The Virgo interferometer and astrophysical sources

Science Fair, 22/02/2023
Elena Codazzo, PhD student

Ground-based detector network

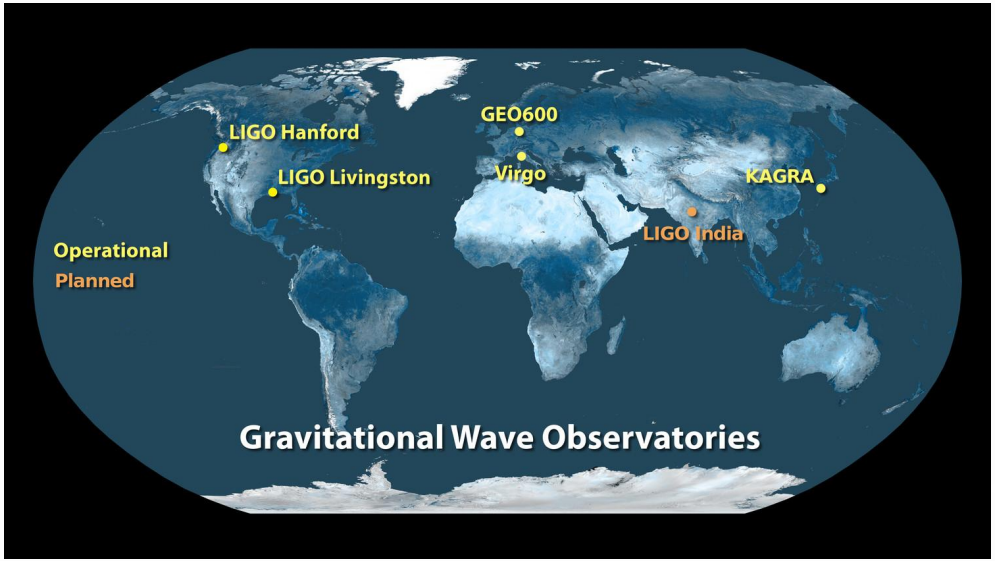
LIGO Hanford

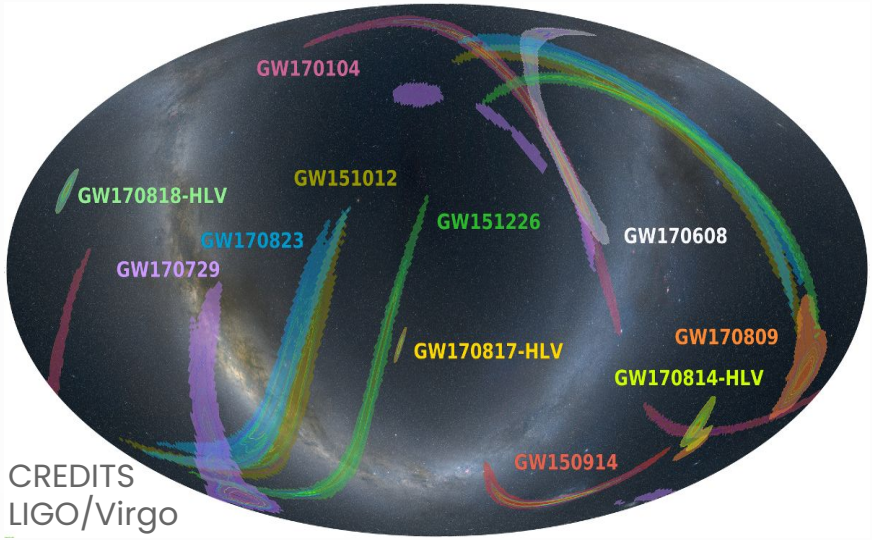
LIGO Livingston

Virgo

KAGRA

GEO600



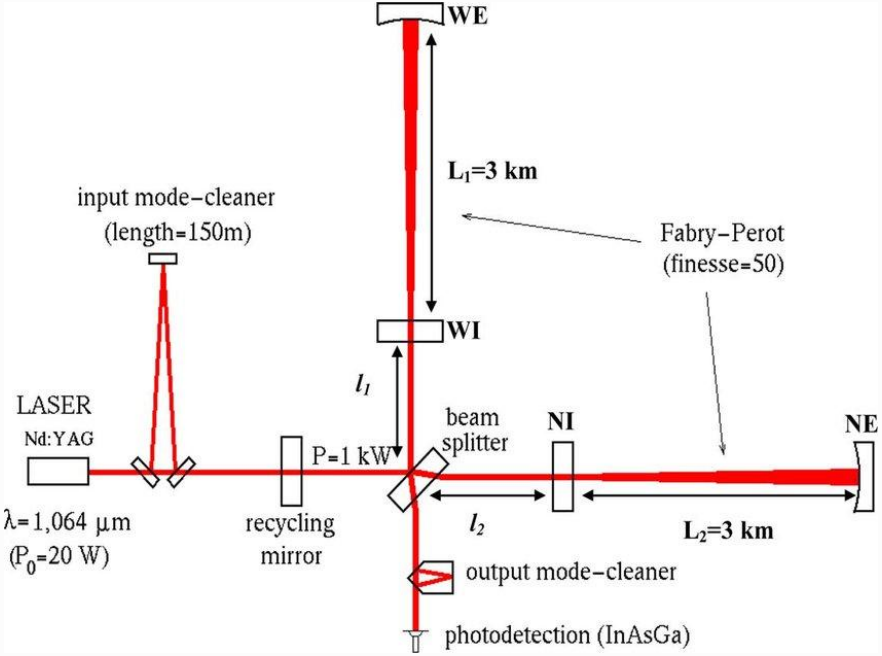


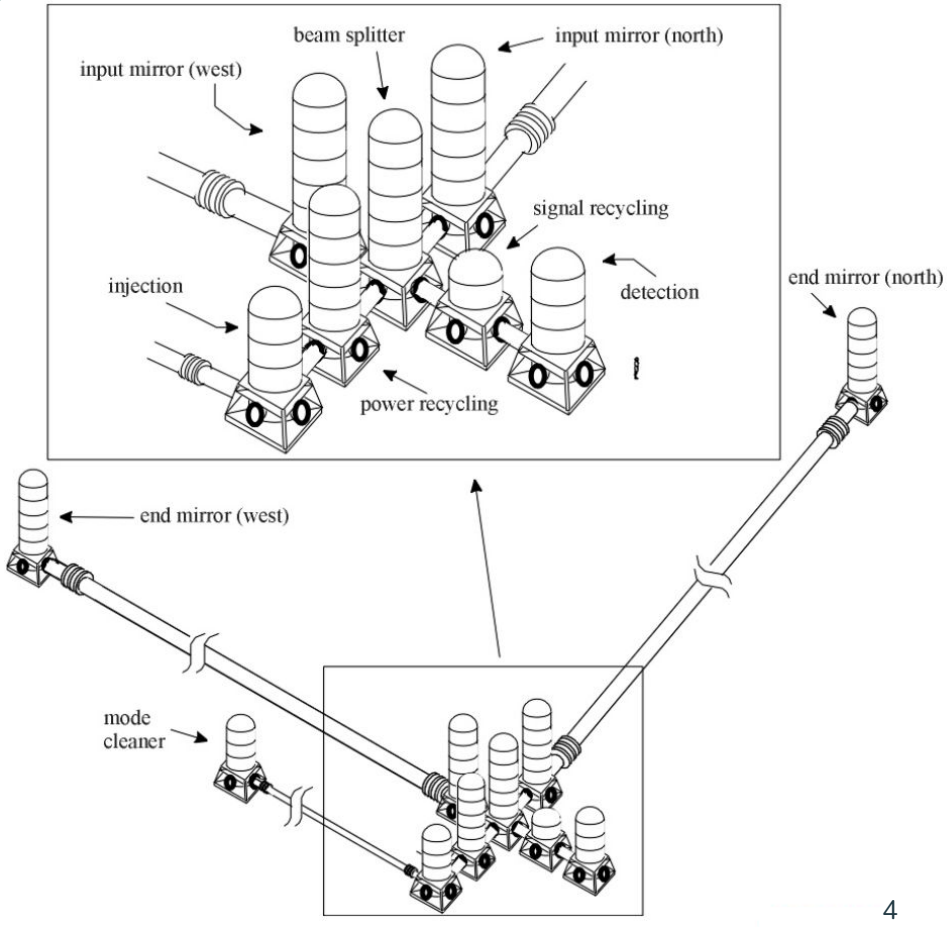
Virgo timeline

Run	Status	BNS detection up to
	Virgo	15 Mpc
O2	AdVirgo	30 Mpc
O3	AdVirgo	60 Mpc
O4	AdVirgo + Phase I	100 Mpc
O5	AdVirgo + Phase II	200 Mpc

- ★ 1994: approved
- ★ 1996: construction started
- ★ 2007-2011: four observing runs (Virgo)
- ★ 2017: joined AdLIGO in **O2** run (Advanced Virgo)
- ★ 2019-2020: **O3a-O3b**
- ★ 2023-2024: **O4**, Advanced Virgo + Phase I
- ★ 2026: **O5** , Advanced Virgo + Phase II

Advanced Virgo interferometer

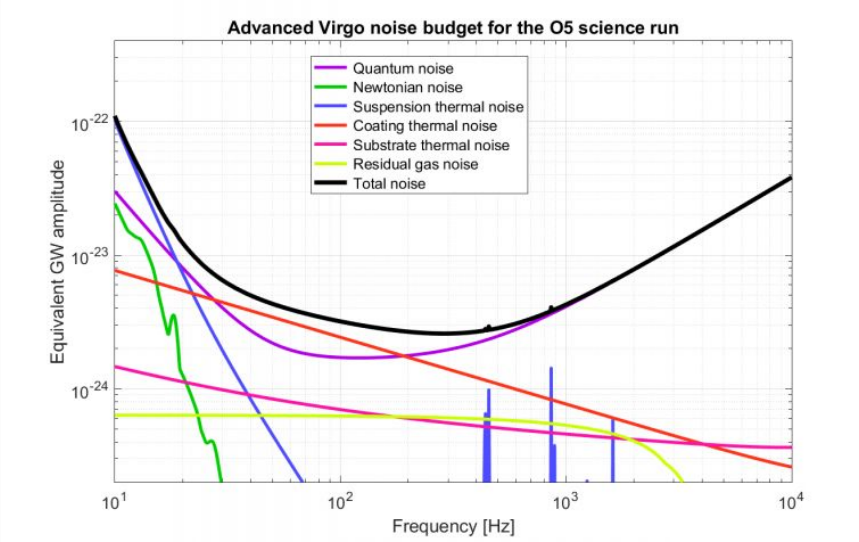




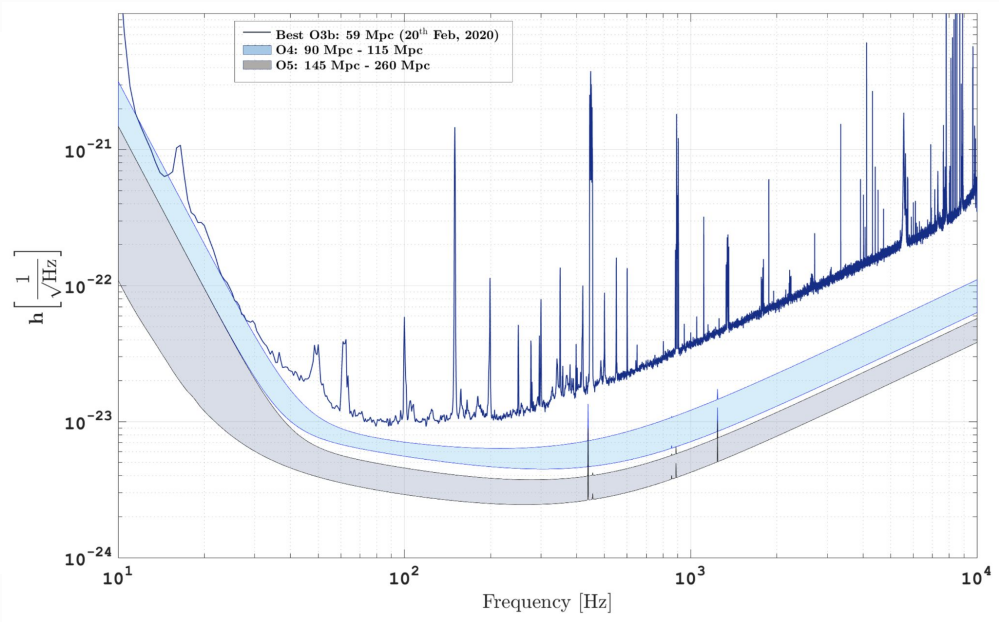
IEEE Transactions on Nuclear Science. 2008 Feb 22;55(1):302-10.

Credits: V.Fafone

Sensitivity curve: types of noise

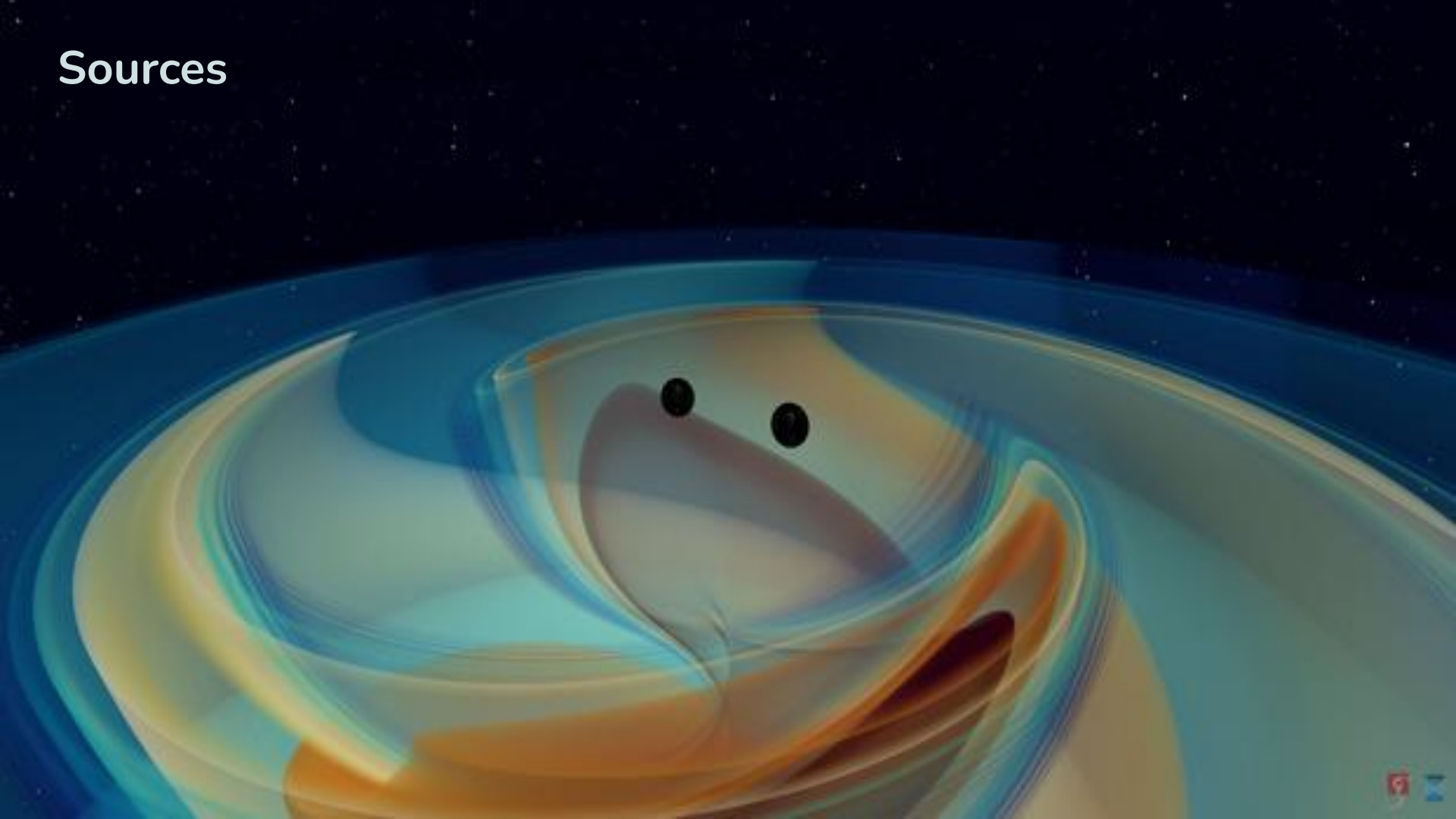


Credits: Virgo

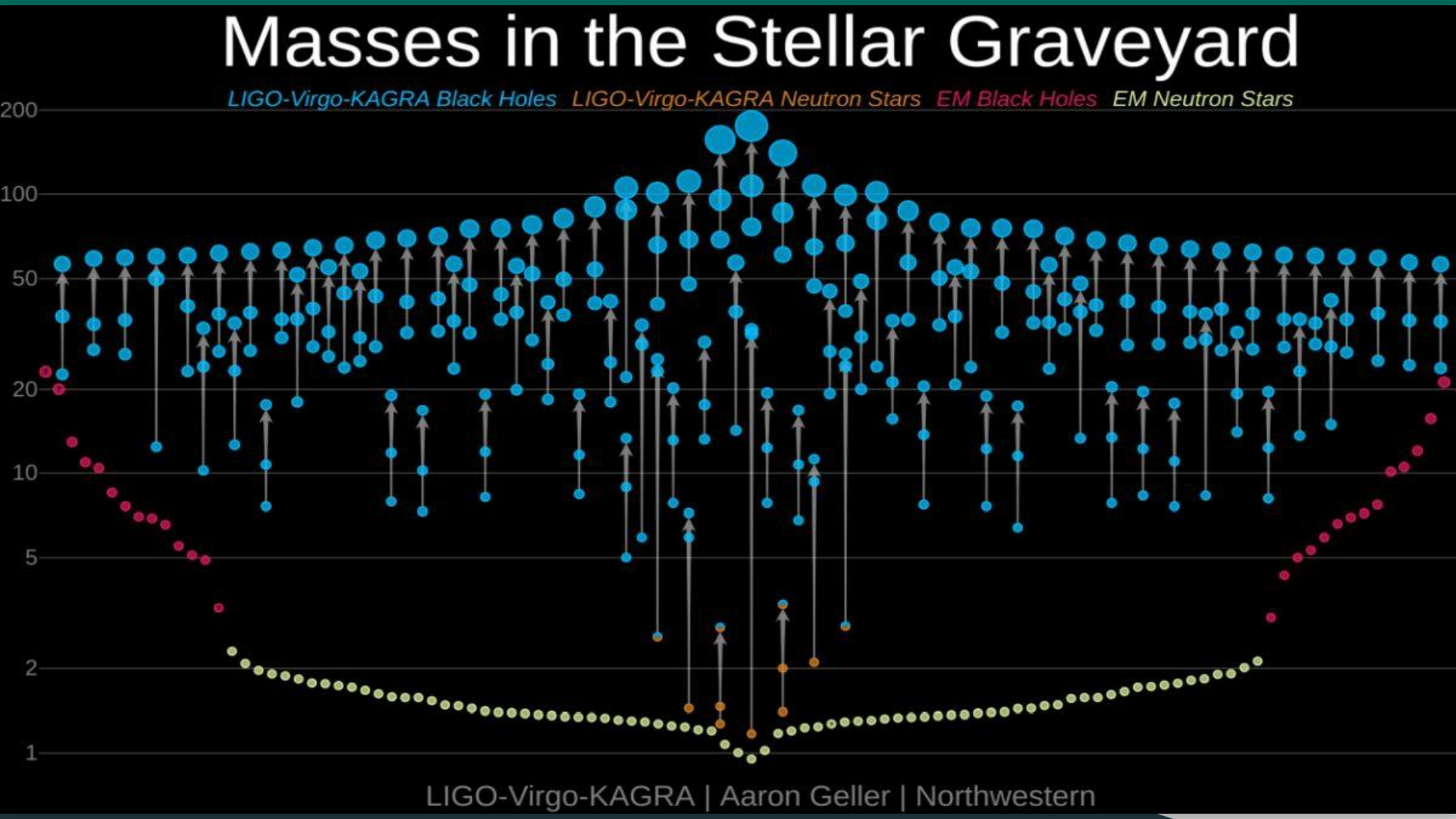


Living Rev. Relativ. **2020**, *23*, 3.

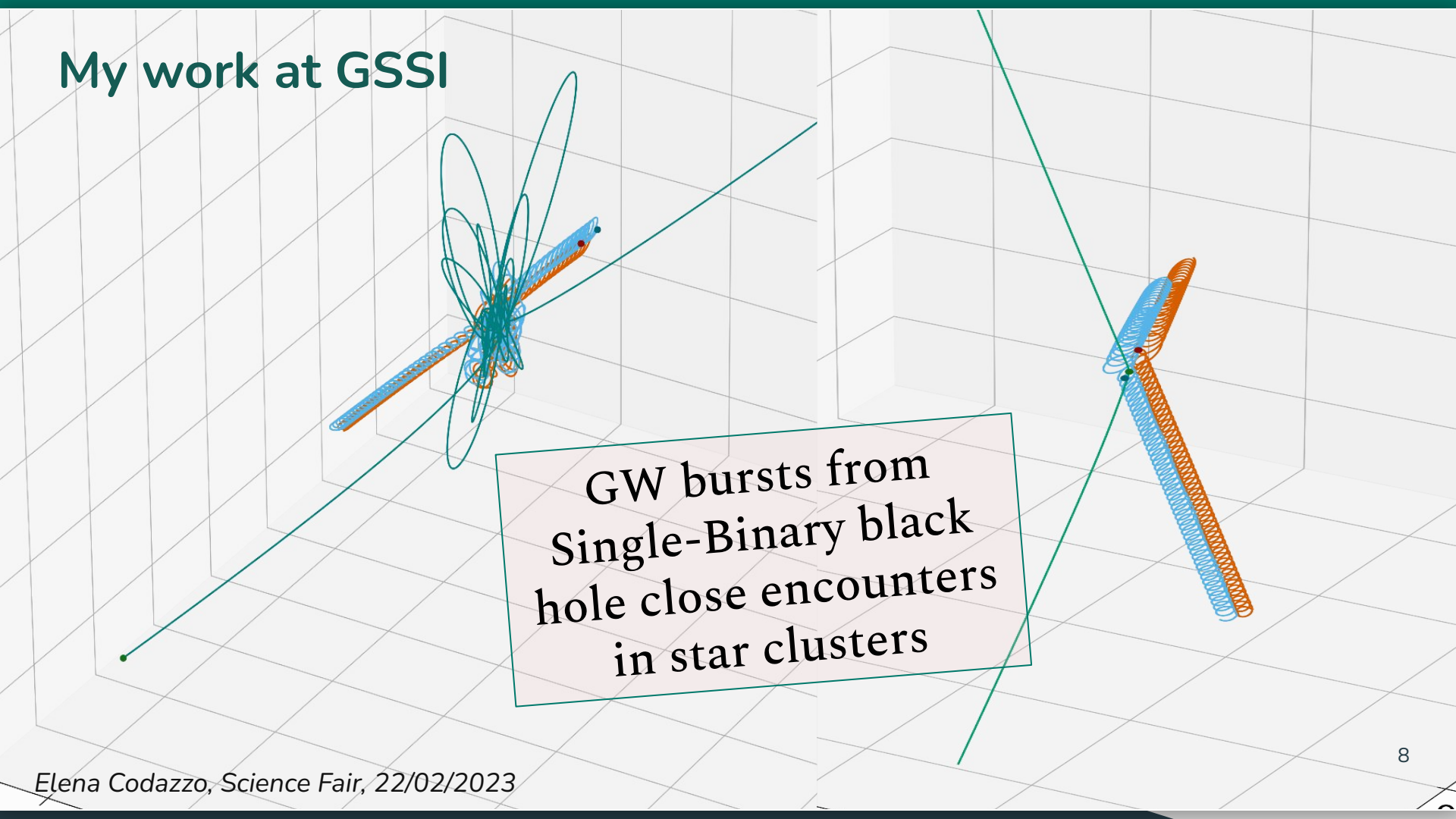
Sources



Masses in the Stellar Graveyard



My work at GSSI

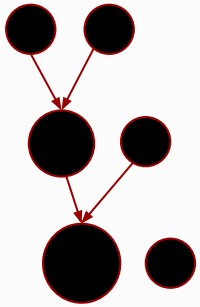


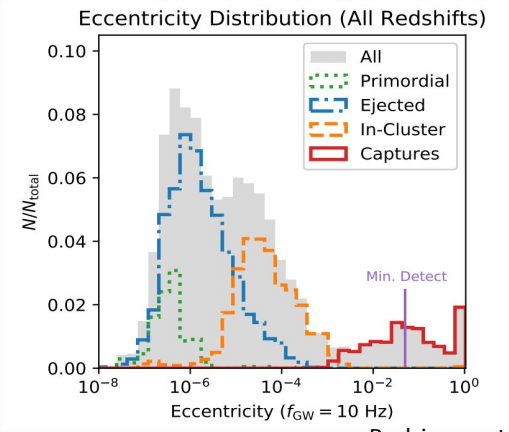
GW bursts from Single-Binary black hole close encounters in star clusters

Star clusters: the dynamical BBH formation channel

- binaries with more extreme masses
  (+ hierarchical merger)
- isotropically distributed spin tilt angles
- nonzero orbital eccentricities.

$$\frac{da}{dt} = -2\,\pi\,\xi\,\frac{G\,\rho}{\sigma}\,a^2 - \frac{64}{5}\,\frac{G^3\,m_1\,m_2\,(m_1+m_2)}{c^5\,(1-e^2)^{7/2}}\,a^{-3}$$

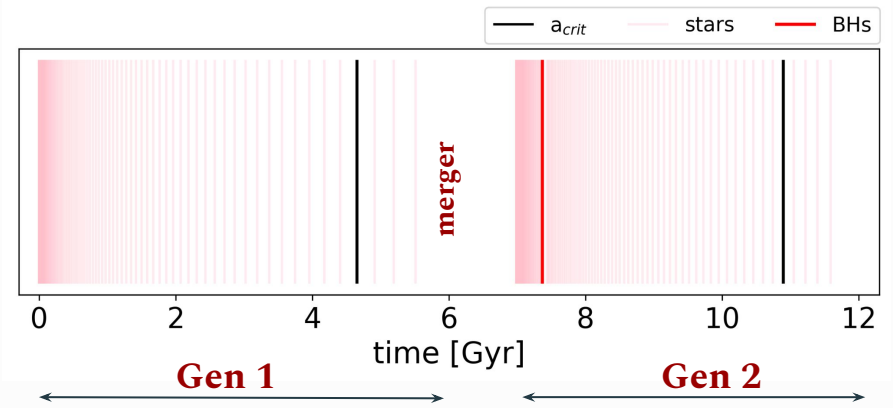


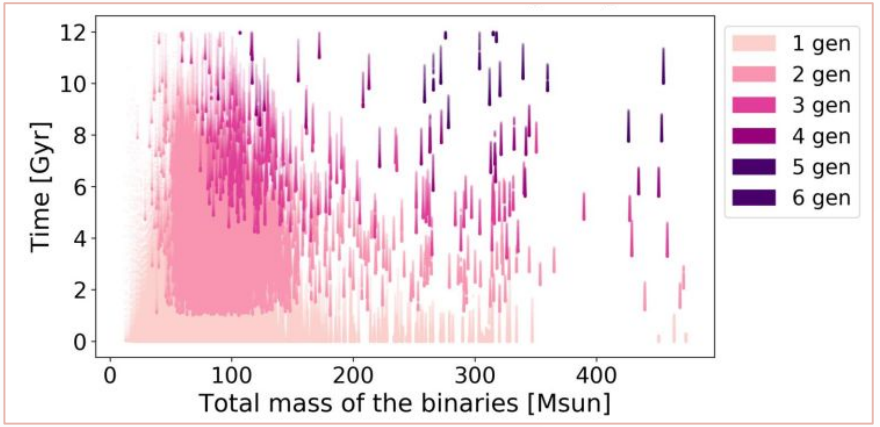


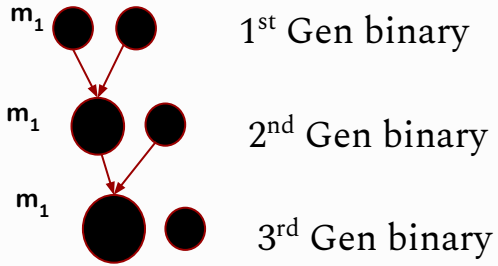
Rodriguez et al 2018

Credit: NASA, ESA

Population model





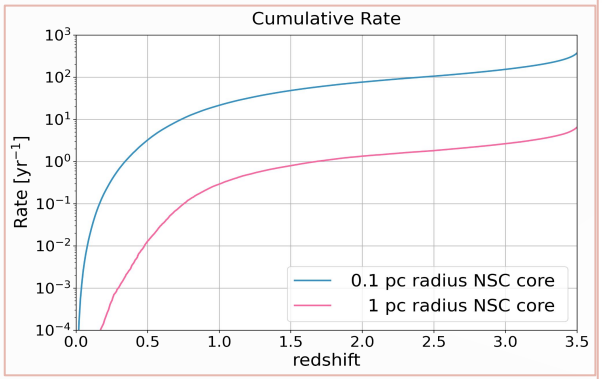


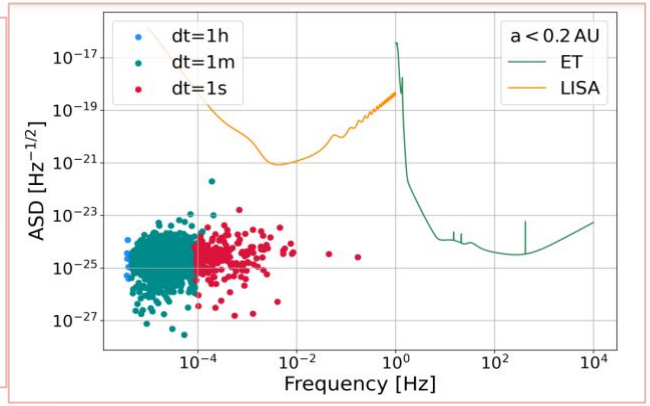
1st Gen binary

2nd Gen binary

3rd Gen binary

...

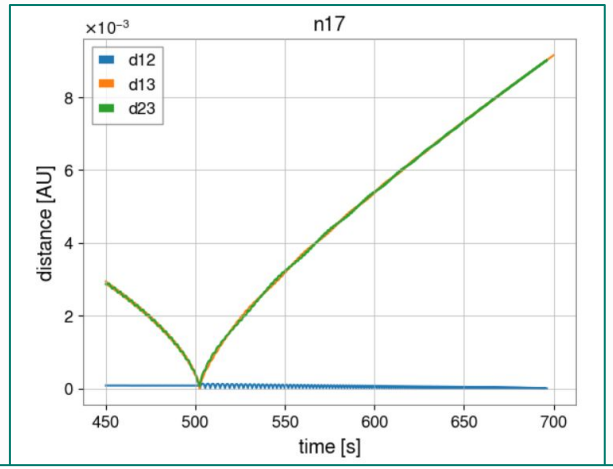


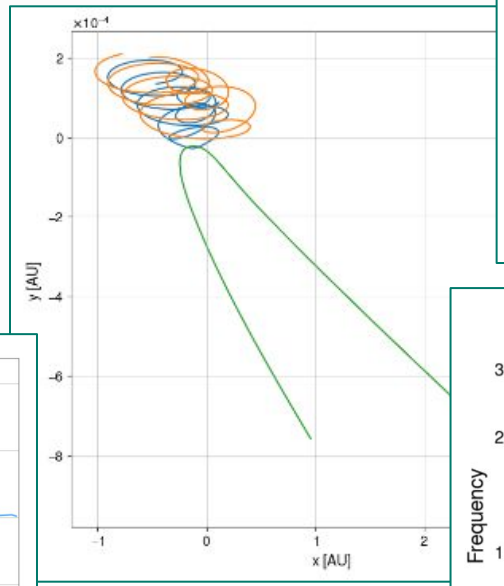


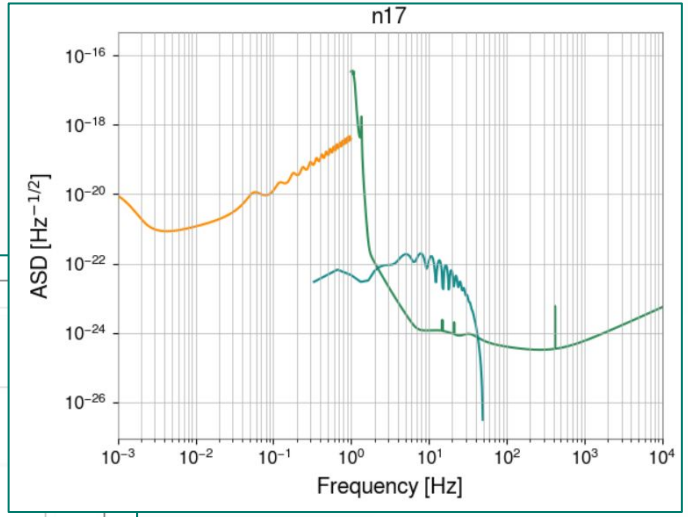
Codazzo et al. *Physical Review D* 107.2 (2023): 023023.

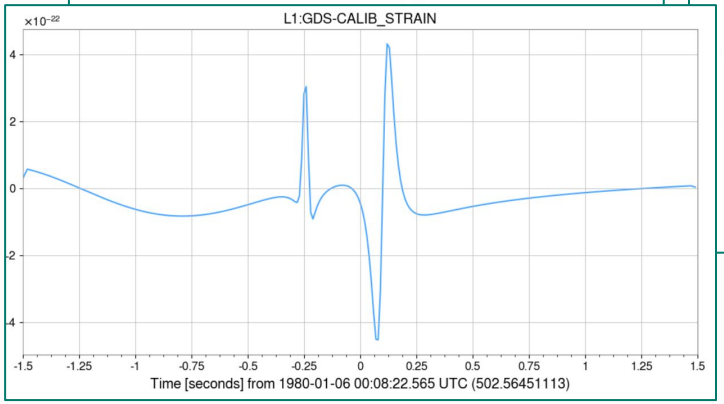
Signal characterization

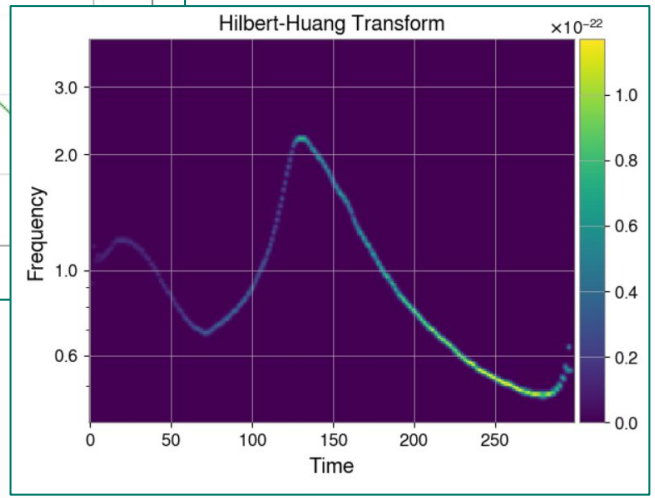
Ongoing work











Enjoy your PhD!
@EGO PHOTO