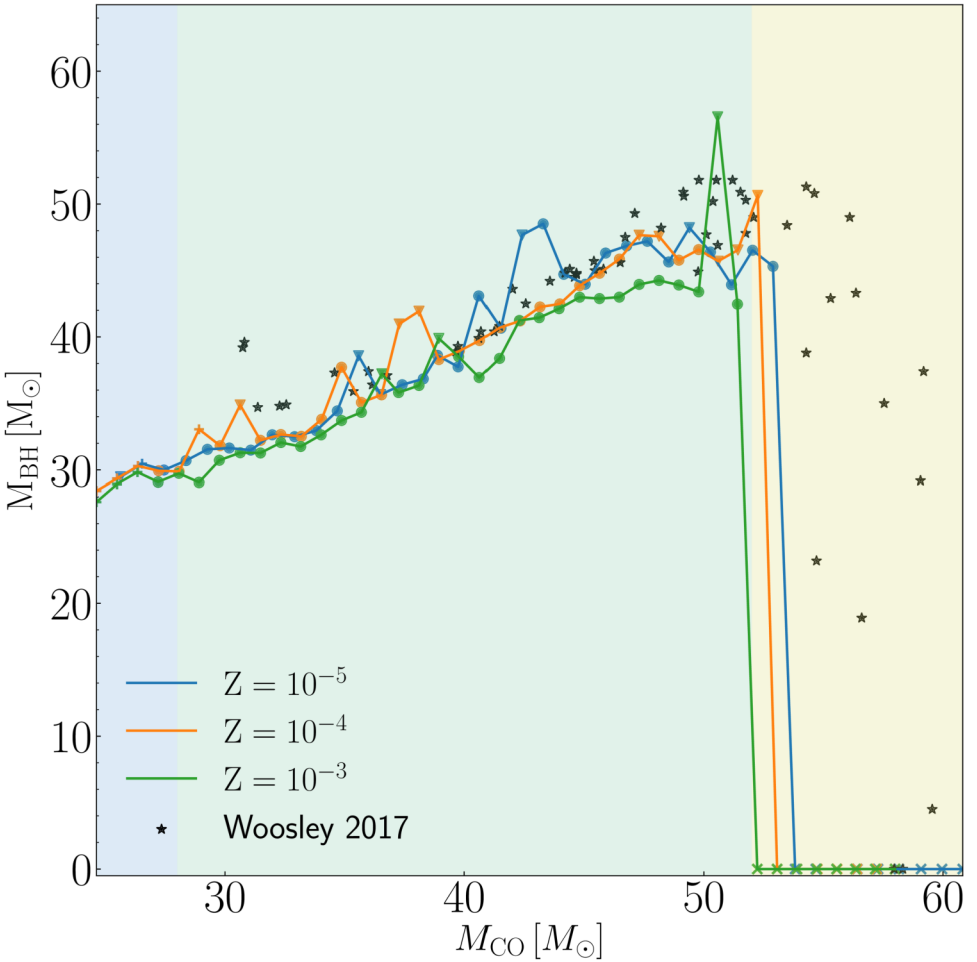
Does the environment matter?

Winds



Z



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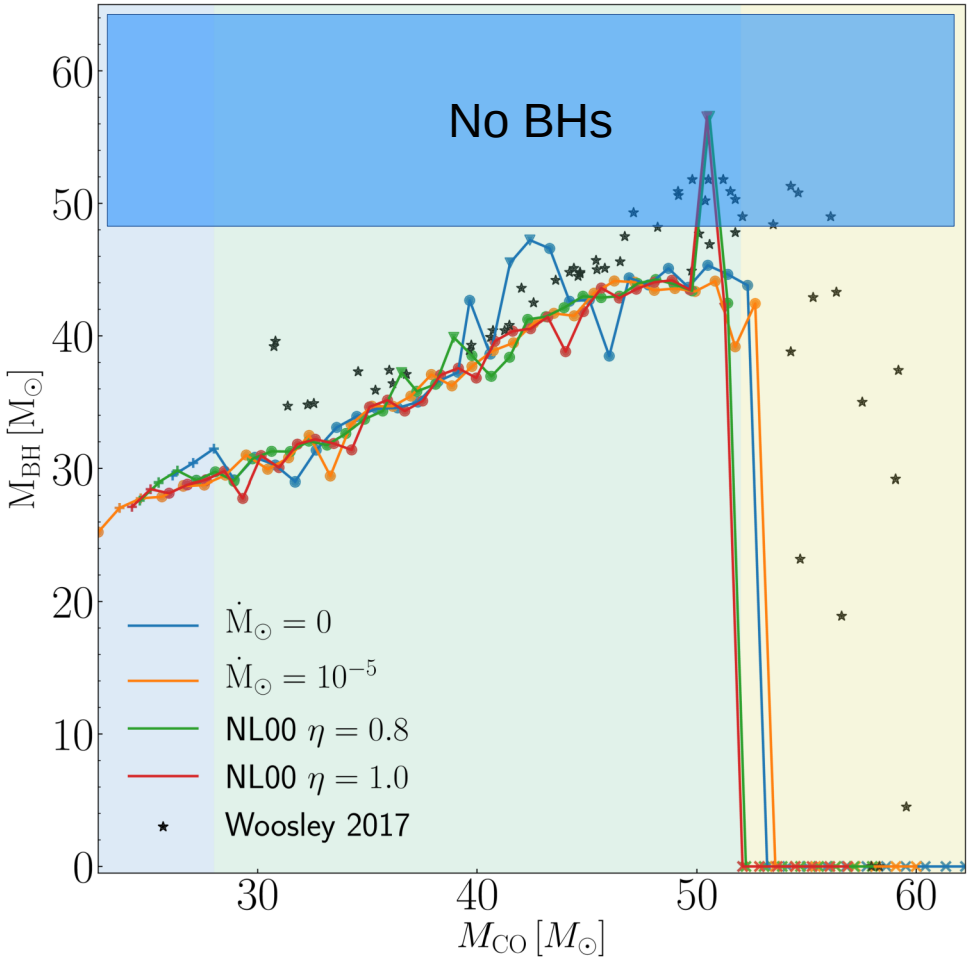

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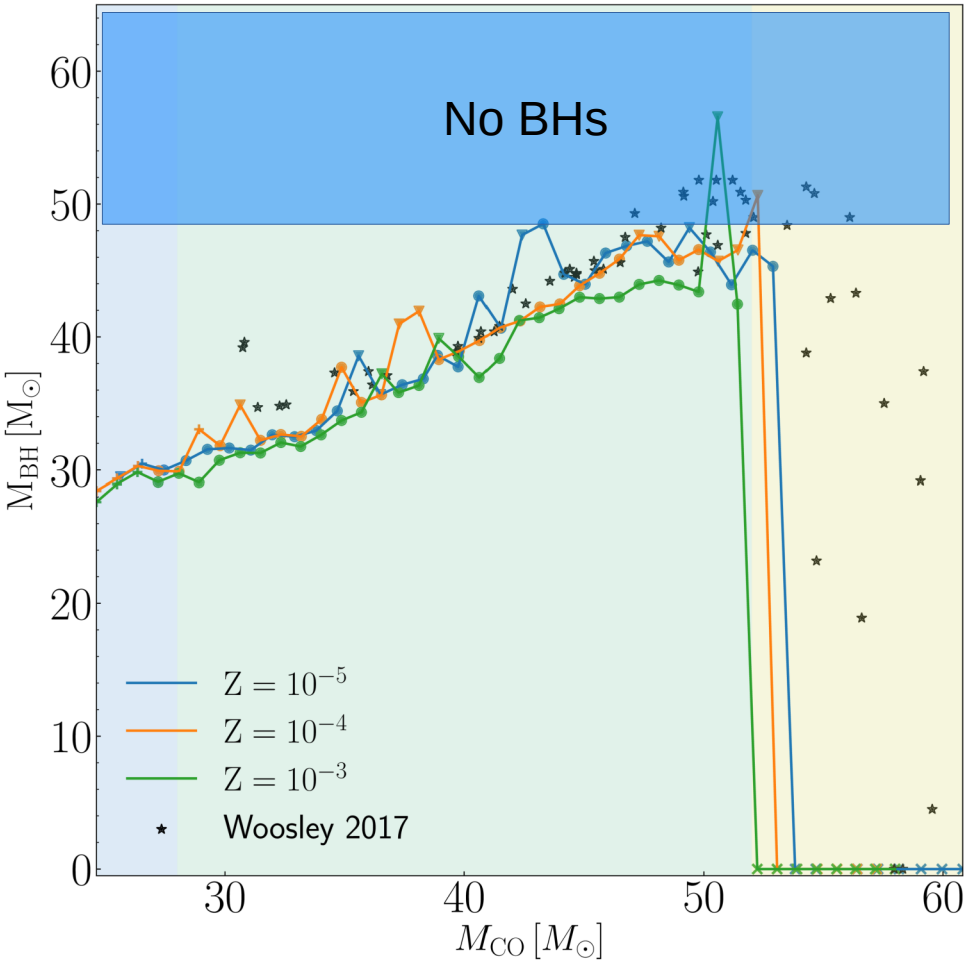

Maximum predicted BH is ~48Msun

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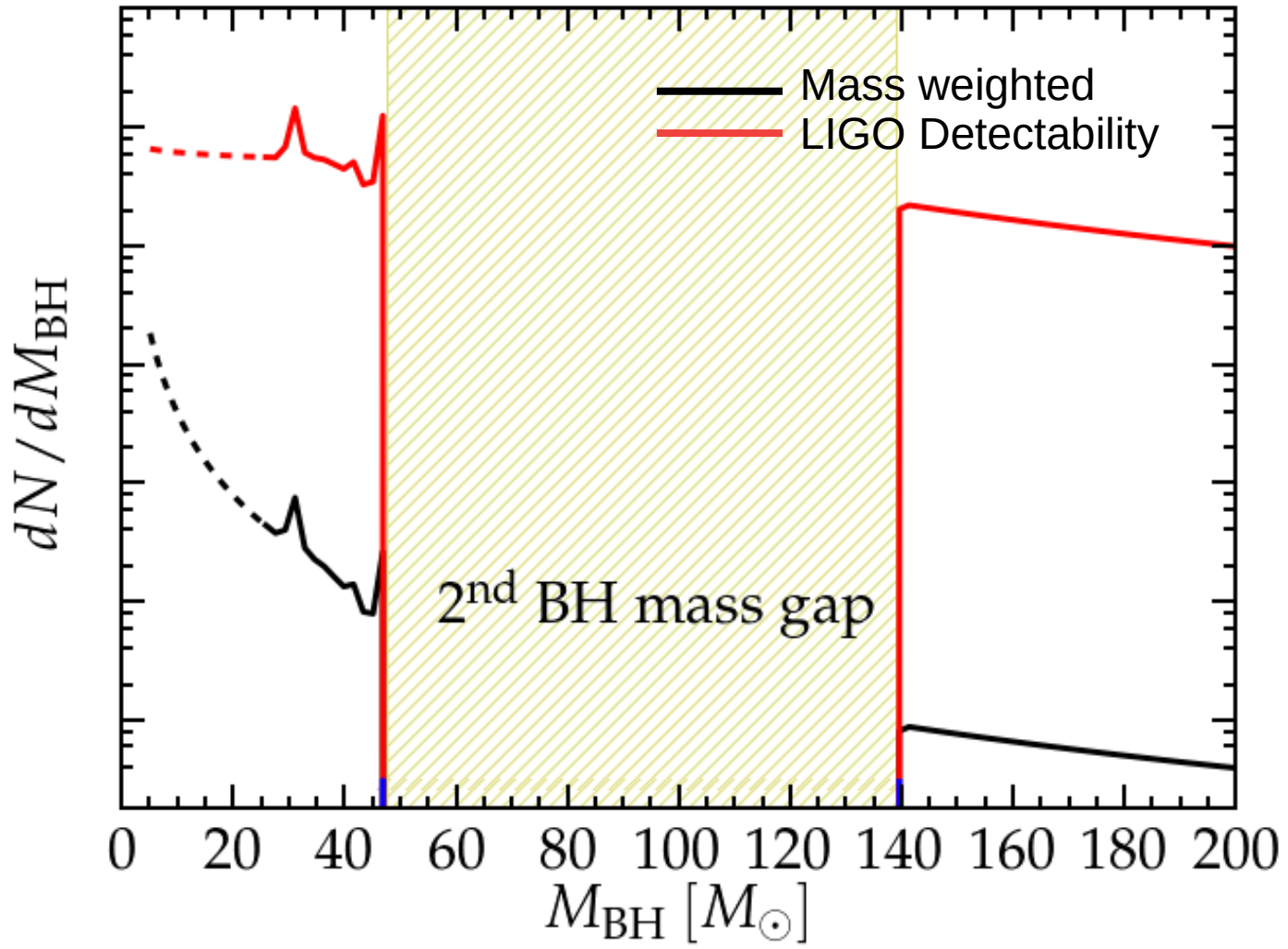
Summary

- We have predicted the 2nd BH mass gap between 48-140 Msun
- Results agree well with previous theoretical predictions
- We predict a ”pileup” of BHs at the boundaries of the PPISN regime
- Maximum mass of BH is insensitive to input physics (Mass loss and metalicity)

BACKUP

Black hole mass distribution



Abbot+16, Fishbach&Holz17

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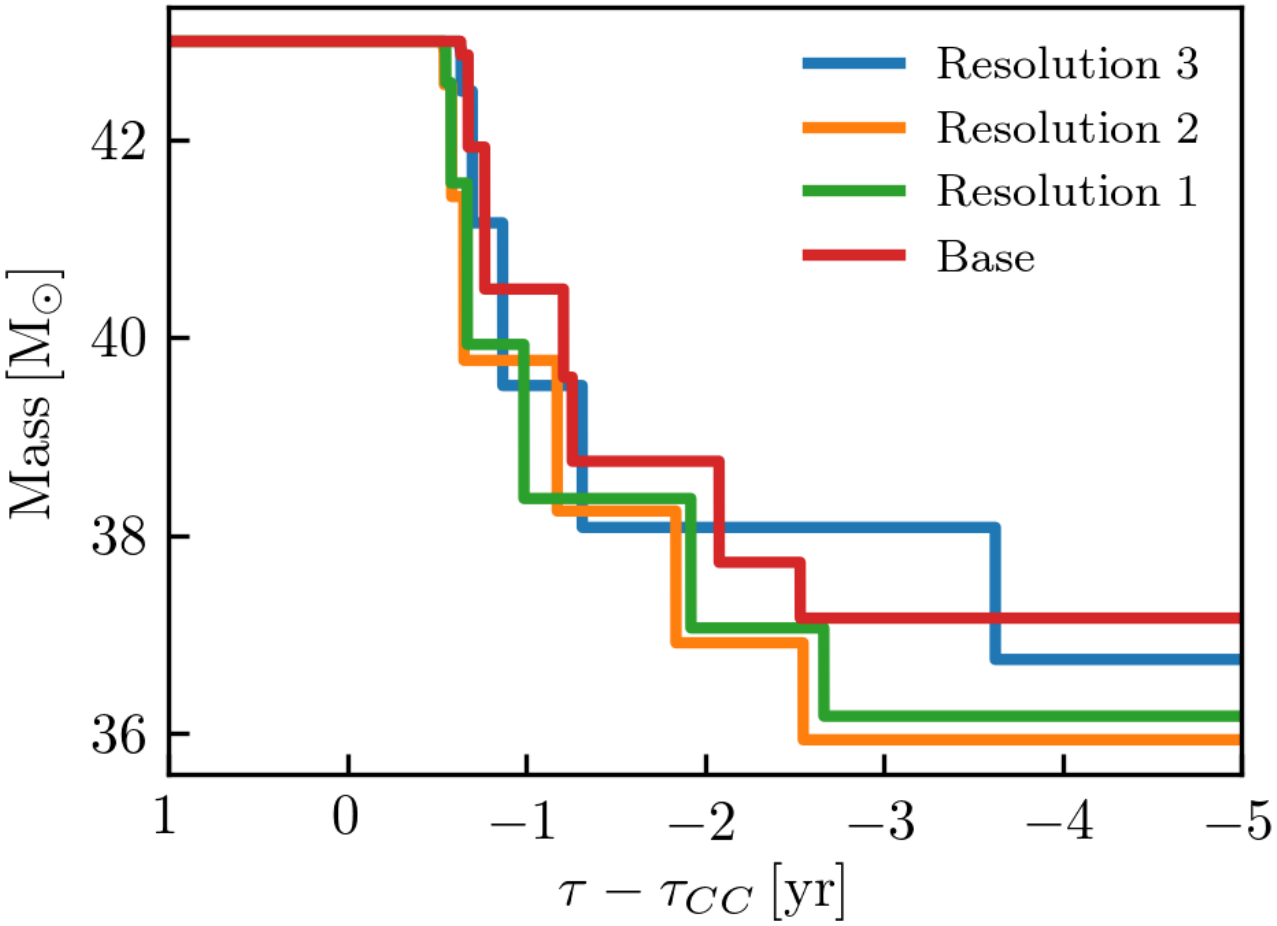
Robustness to numerical resolution



~1Msun uncertainty in BH mass due to numerics

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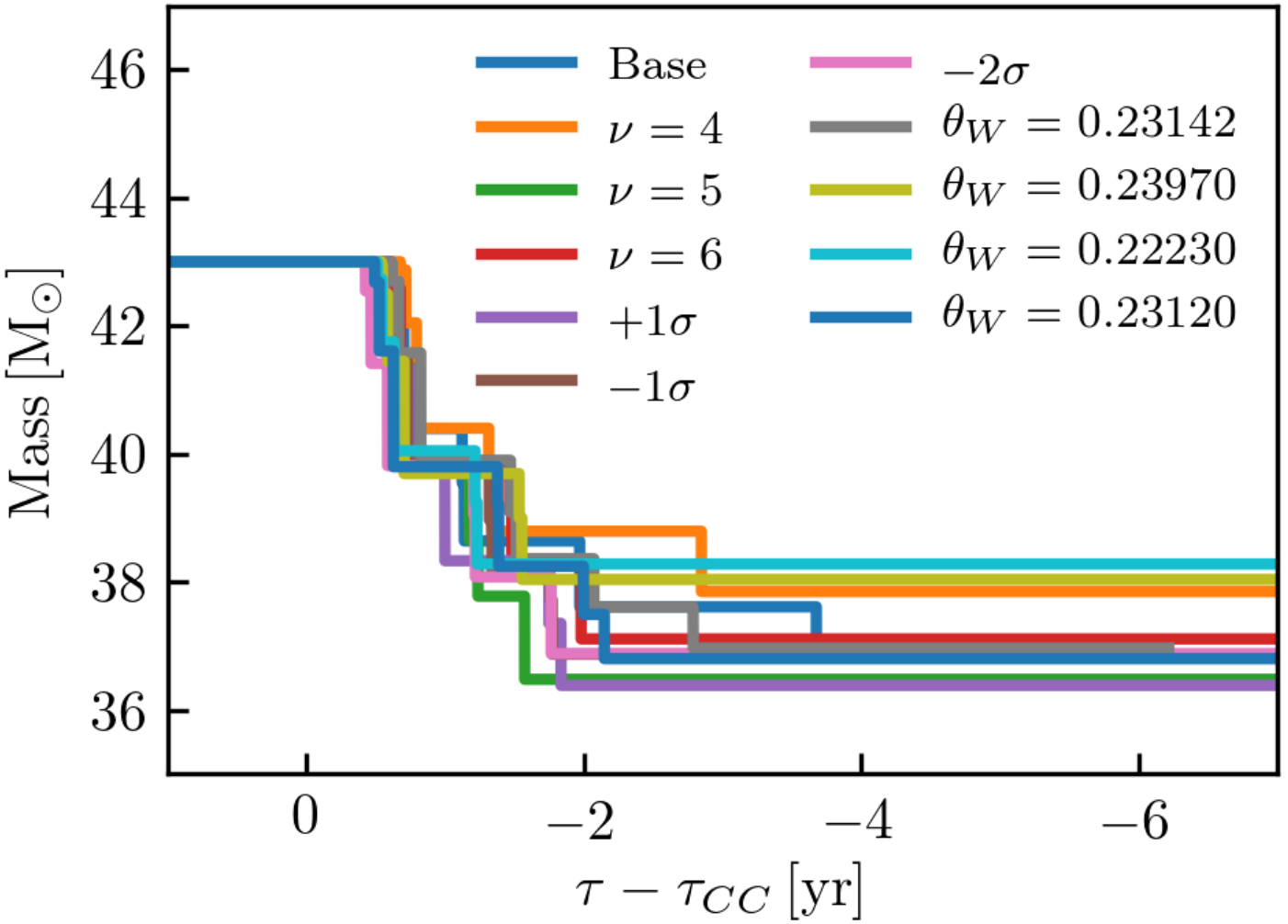
Variations in neutrino physics



~2Msun variations in BH mass due to neutrino physics

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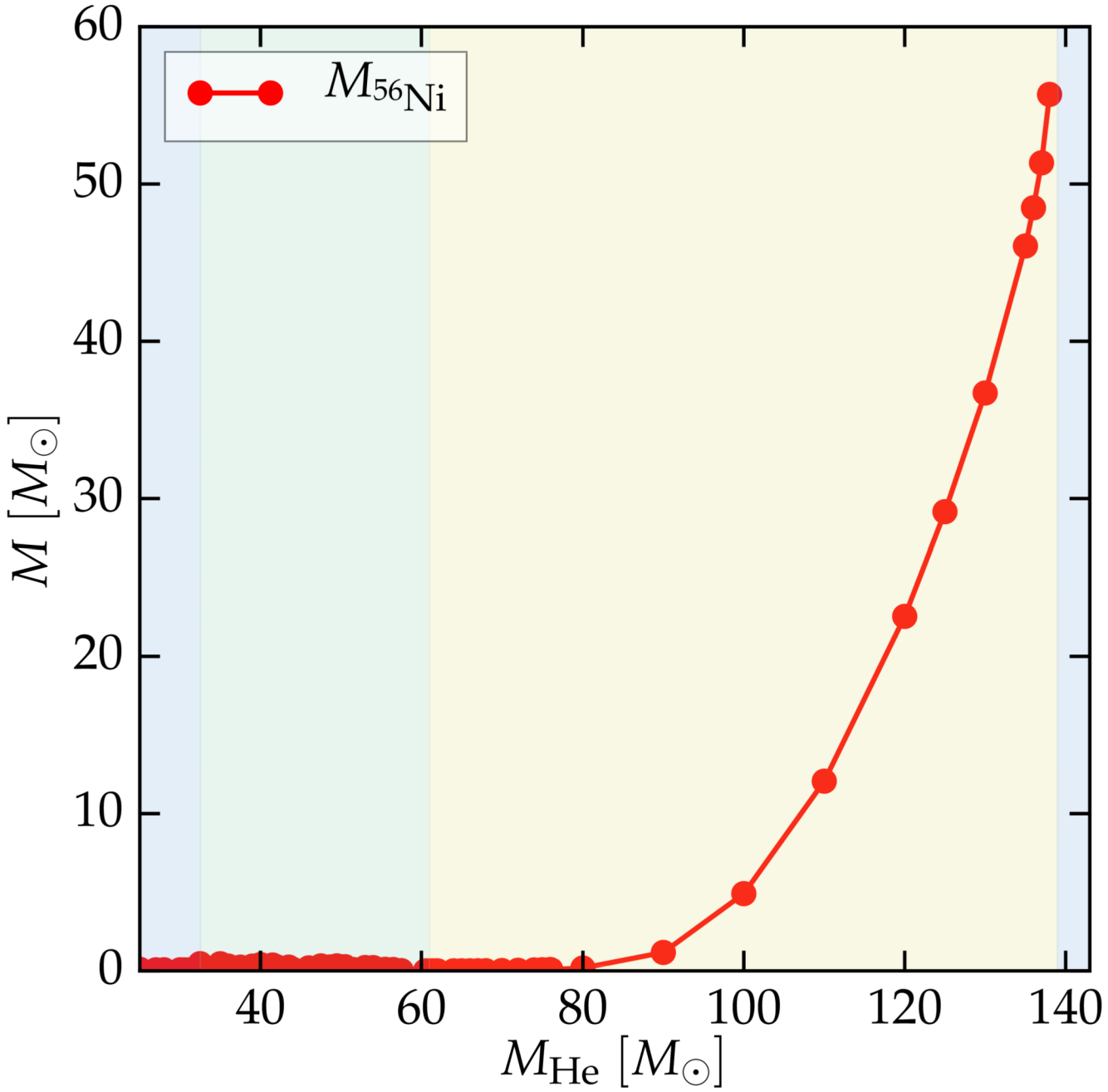
$M_{^{56}\mathrm{Ni}}$
60
50
40
30
20
10
0
$M\ [M_\odot]$
40
60
80
100
120
140
$M_{\mathrm{He}}\ [M_\odot]$