

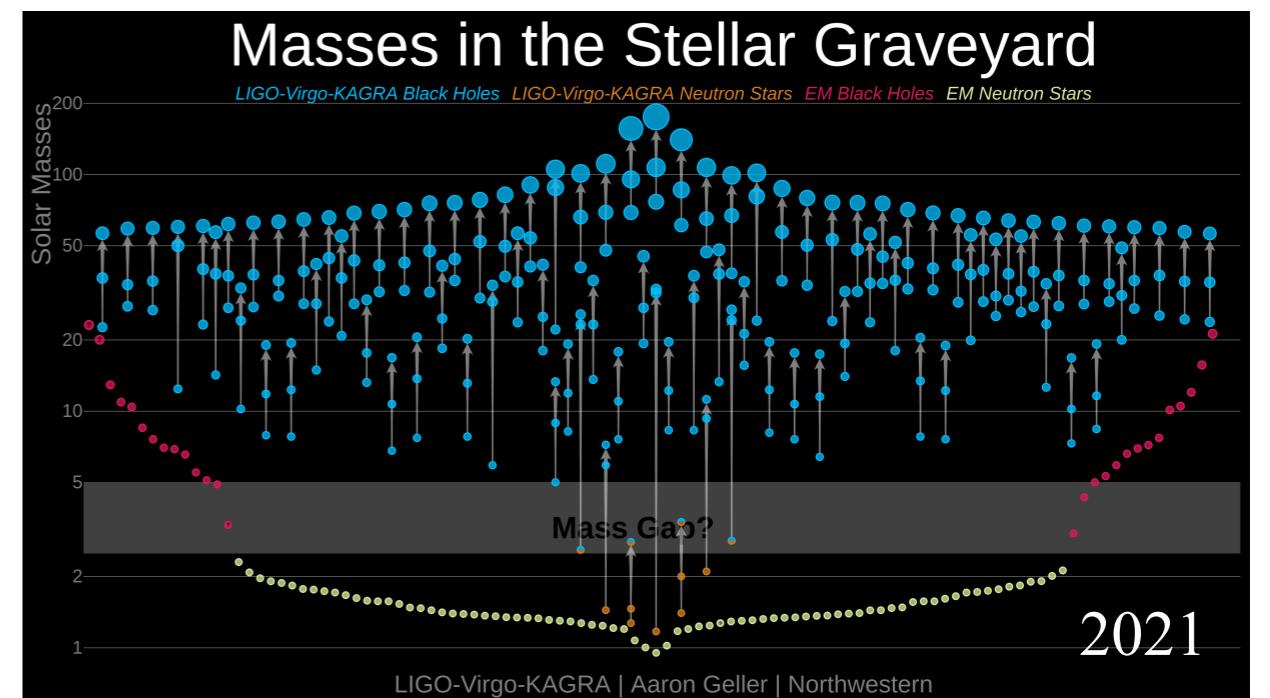
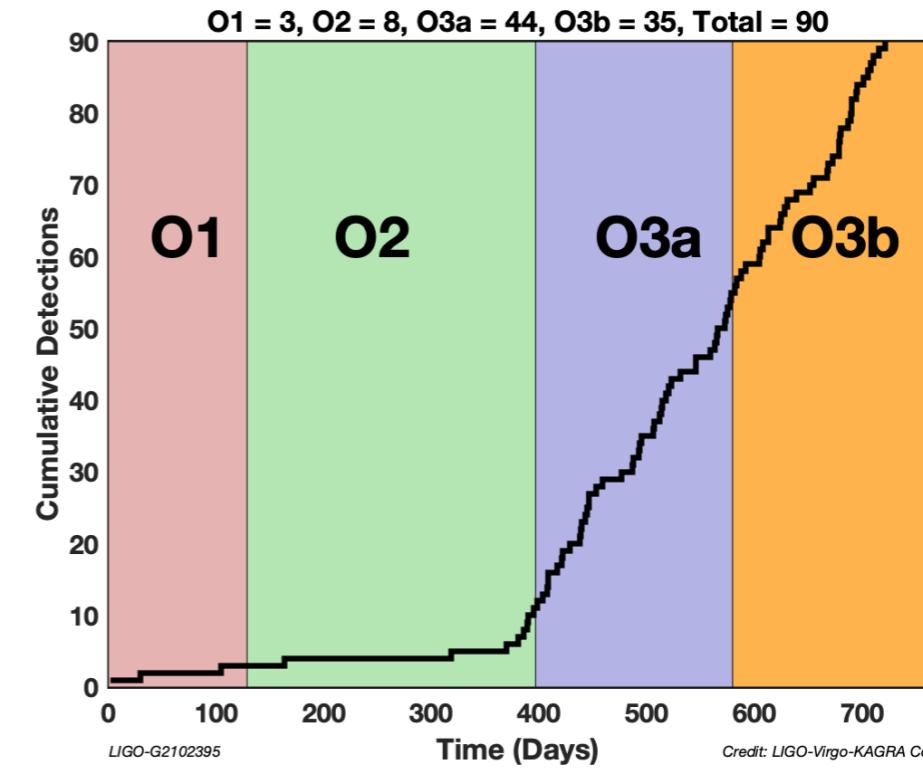
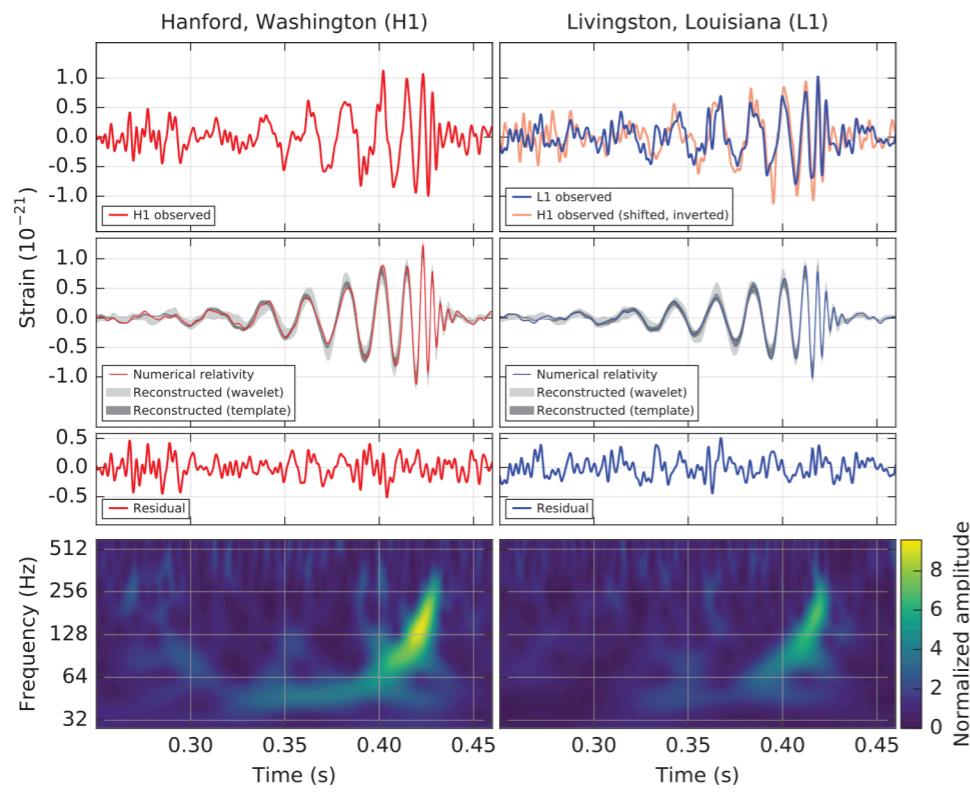
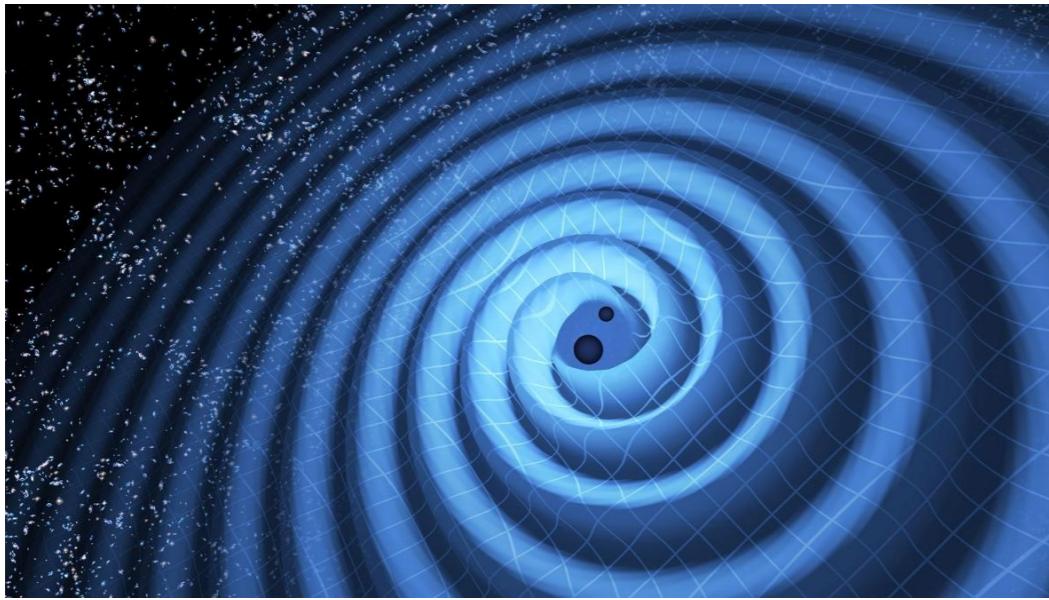
# Binary population synthesis for merging binary black hole formation

The 9th East Asia Numerical Astrophysics Meeting EANAM9

Sep. 28th 2022, Naha, Okinawa, Japan

Ataru Tanikawa, 谷川衝 (University of Tokyo)

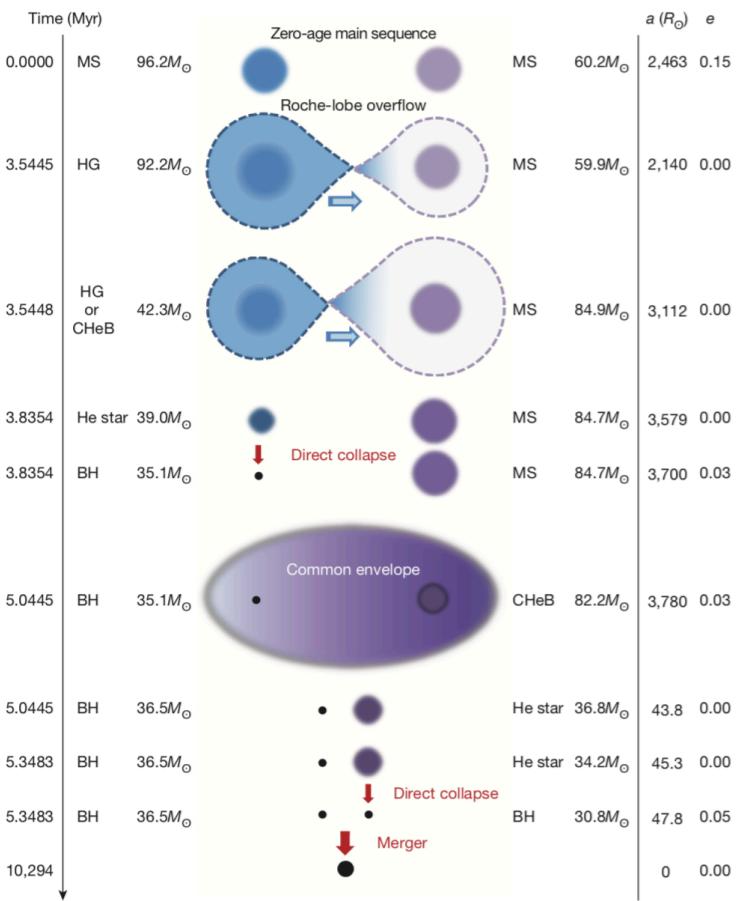
# Binary black holes



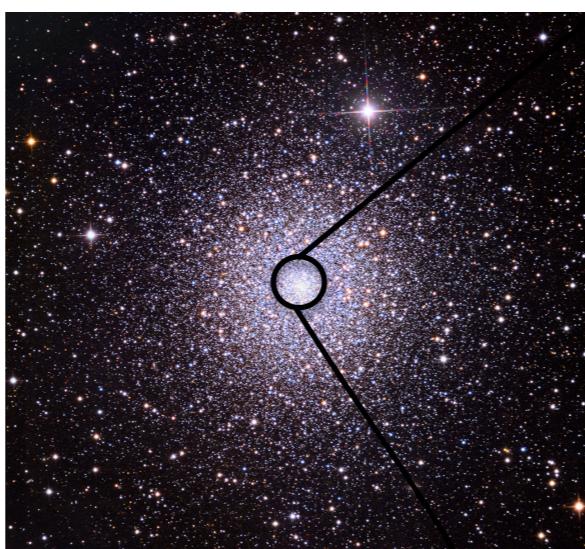
The first detection 2015/09/14 (GW150914)

# Origin of binary black holes

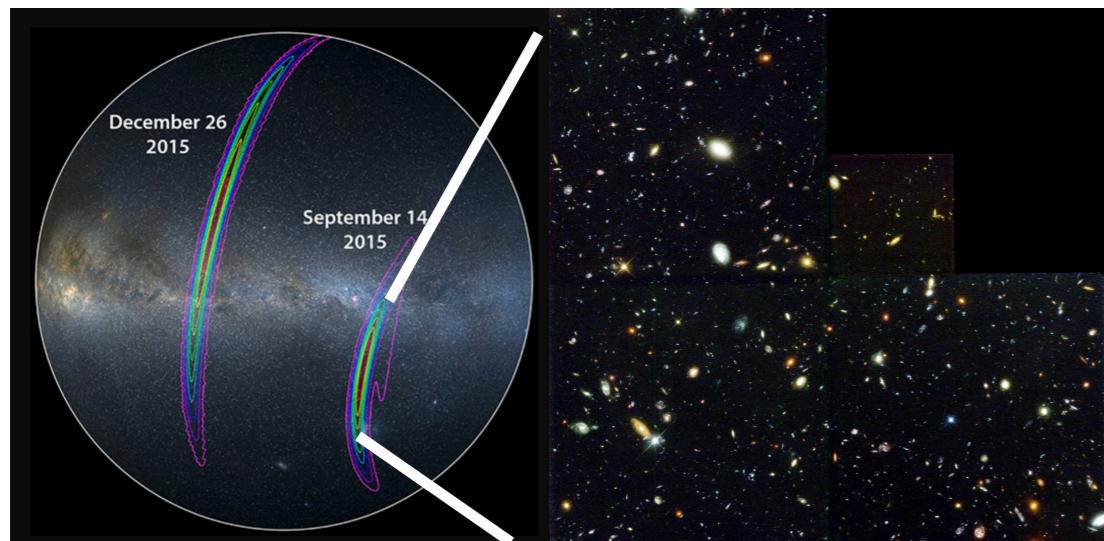
## Isolated binary



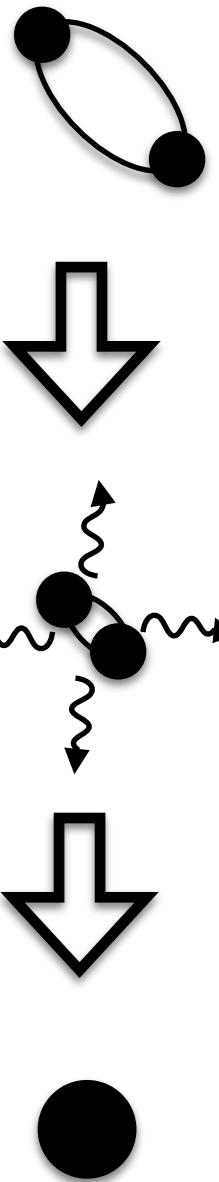
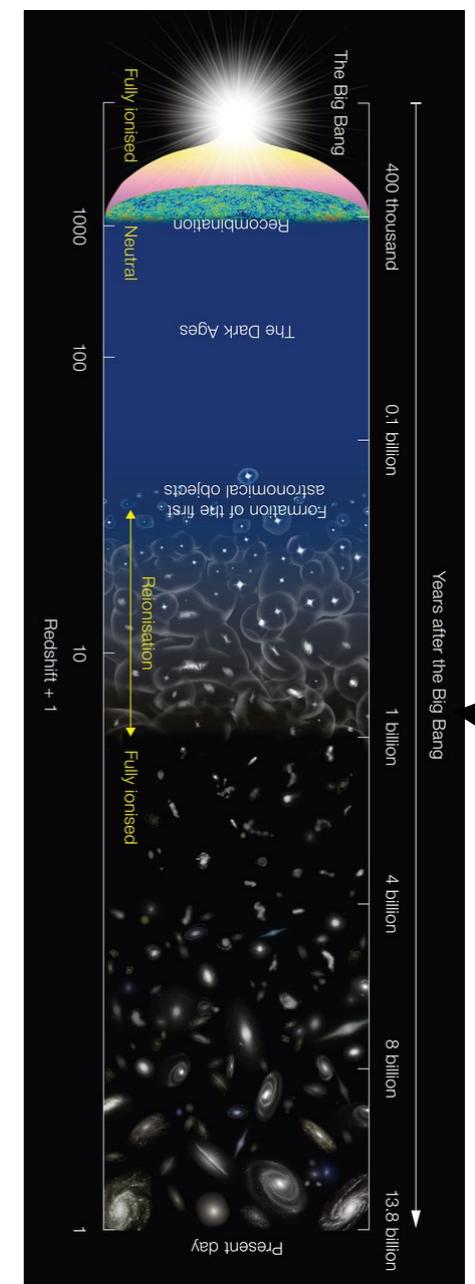
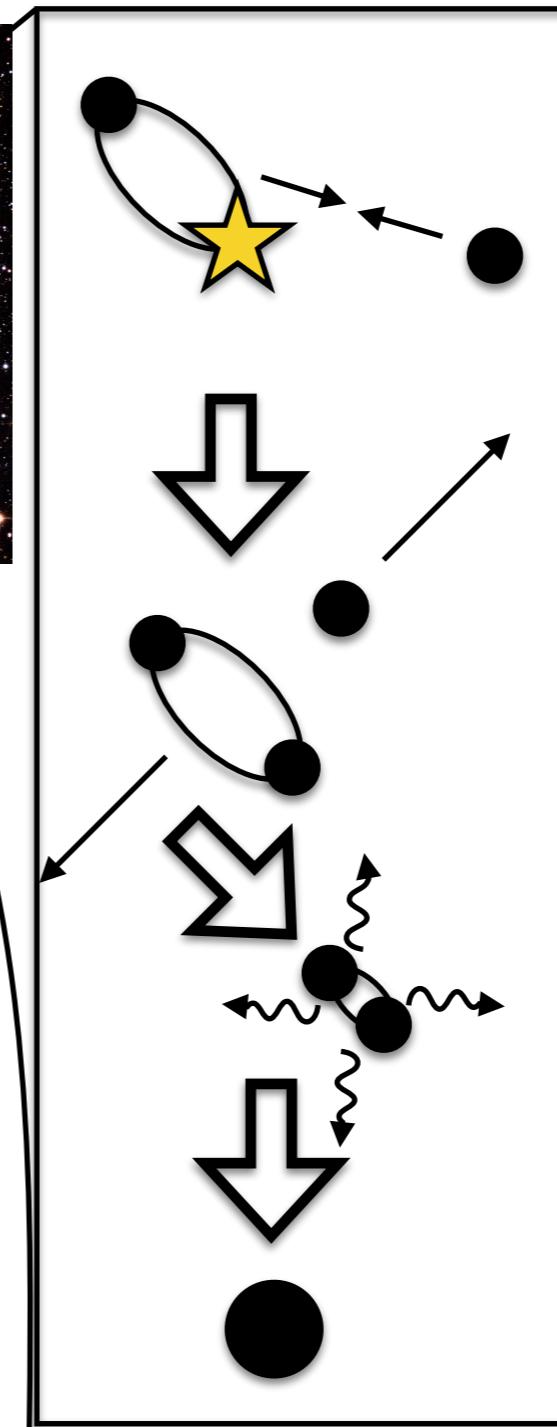
## Dense star cluster



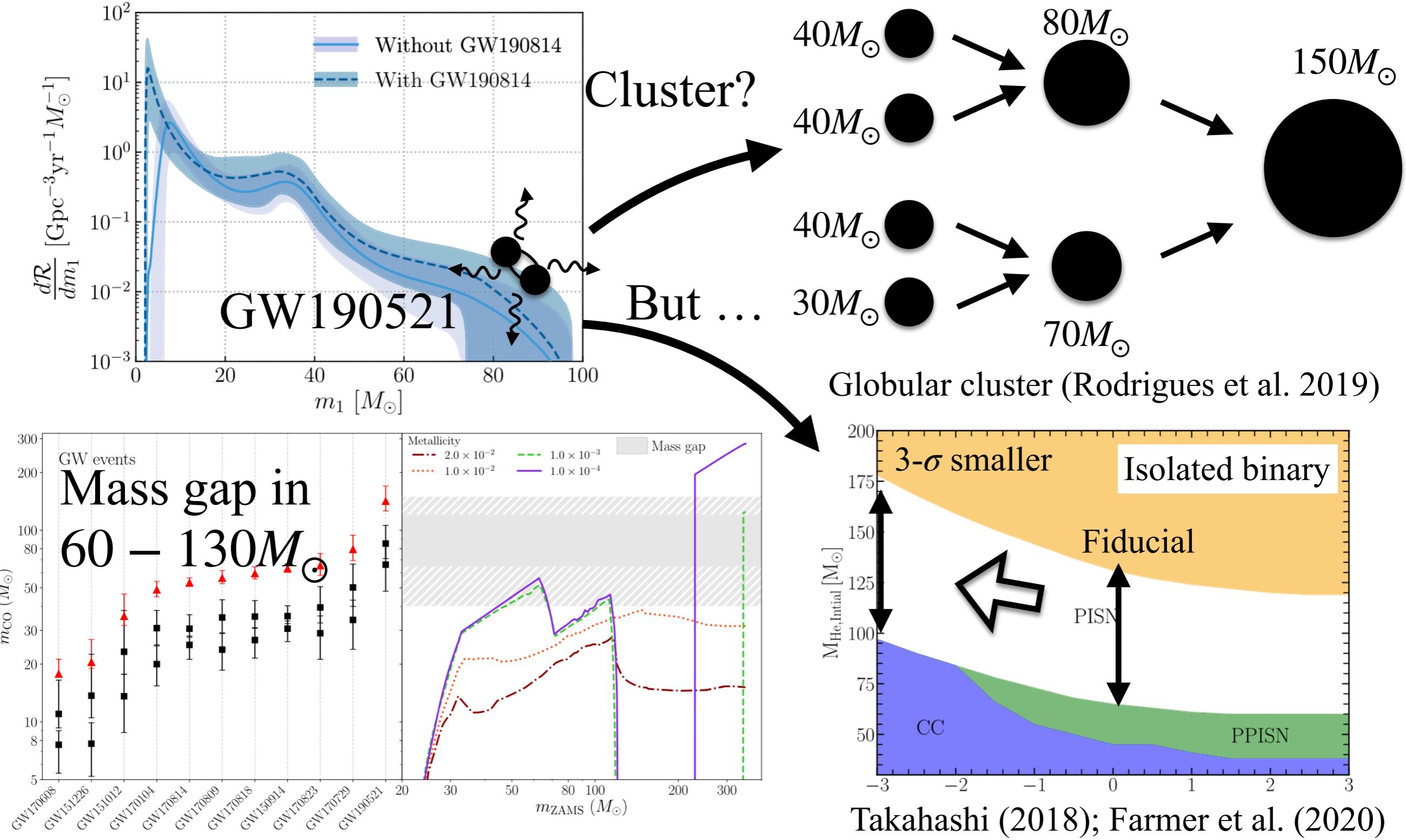
- Open clusters
- Globular clusters
- AGN disk



## Primordial BH

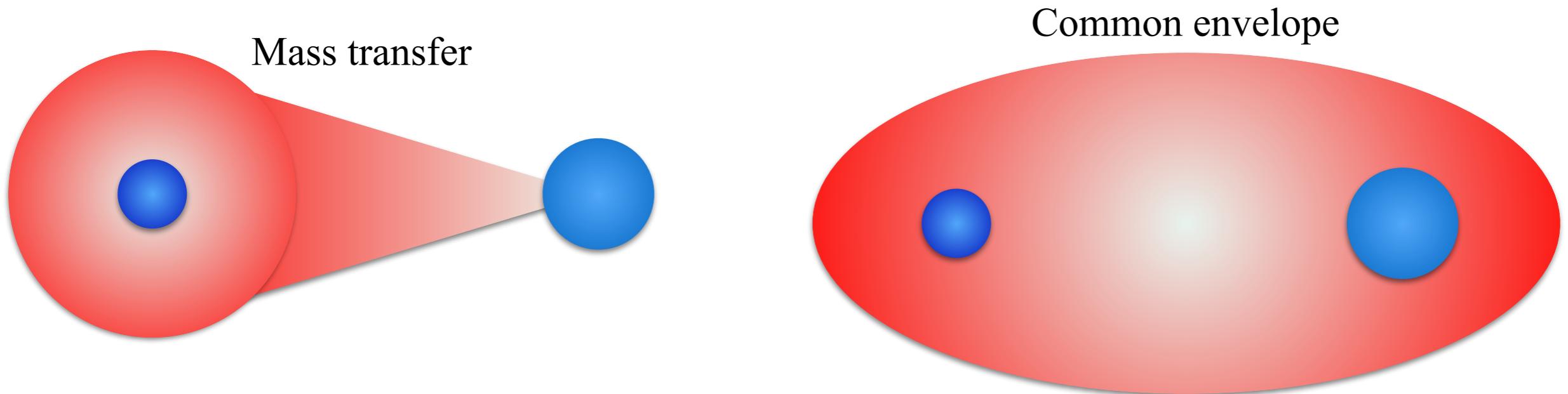


# Pair instability mass gap event



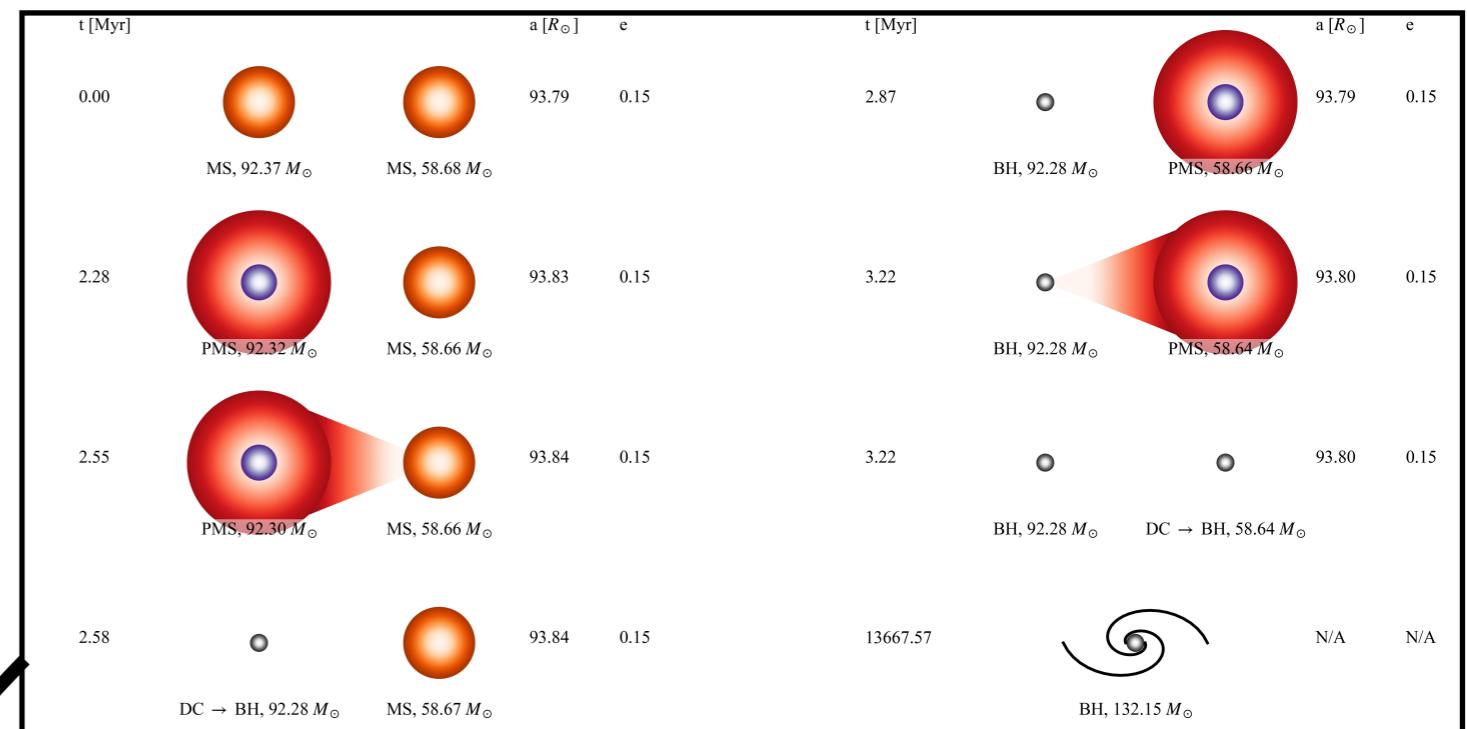
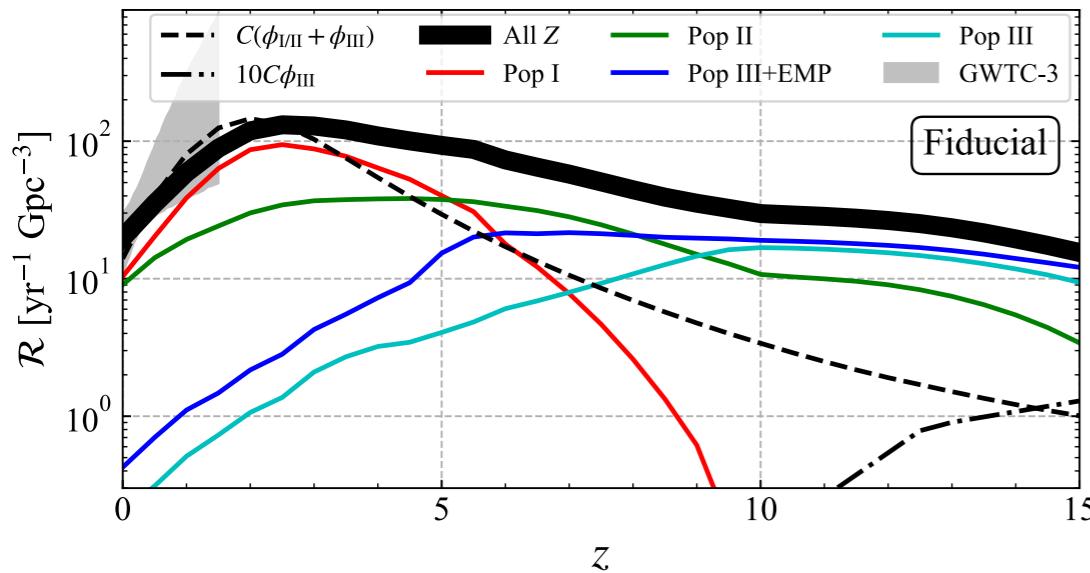
# Our study

- Binary population synthesis for isolated binary scenario
- Choosing Fiducial C(alpha, gamma)O reaction rate
- Considering Pop III and EMP binary stars

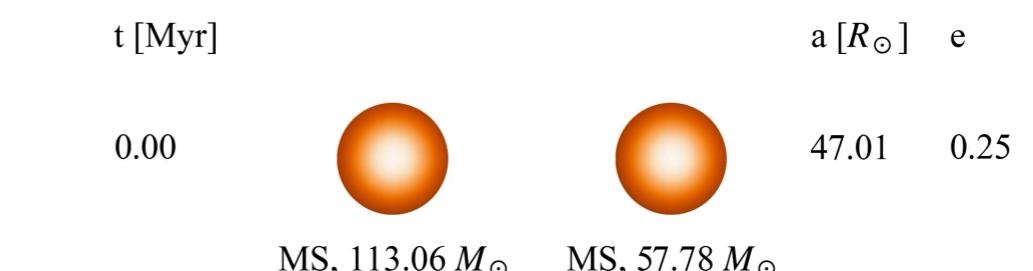
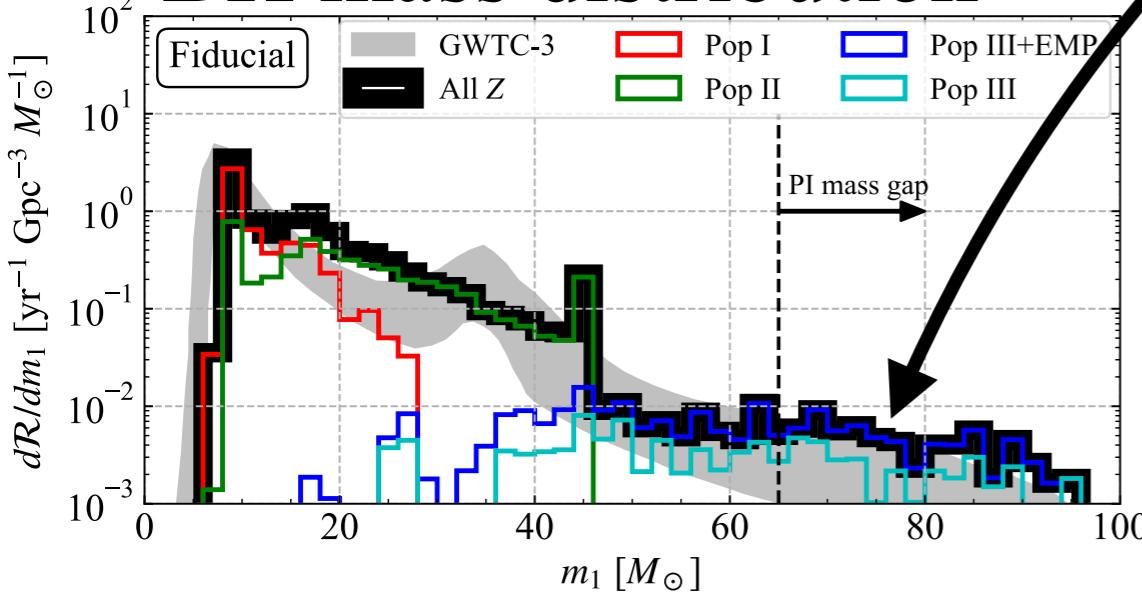


# Pop III and EMP stars

## Merger rate evolution



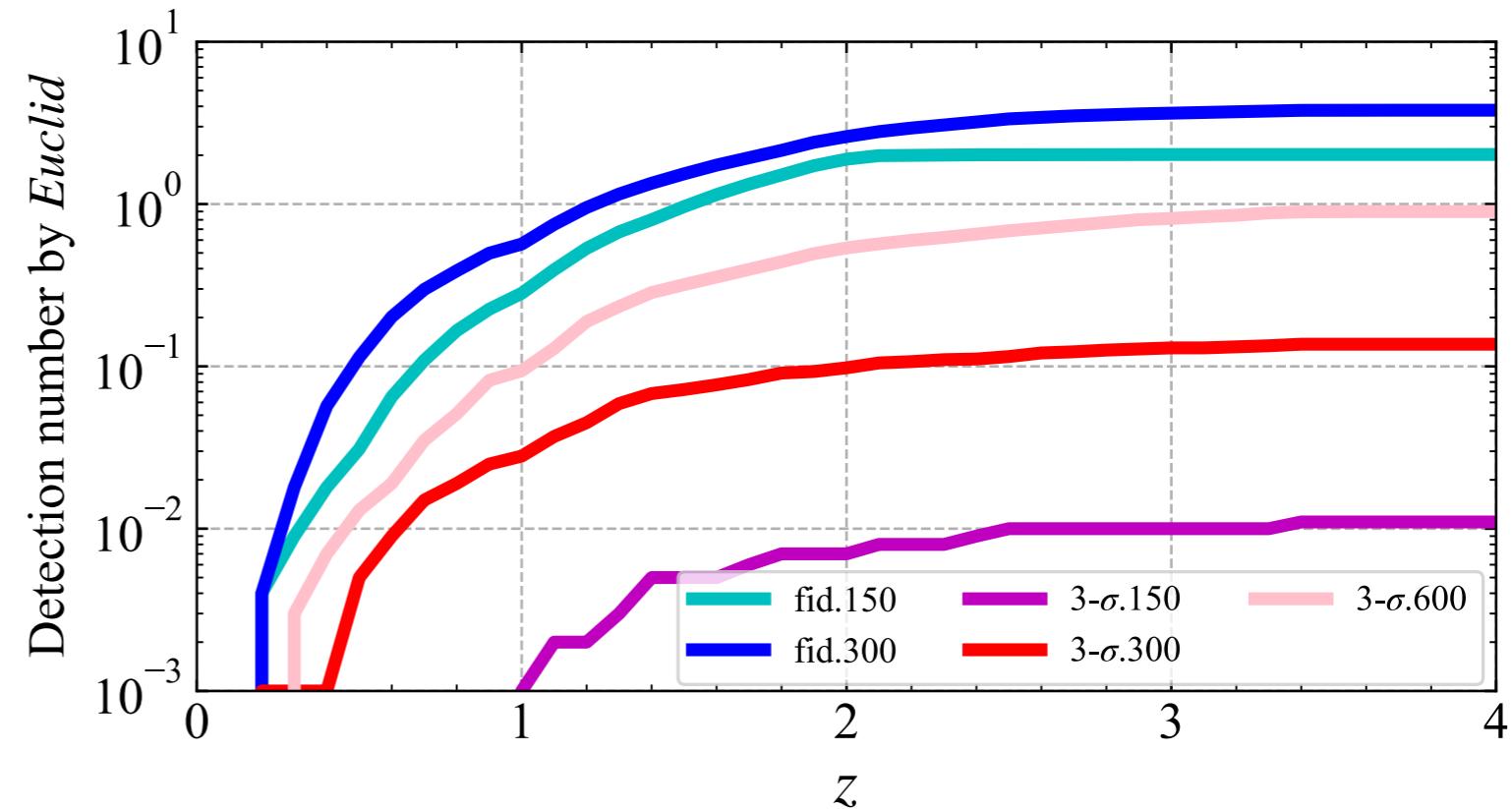
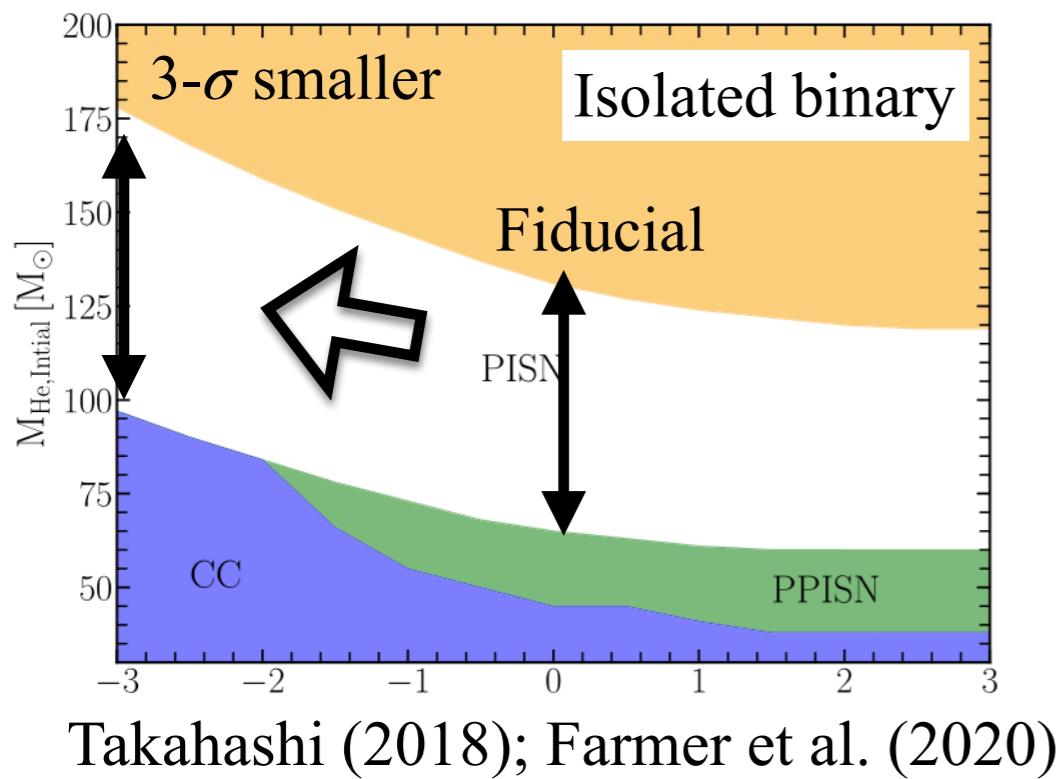
## BH mass distribution



AT+ (2021, MNRAS, 505, 2170)

AT+ (2022, ApJ, 926, 83)

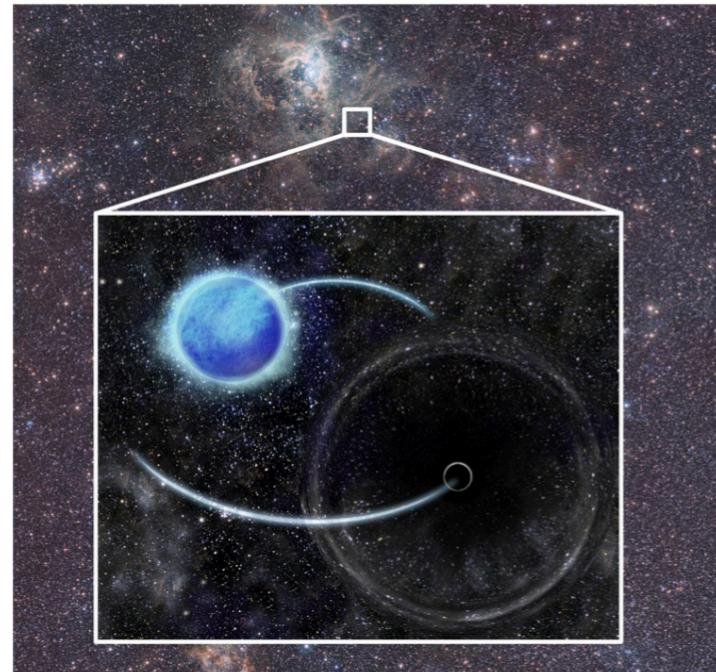
# PISN detection number by Euclid



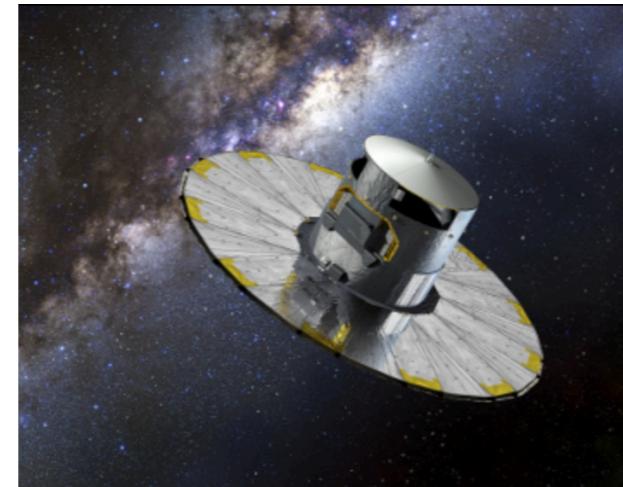
AT+ (2022, arXiv:2204.09402)

- Few detections  $\rightarrow$  Fiducial PISN model
- No detection  $\rightarrow$  3- $\sigma$  PISN model
- 1 detection  $\rightarrow$  Ejecta mass estimate required

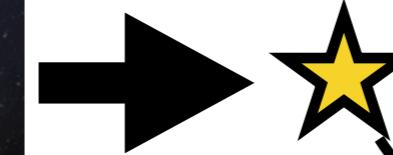
# BH binary (not BH-BH)



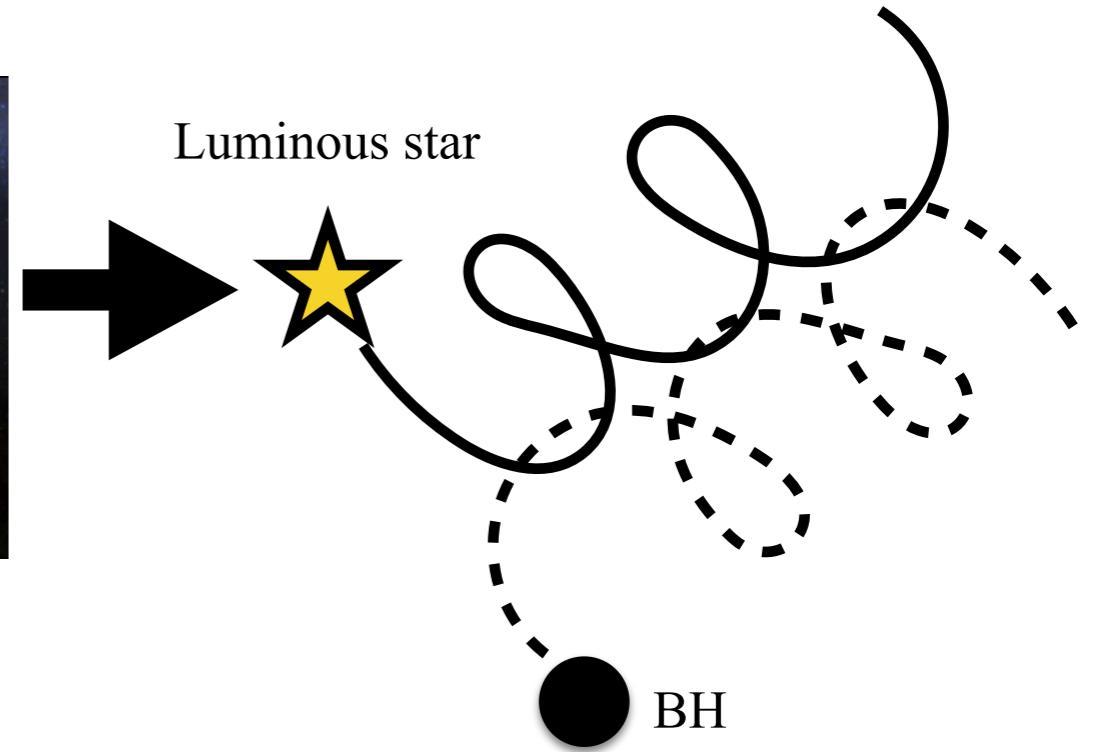
Shenar et al. (2022)



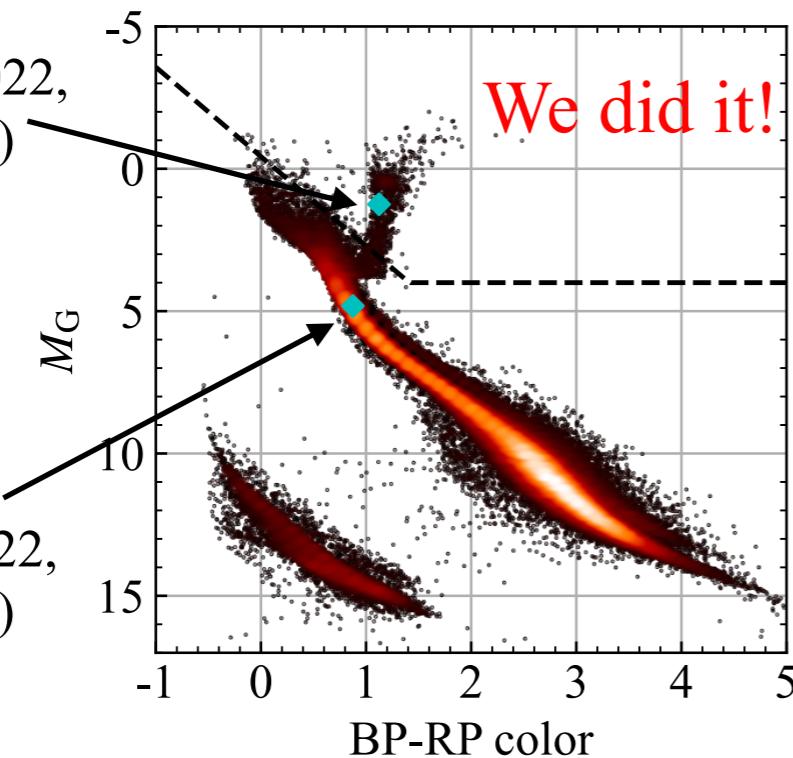
Luminous star



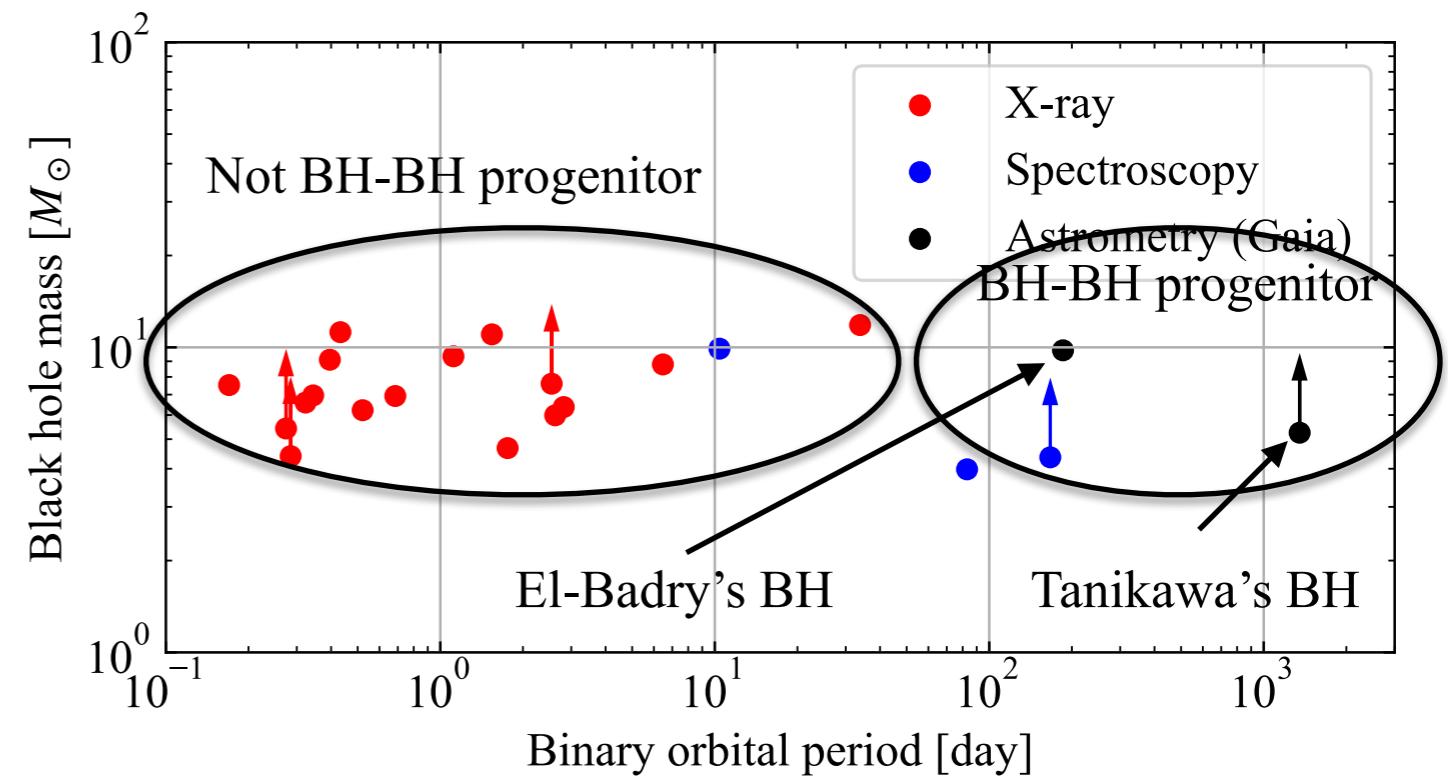
BH



Tanikawa et al (2022,  
arXiv:2209.05632)



El-Badry et al (2022,  
arXiv:2209.06833)



# Summary

- The BH-BH origin is a big mystery.
- The pair instability mass gap event (GW190521) cannot constrain the BH-BH origin.
- Possible ways to constrain the origin:
  - Pair instability supernova survey
  - Discoveries of BH-BH relatives