地下からの重力波観測と
連星ブラックホールの軌道離心率

Z1. 地下からの天文・宇宙観測

日本天文学会2022年秋季年会

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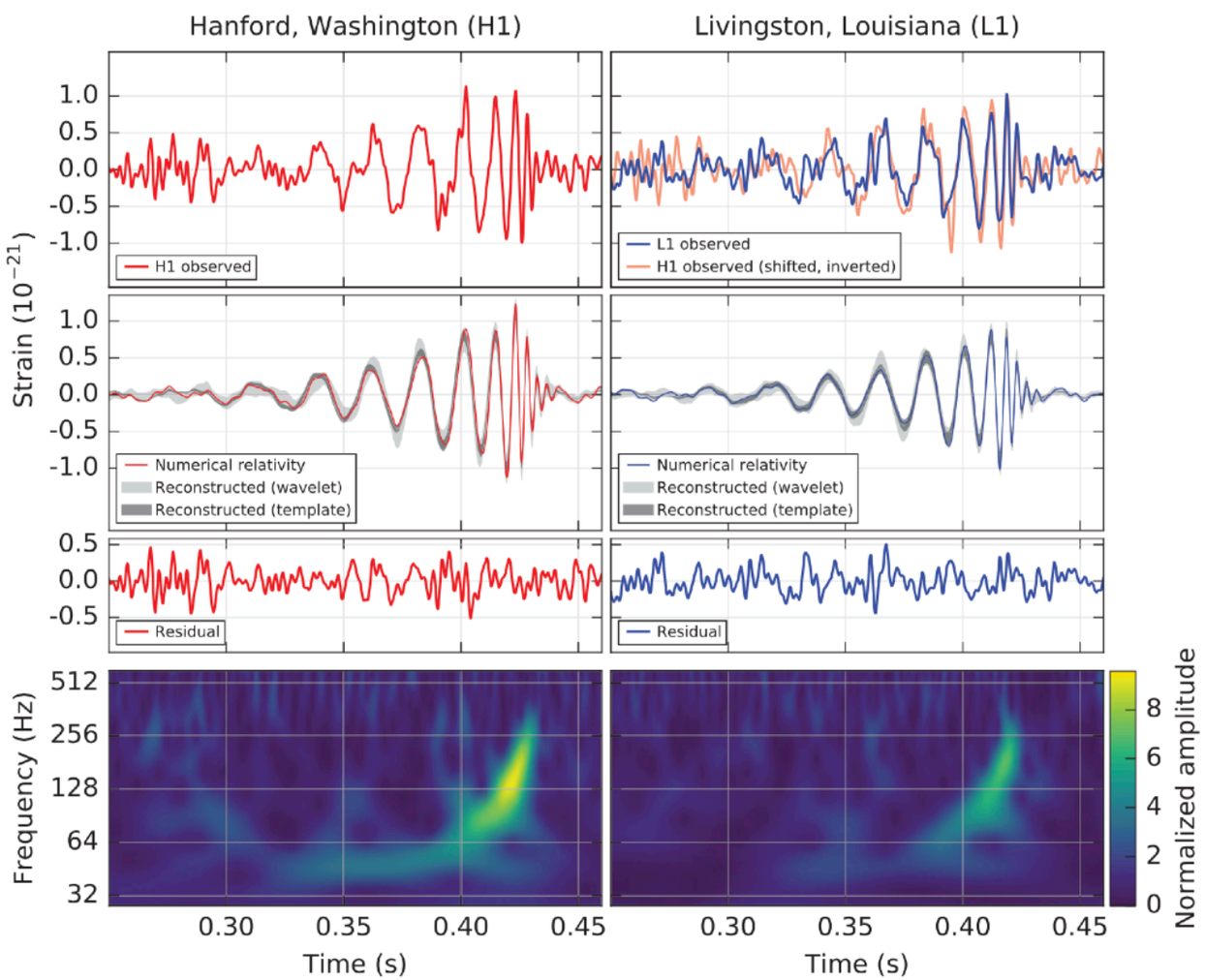
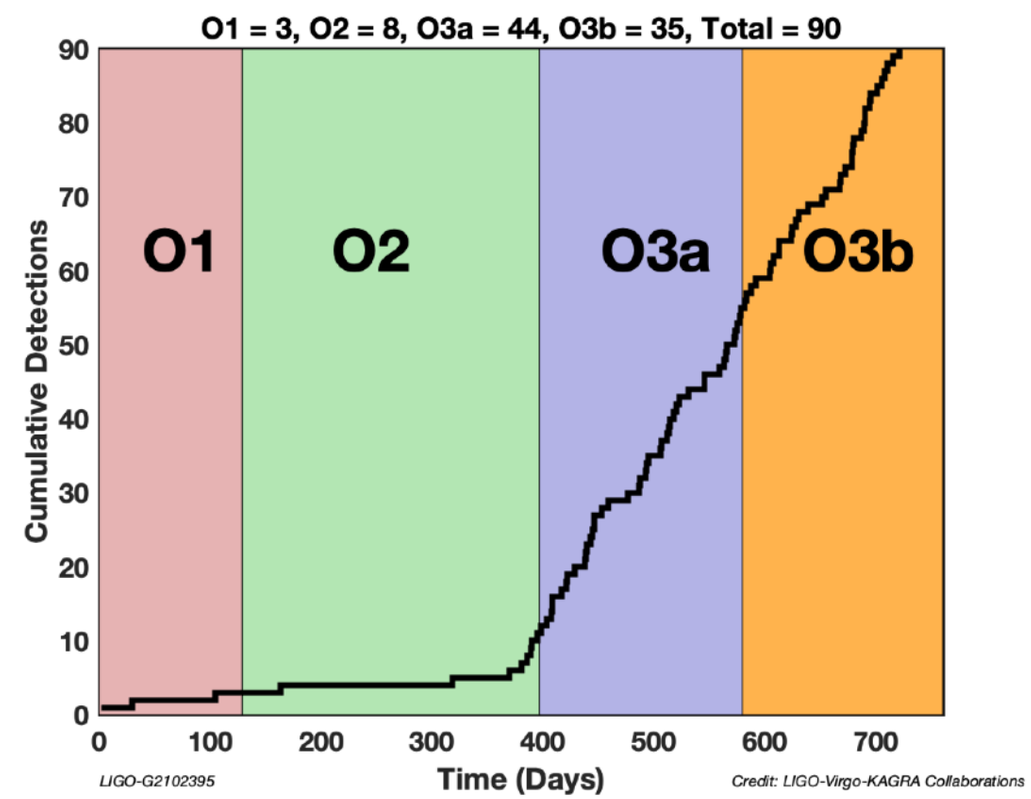
Long Wang（中山大学），藤井通子（東京大学）

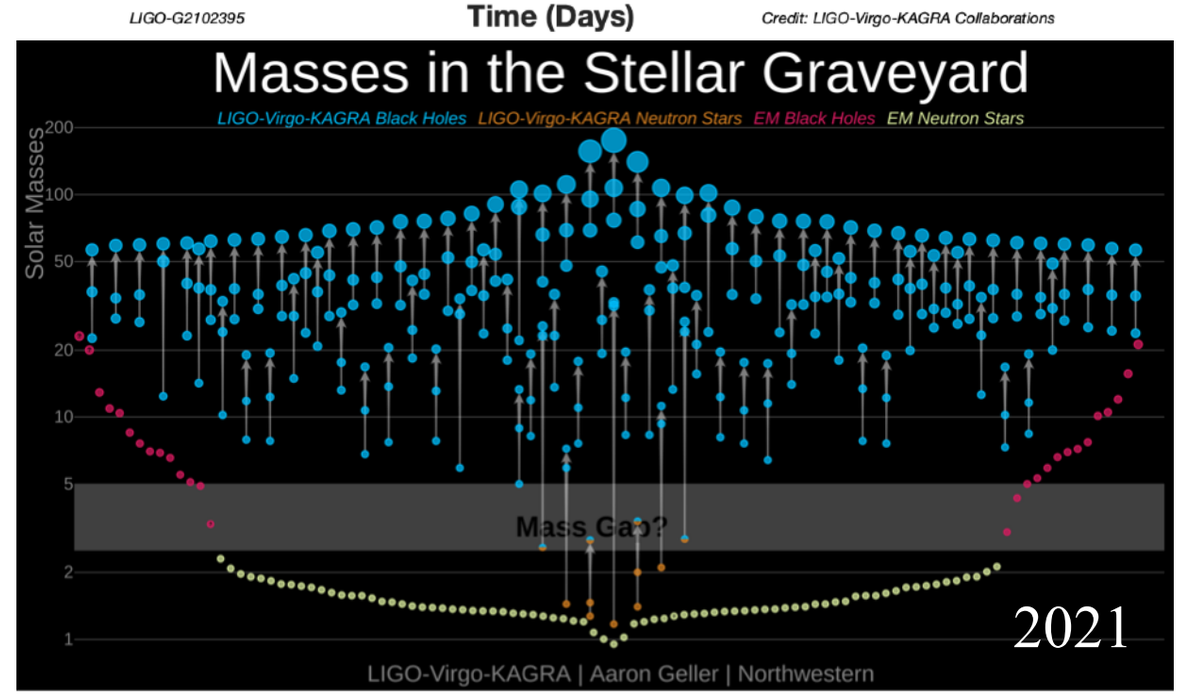
Binary black holes

The first detection 2015/09/14 (GW150914)



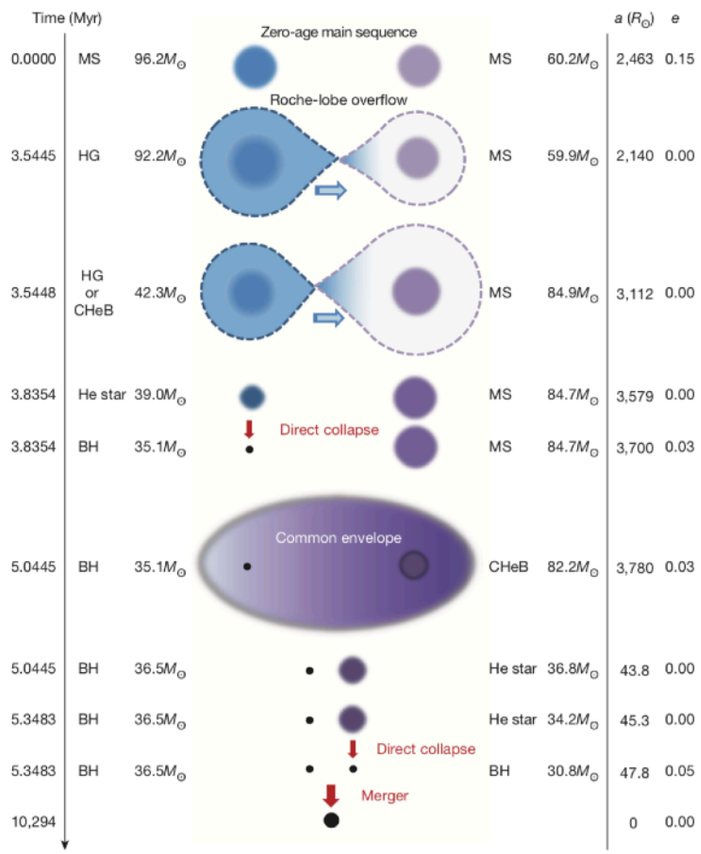
$\sim 30 M_\odot$ BH





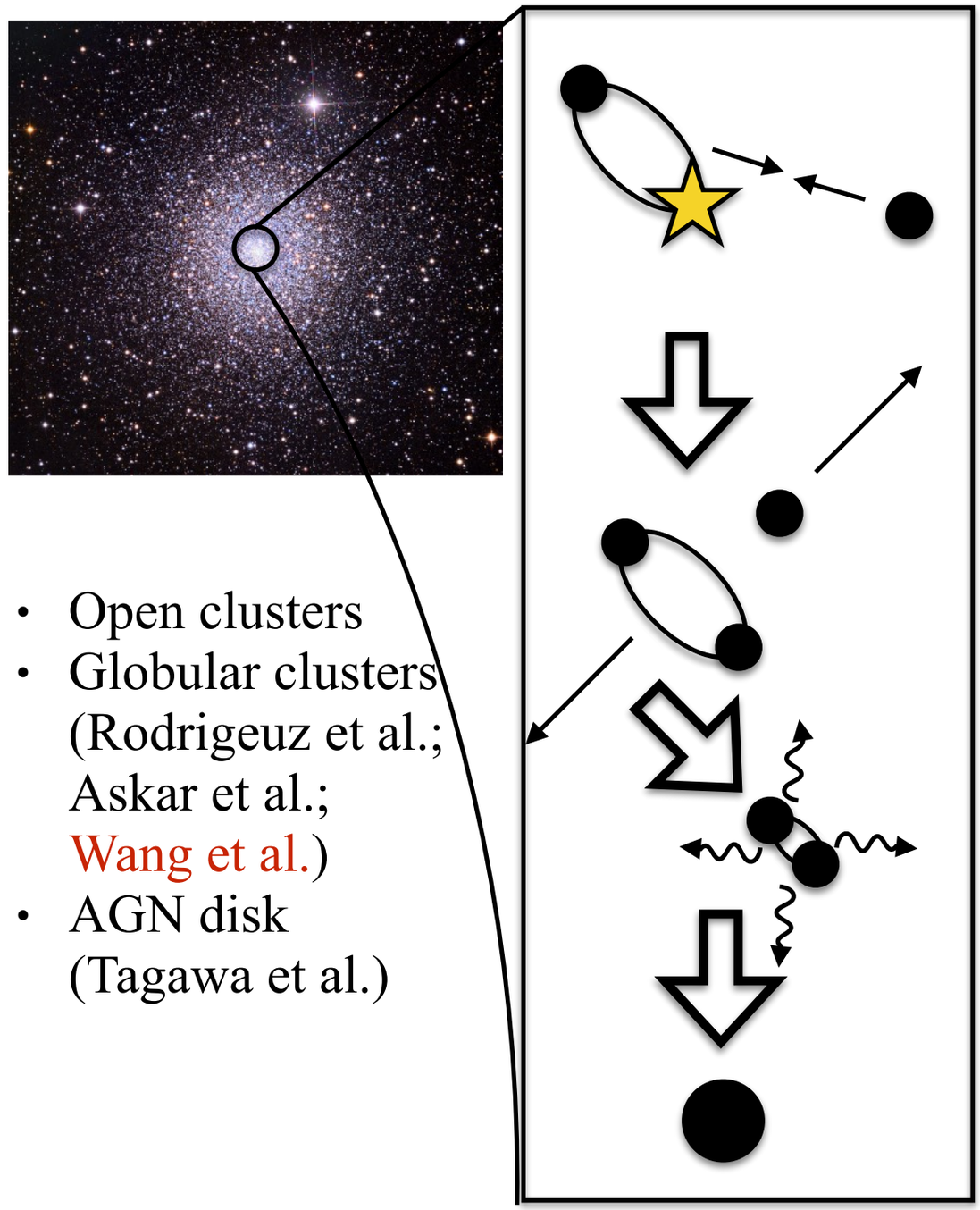
Origin of binary black holes

Isolated binary



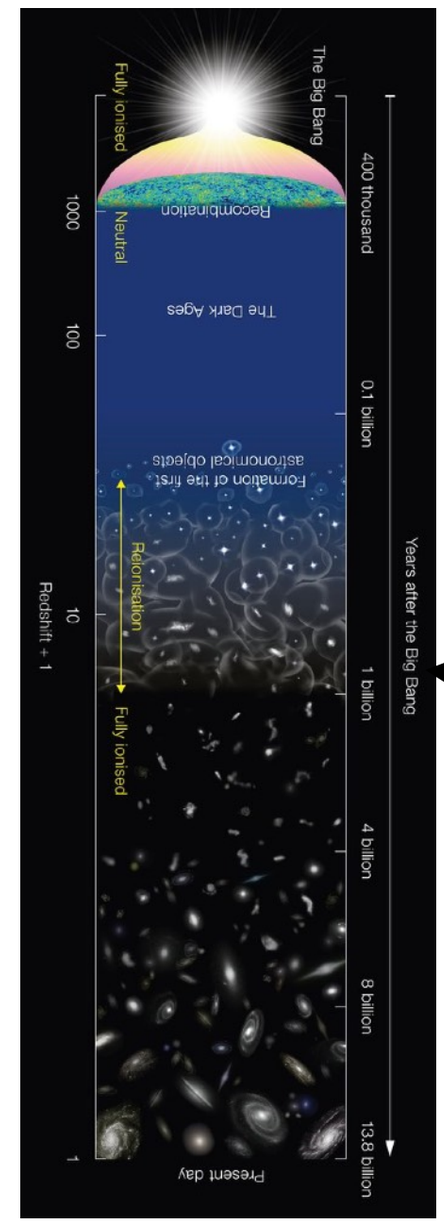
Belczynski et al.; Eldridge et al.; Giacobbo et al.; Kinugawa et al.; Kruckow et al.; Stevenson et al.; Tanikawa et al.;

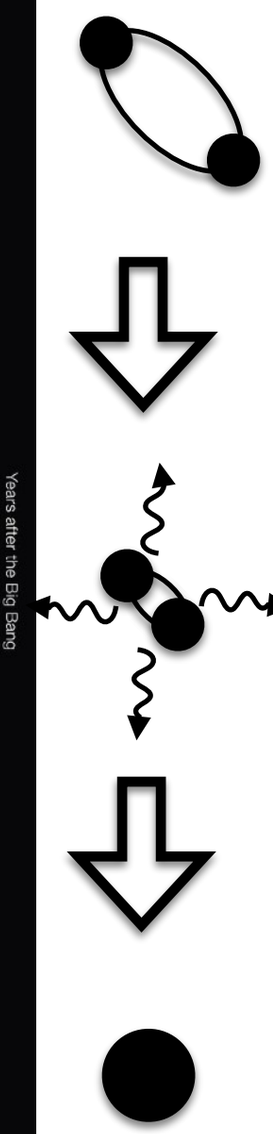
Dense star cluster



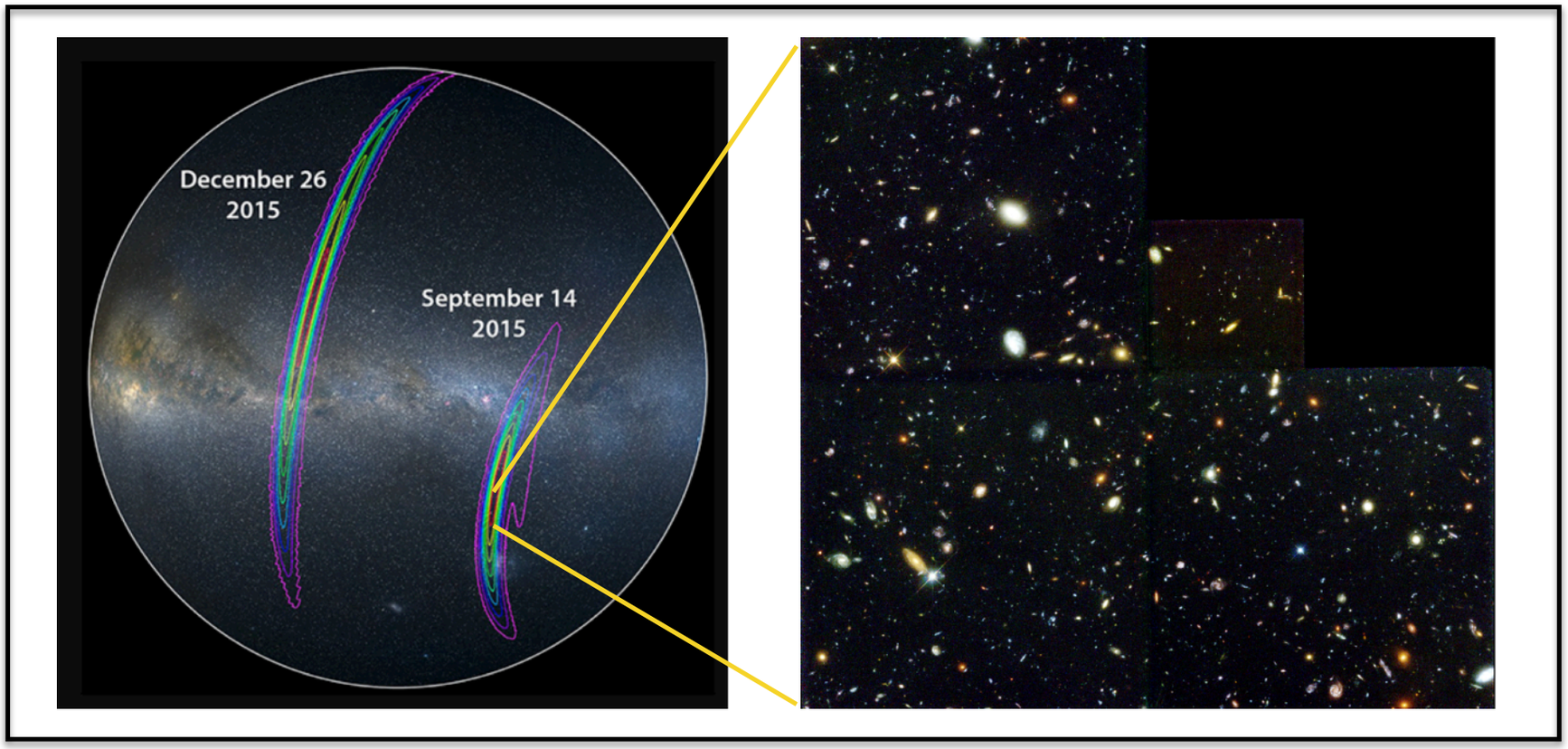
- Open clusters
- Globular clusters (Rodrigeuz et al.; Askar et al.; Wang et al.)
- AGN disk (Tagawa et al.)

Primordial BH

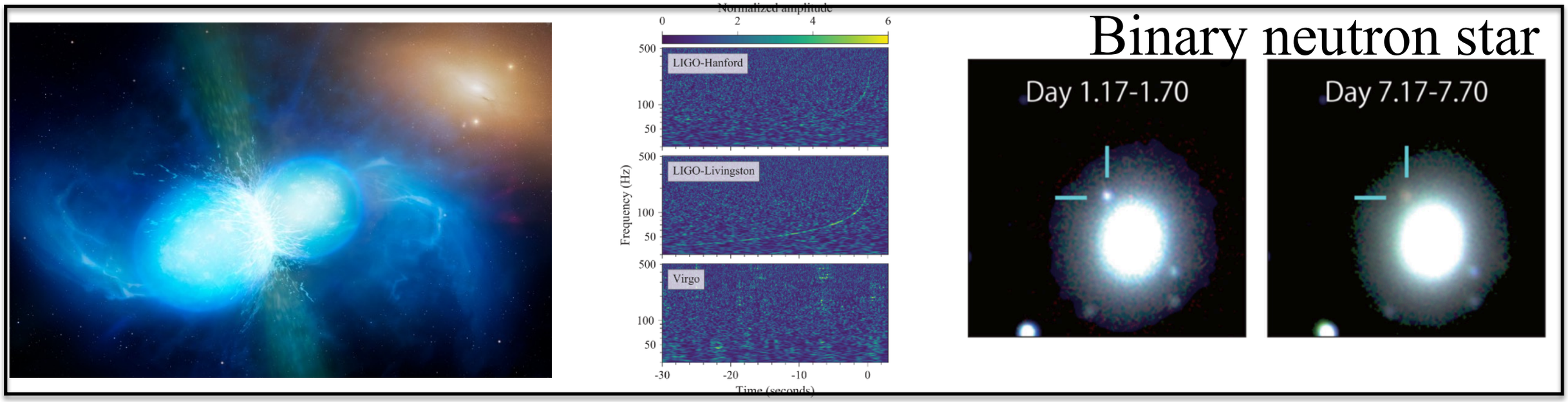




Localization

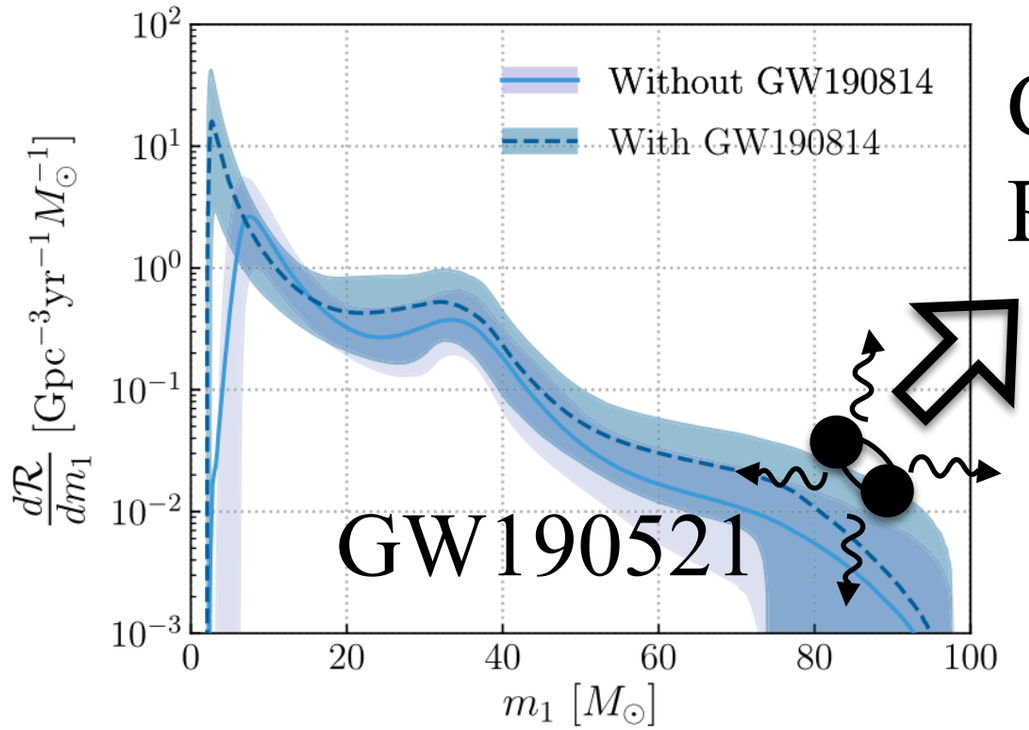


Binary black hole

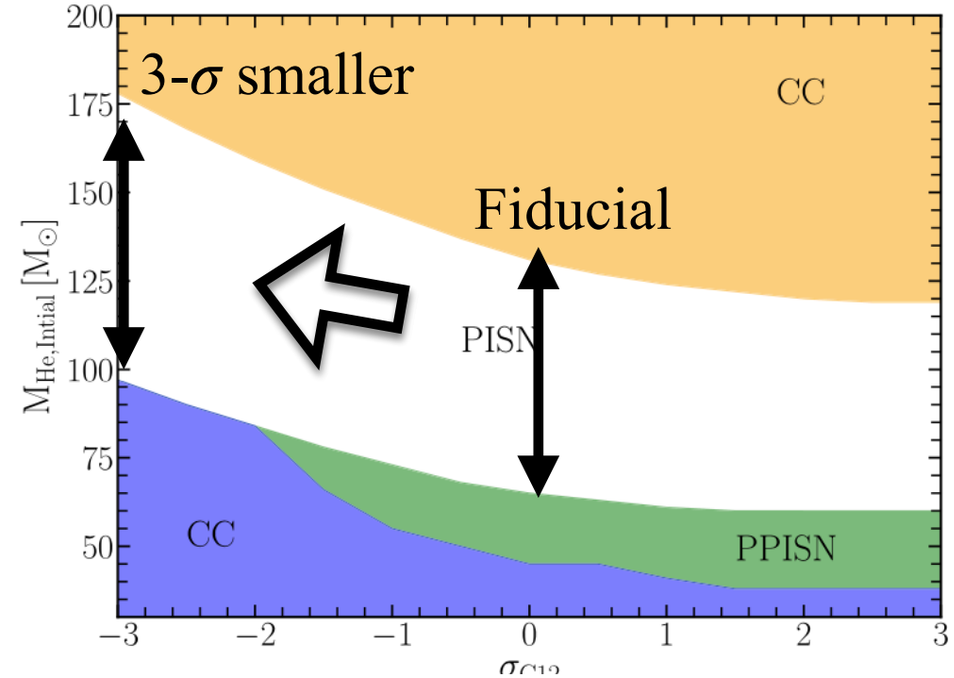


Binary neutron star

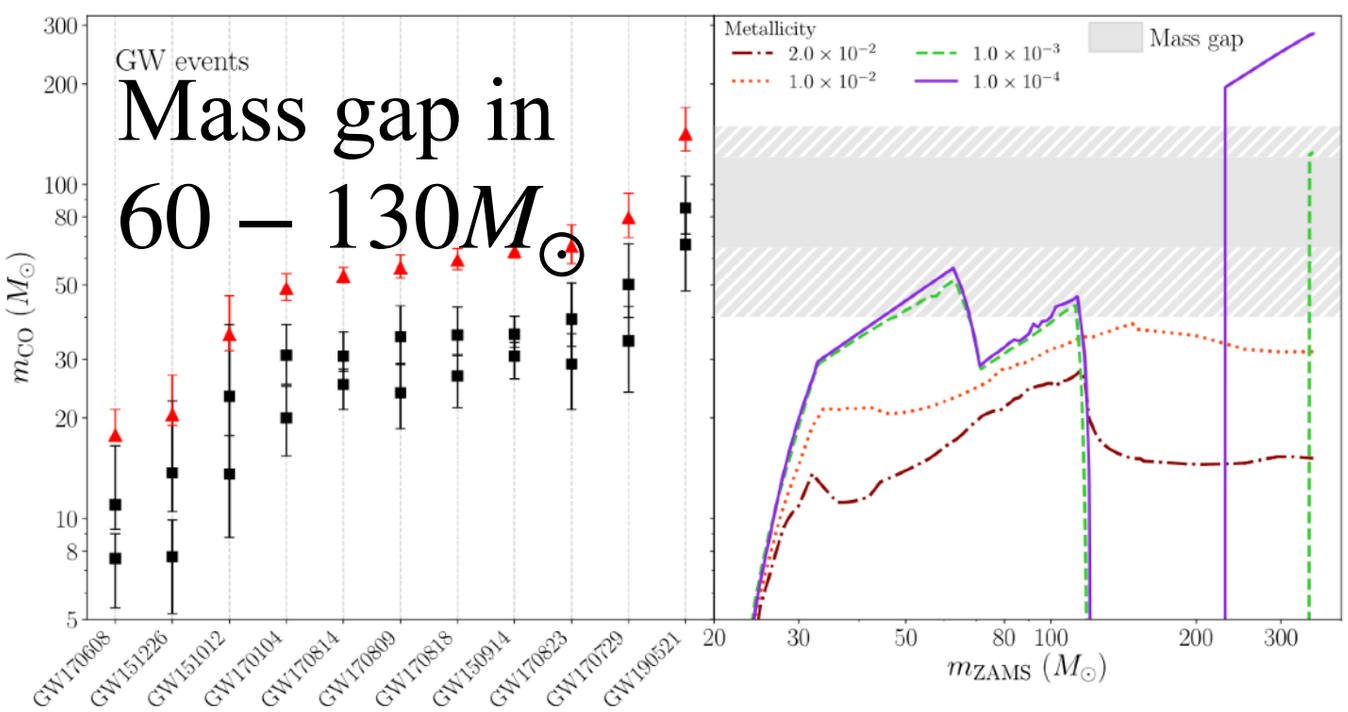
Black hole mass

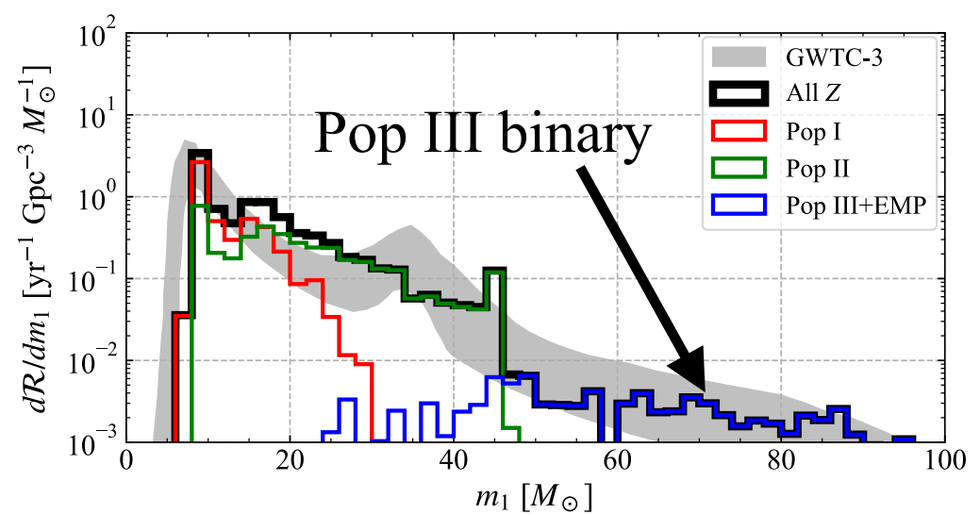


Cluster or PBH?



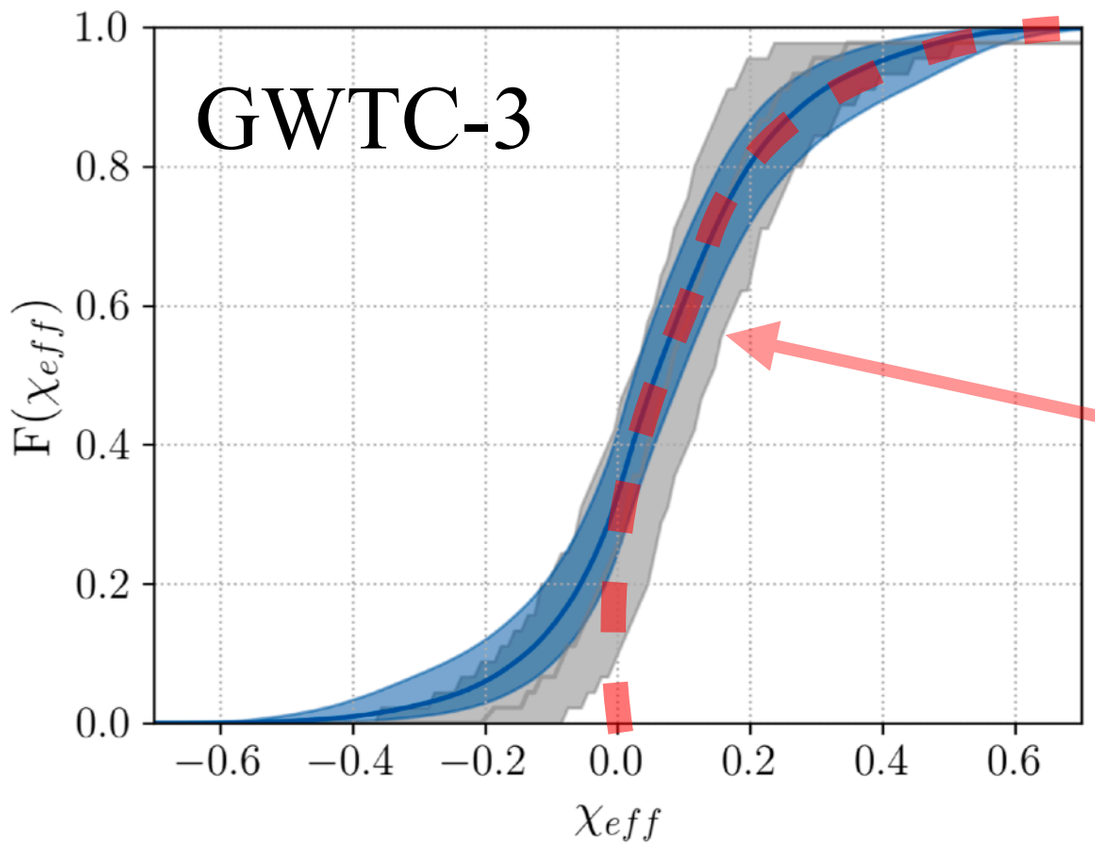
Takahashi (2018); Farmer et al. (2020)



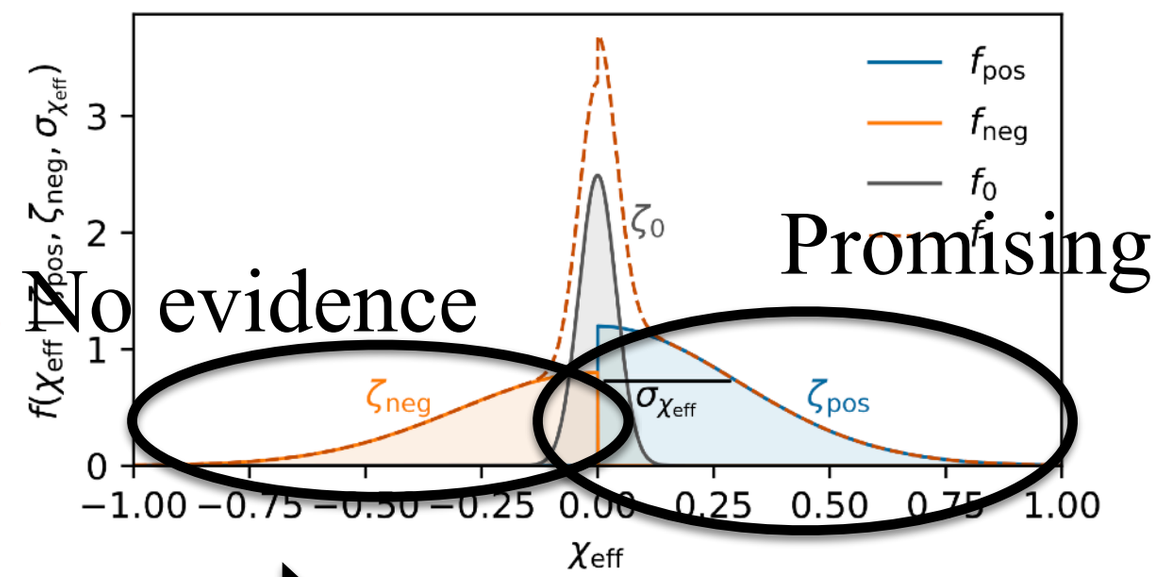


Tanikawa et al. (2022); Kinugawa et al. (2022)

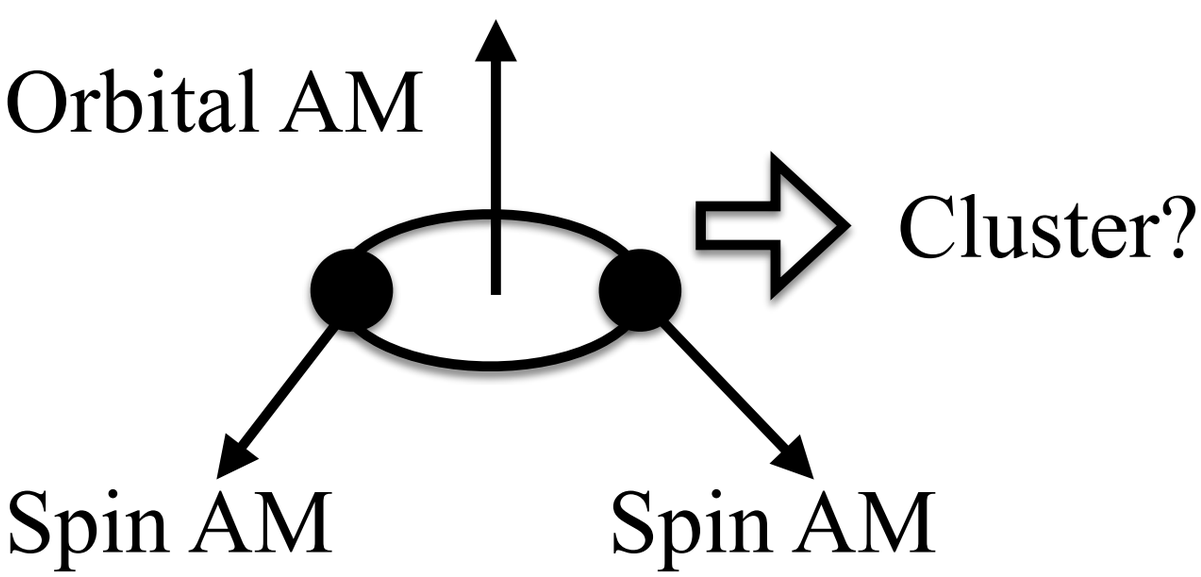
Black hole spin

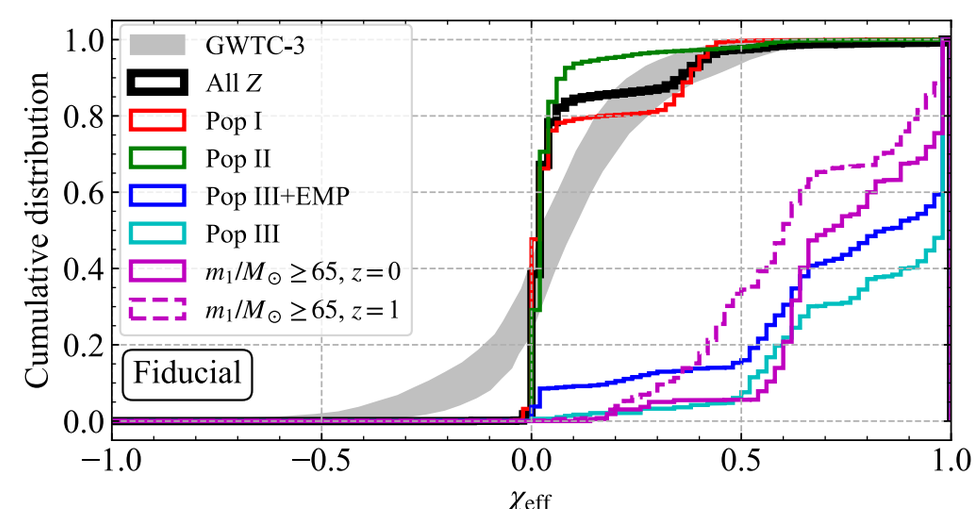


Roulet et al. (2021)



Isolated binary?



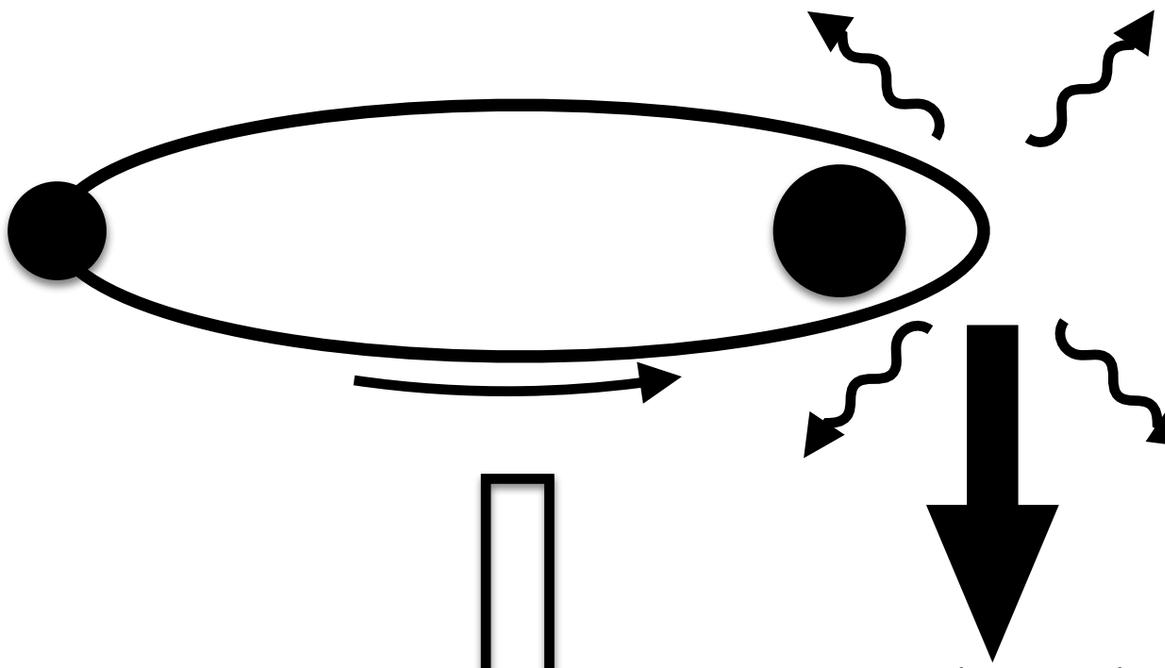


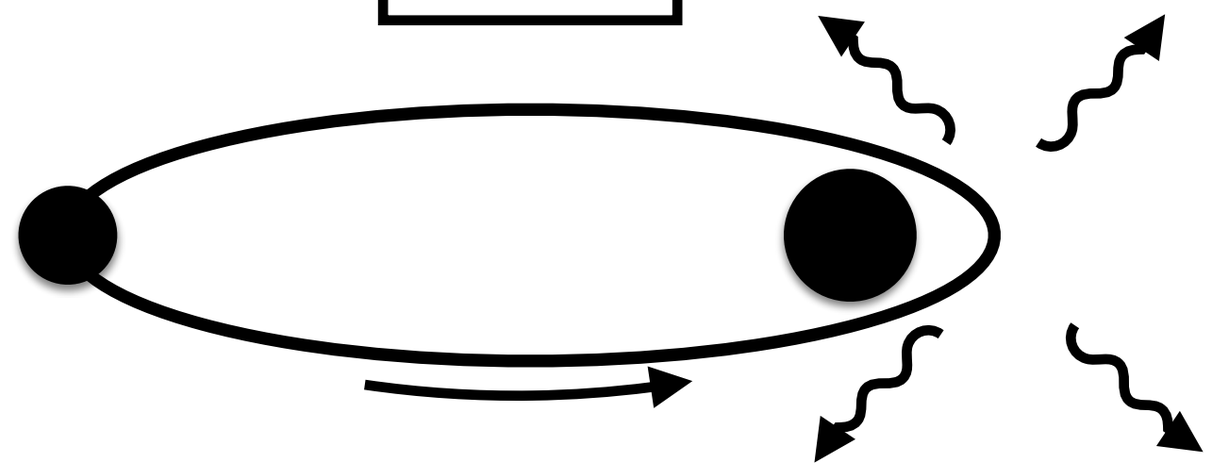
Tanikawa et al. (2022)

Eccentricity

Isolated binary

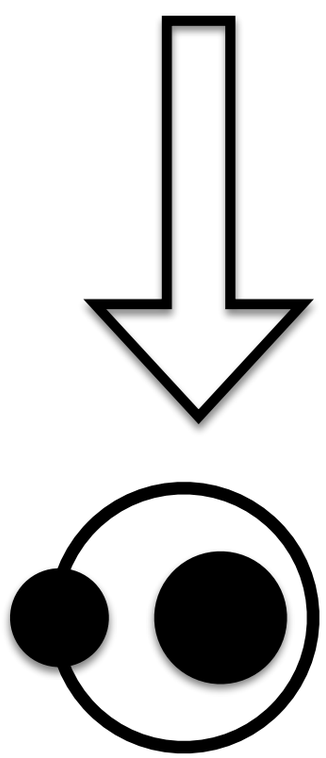
Cluster



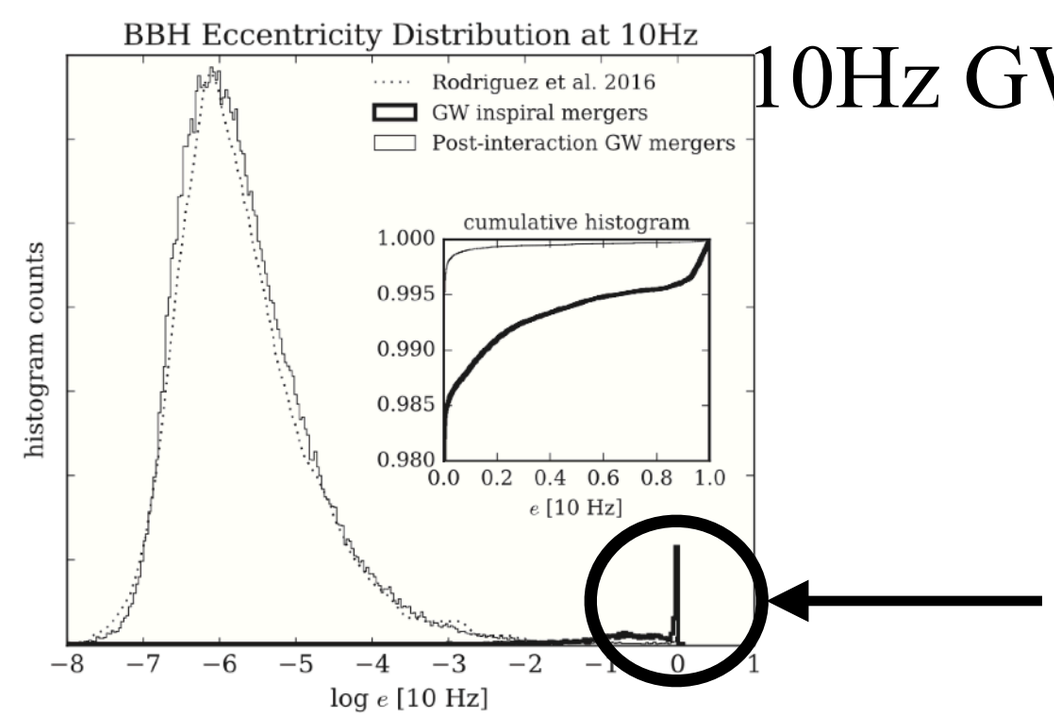


Deceleration

10Hz GWs



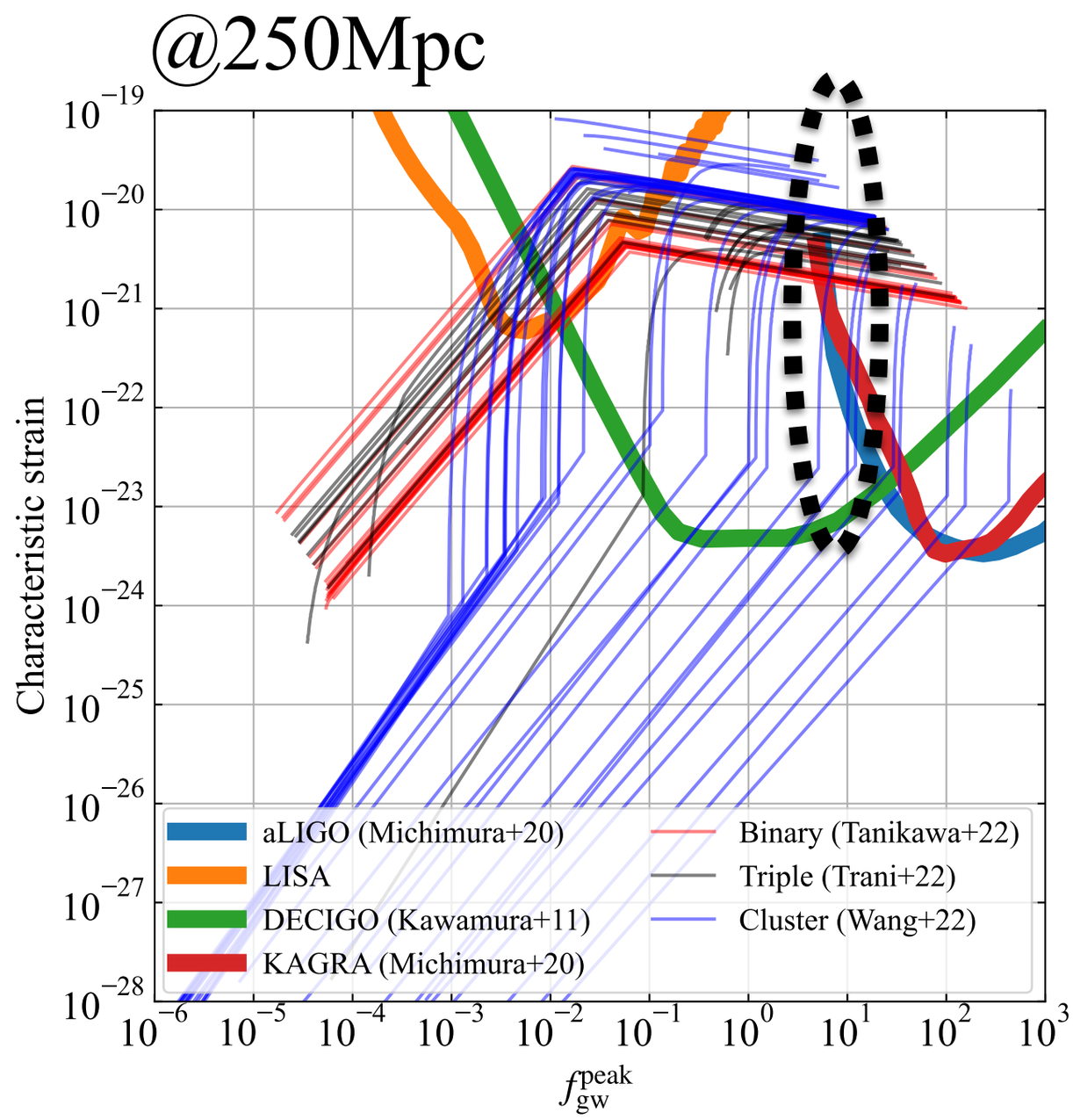
Circularized
at 10Hz



Samsing, Ramirez-Ruiz (2017)

BH-BH evolution

- Isolated binary-origin
  - Detectable by LISA, DECIGO, aLIGO
- Triple system-origin
  - Detectable by DECIGO, aLIGO
- Cluster-origin
  - Detectable by DECIGO, aLIGO
  - Detectable only by aLIGO
- Eccentricity can be more easily detected if <10Hz GW is available.



Summary

- The BH-BH origin is a big mystery.
- Localization, BH mass, BH spin are indecisive.
- Eccentricity is a signal of cluster-origin BH-BHs, and it is pronounced at a GW of <10 Hz.
- KAGRA, the underground GW observatory, should be advantageous for such low-frequency GW.