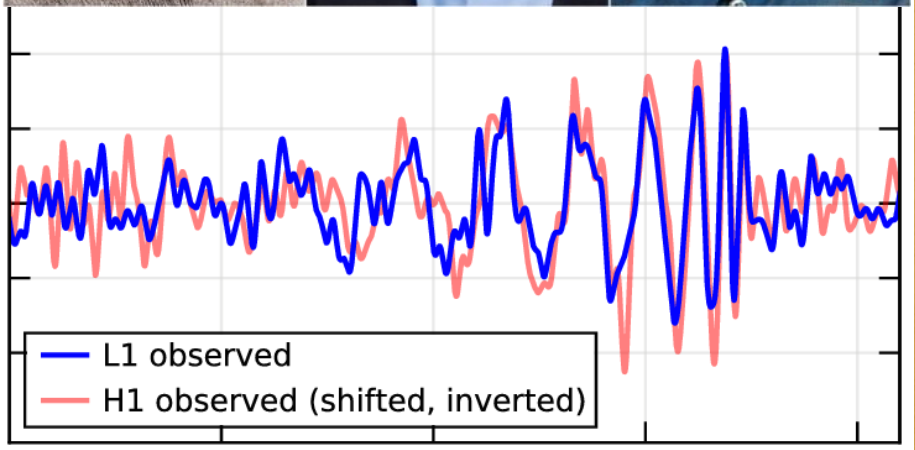
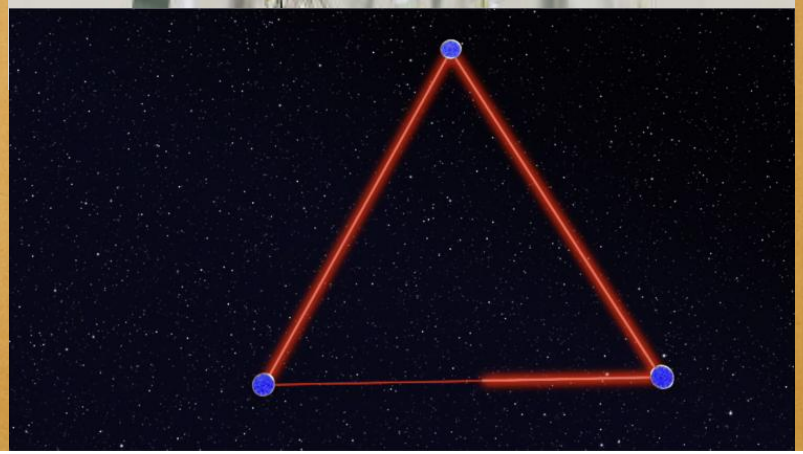
Dark matters, paris 2017

Gravitational Wave Astronomy and Cosmology

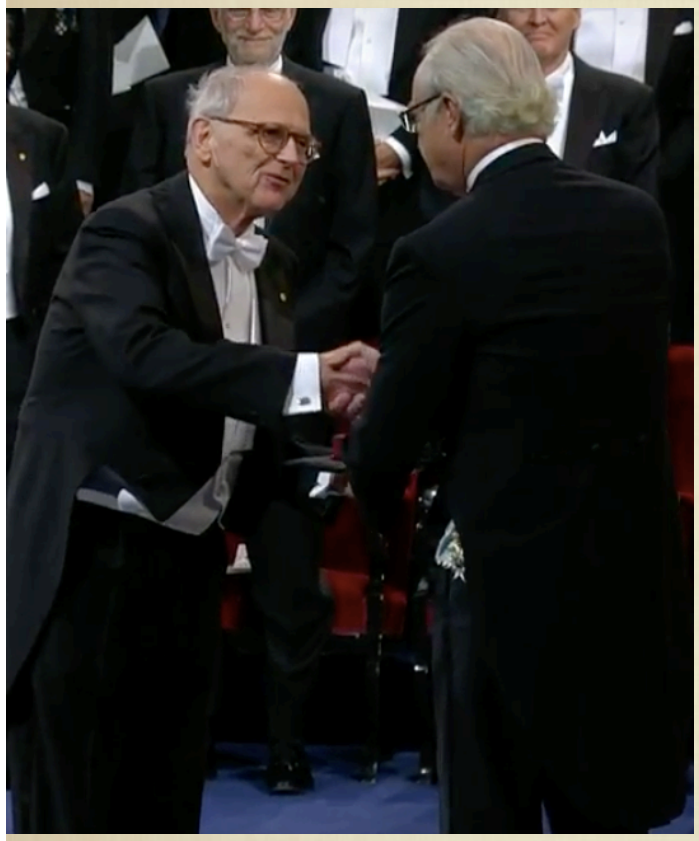
Bernard Schutz

Cardiff University, Wales; Albert Einstein Institute, Germany

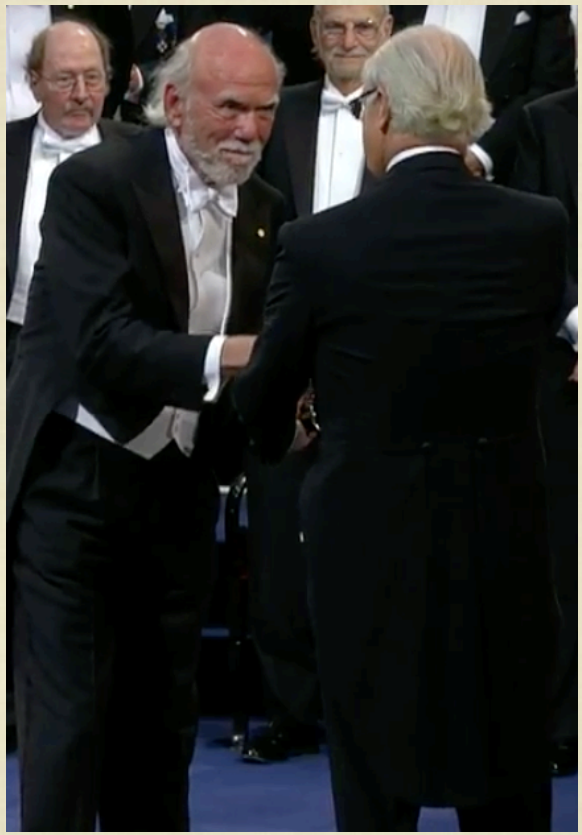




Just on Sunday, the GW detections recognised with the Nobel Prize.



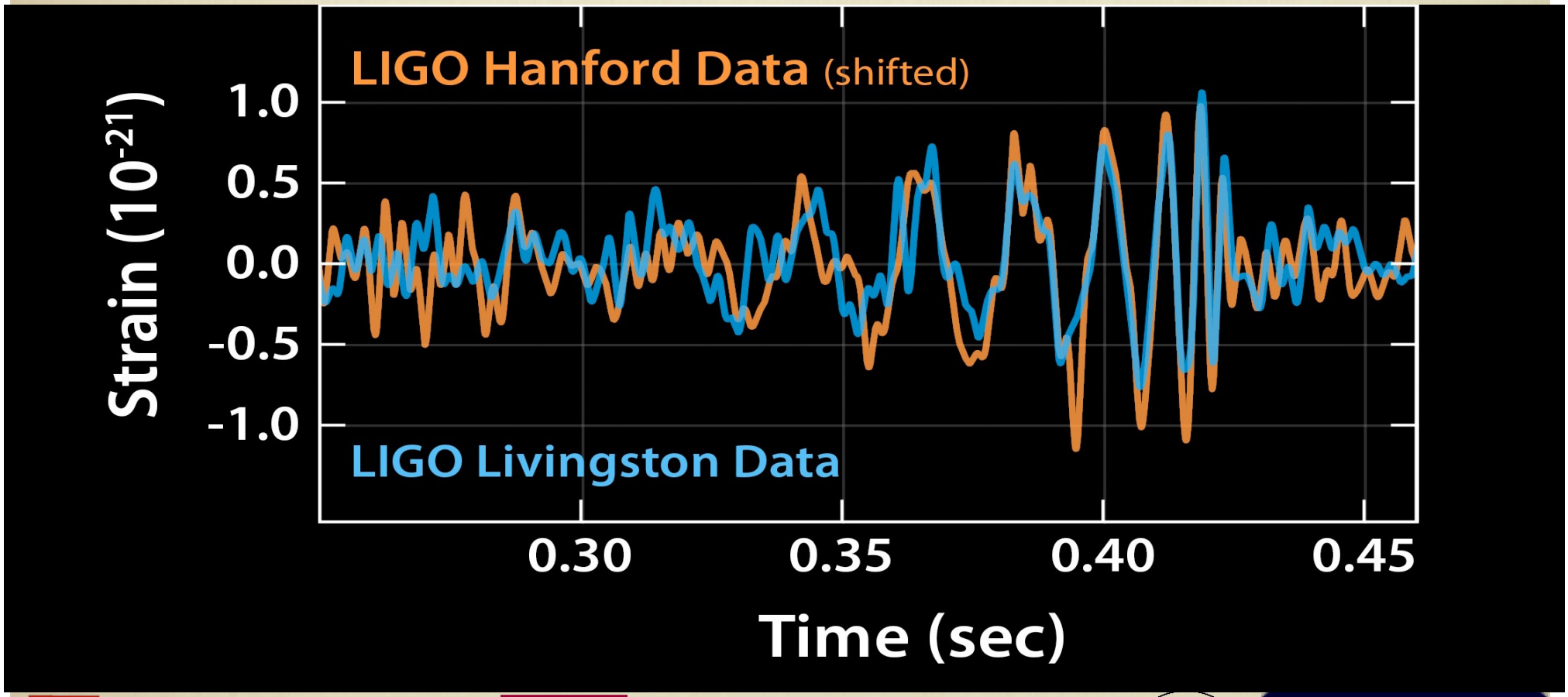
Rainer Weiss
(MIT)



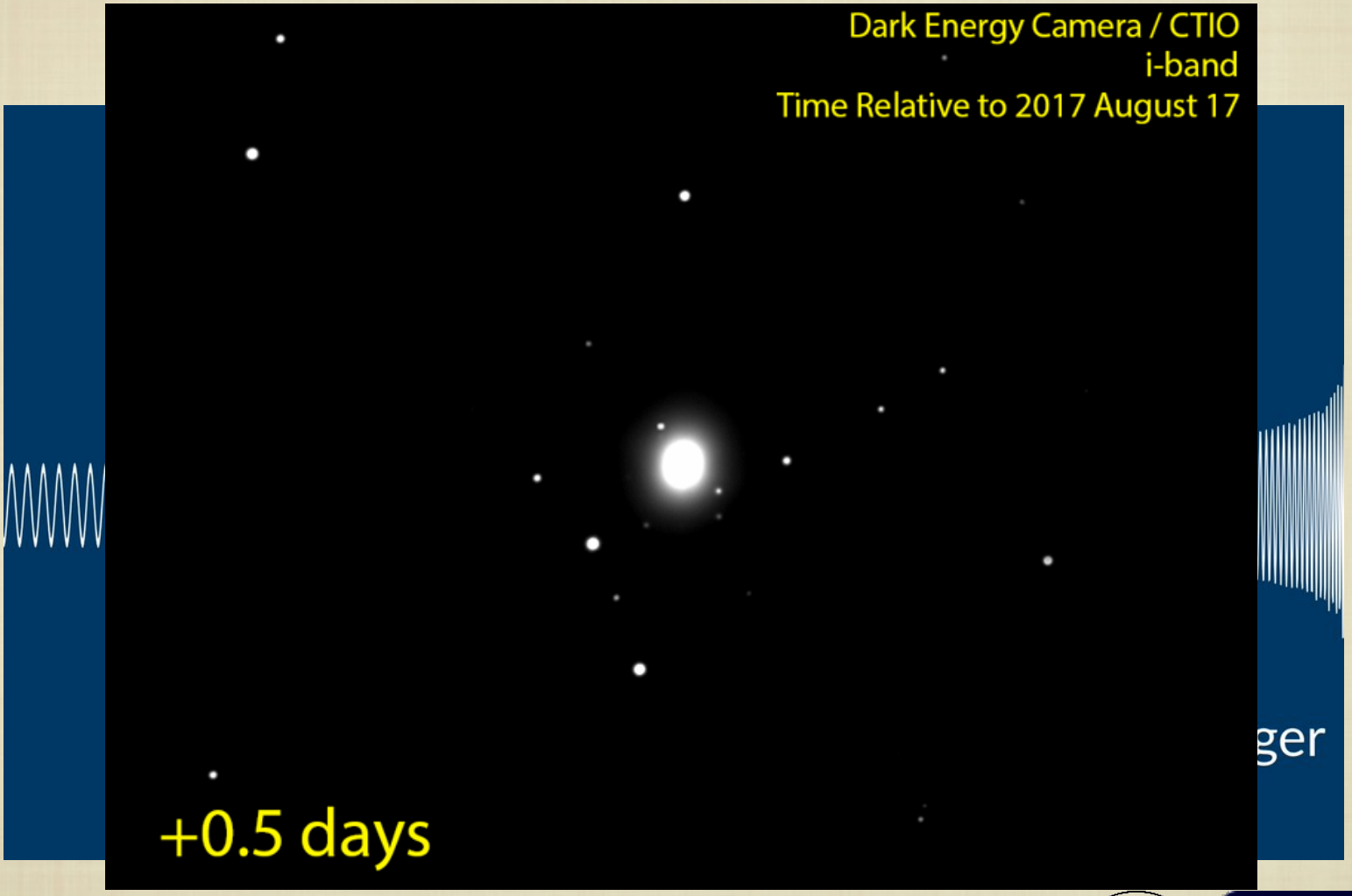
Barry Barish
(Caltech)

Kip Thorne
(Caltech)

On 14 September 2015, we listened, for the first time, to a *sound* from the Universe, made by two BHs!

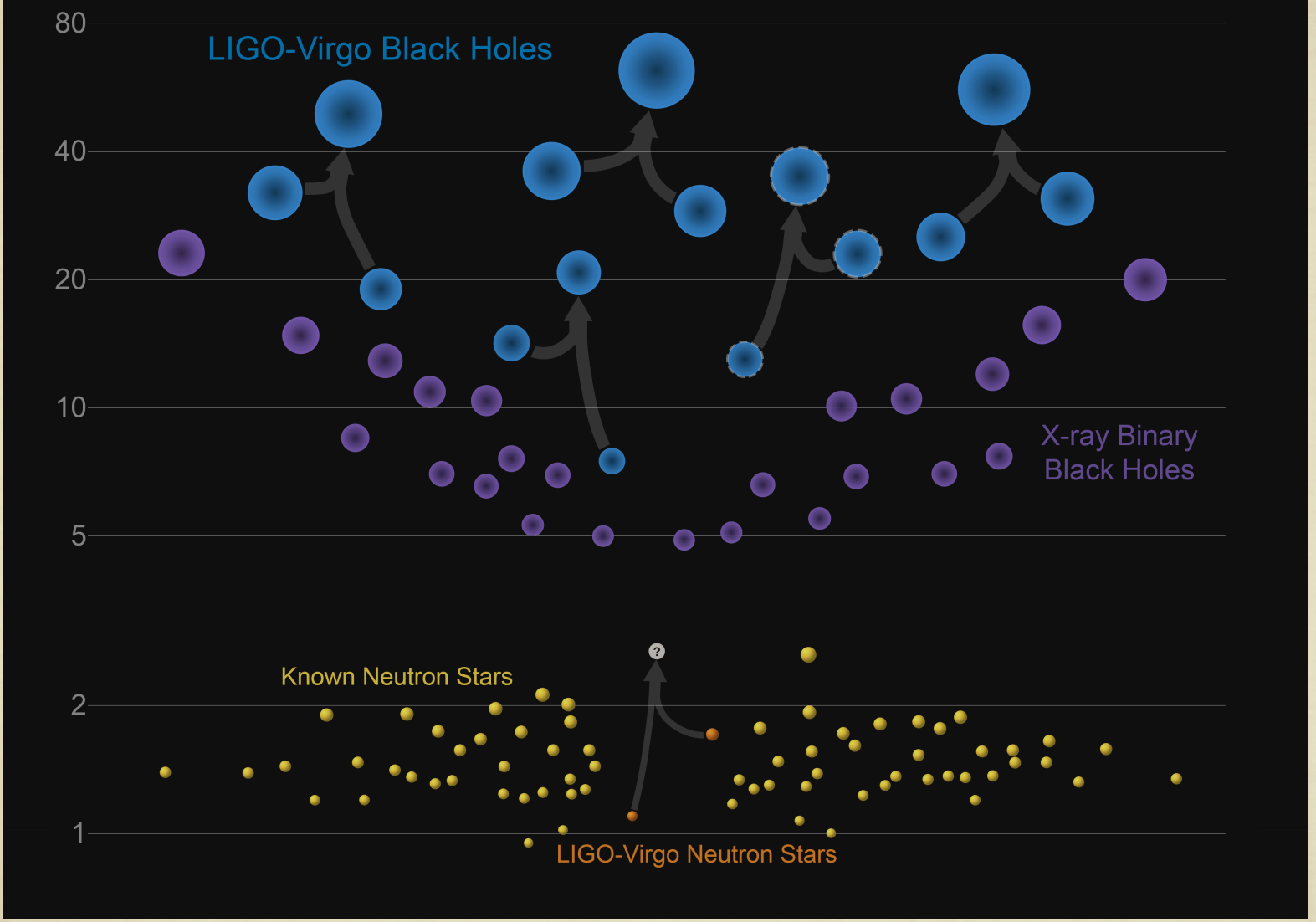


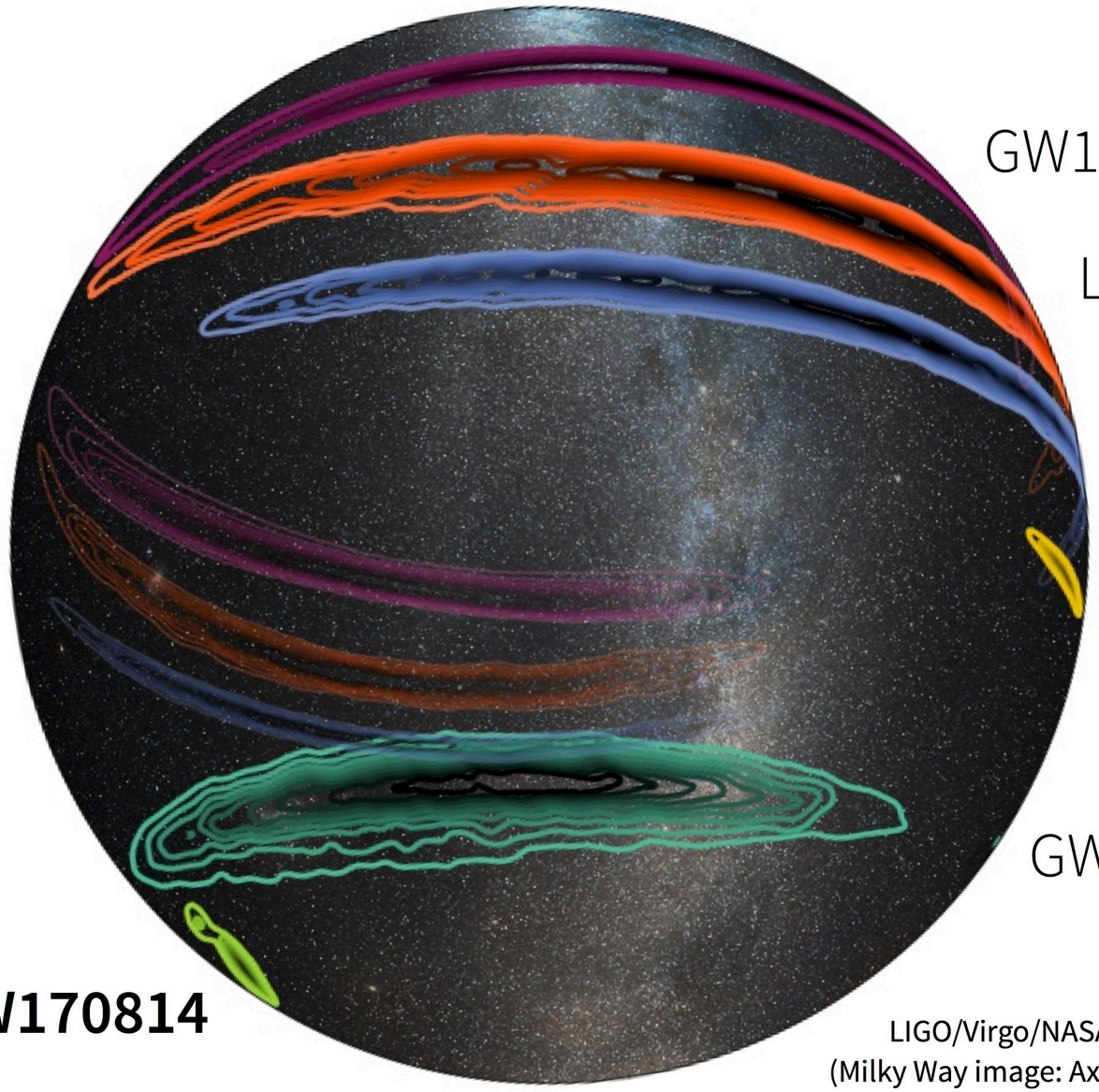
Then, on 17 August 2017, we saw the explosion associated with another



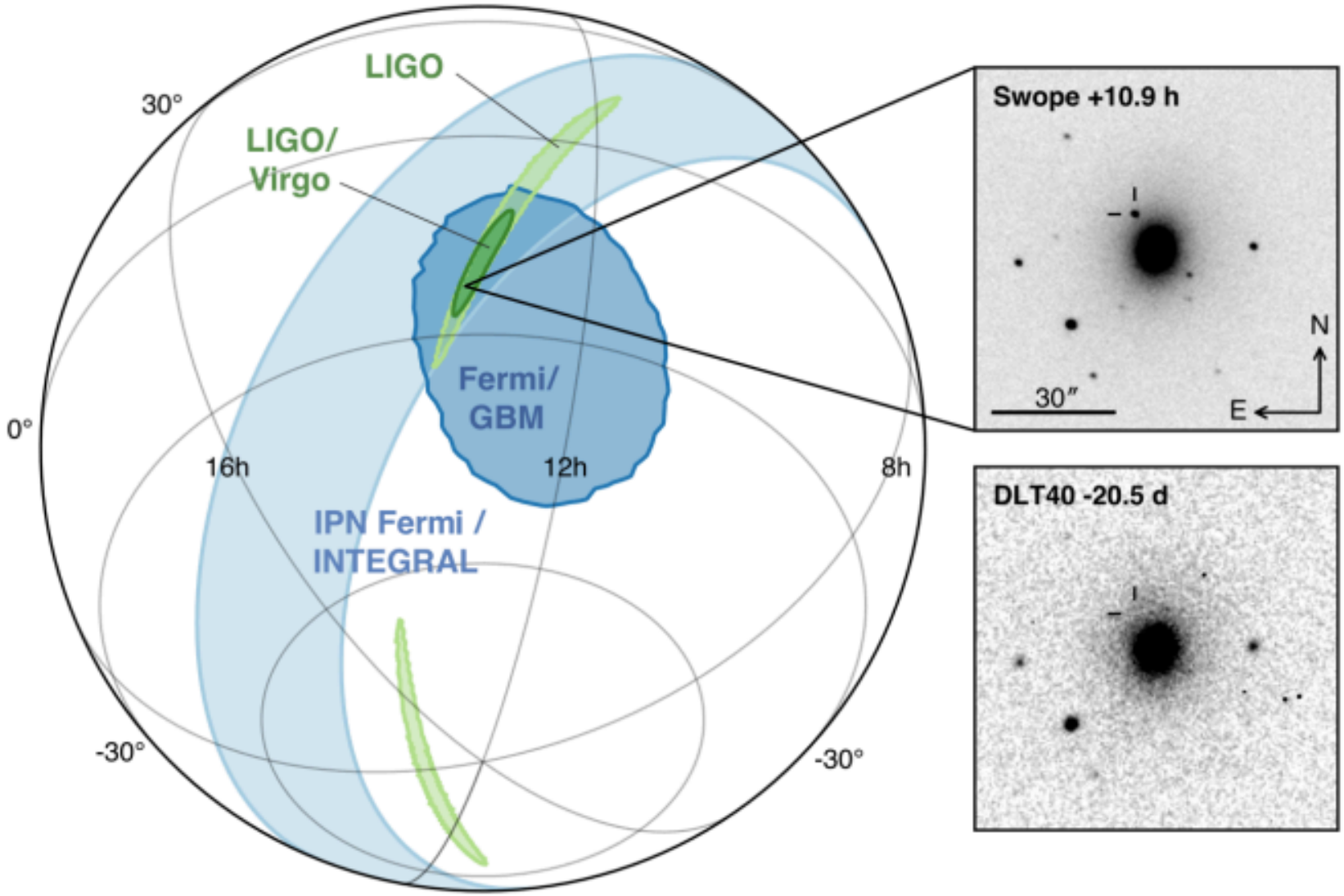
Masses in the Stellar Graveyard

in Solar Masses





LIGO/Virgo/NASA/Leo Singer
(Milky Way image: Axel Mellinger)


LIGO
LIGO/
Virgo
Fermi/
GBM
IPN Fermi /
INTEGRAL
30°
0°
-30°
16h
12h
8h
-30°
Swope +10.9 h
30″
N
E
DLT40 -20.5 d

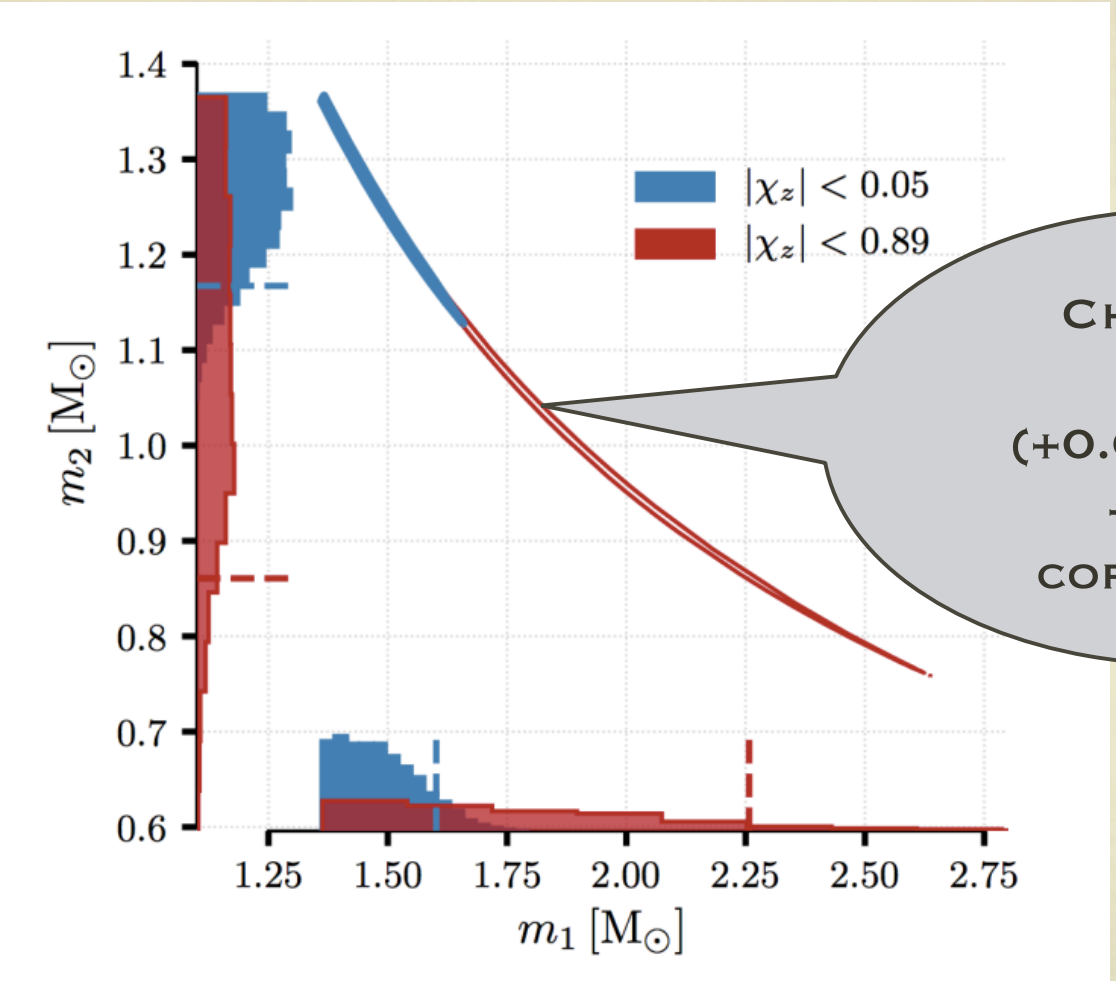
Standard Sirens

Binary system signals carry the information about their distance: they are called standard sirens.

The formula for the radiation amplitude h depends on 3 intrinsic variables that determine the Newtonian orbit, (m1, m2, Ω), and of course h falls off as 1/r. But at the lowest pN order (talk by Blanchet), it happens that h depends only one one mass, the chirp mass $\mathcal{M} = (m1*m2)^{3/5}/(m1+m2)^{1/5}$

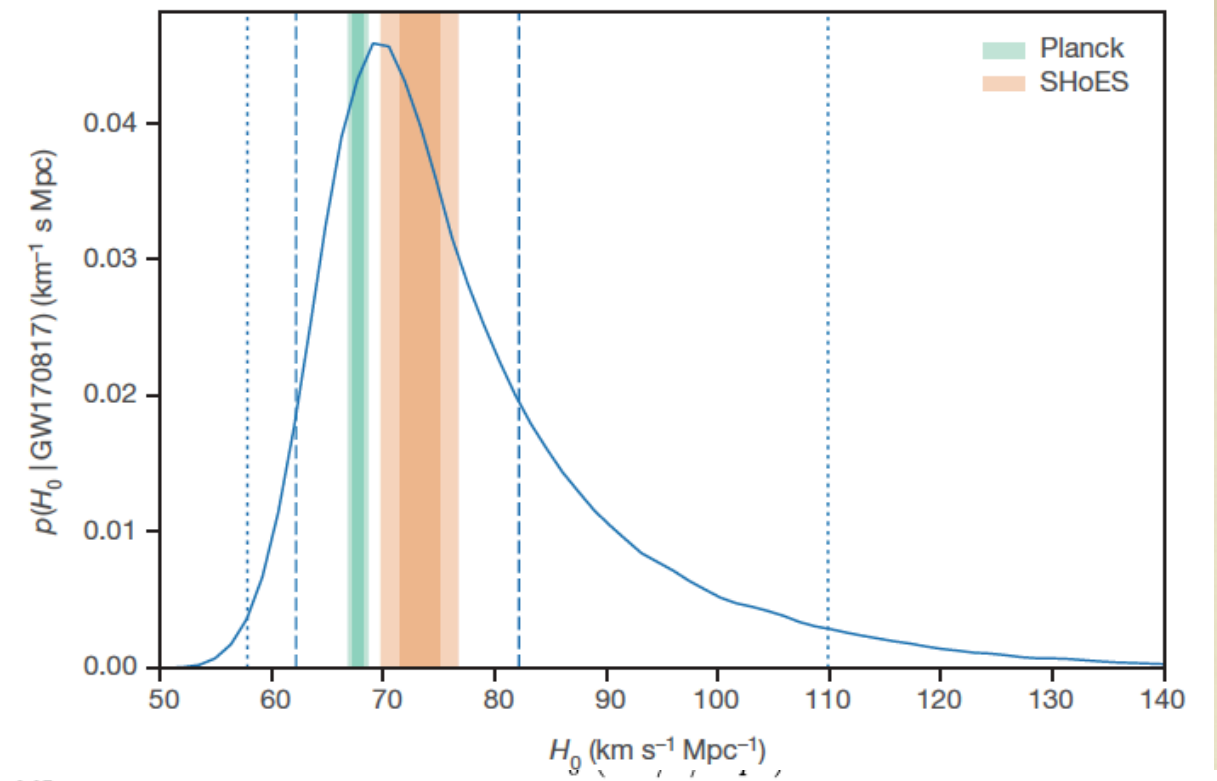
There is enough information in the phase of the signal to solve for these lowest order variables: f and df/dt determine $\mathcal{M}$ and then h determines r. But to determine h one needs all orientations: location on sky, inclination of binary orbit. For GW170817, we did not get the inclination accurately.

Masses of the stars

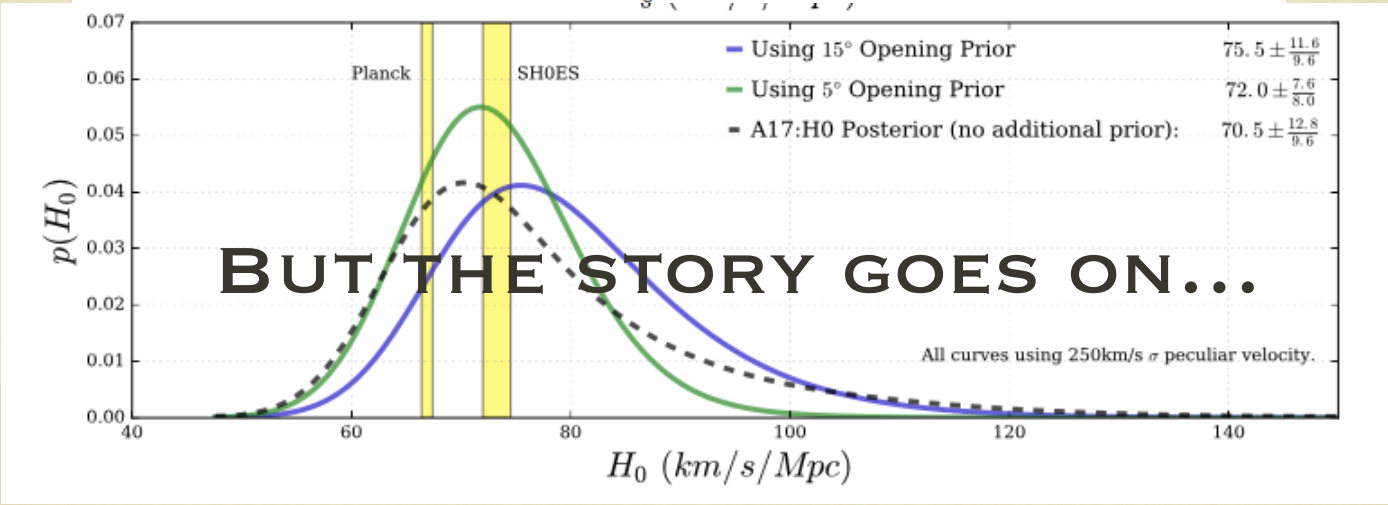


Chirp mass
1.188
(+0.004,-0.002)
-- tight
correlation.

LIGO-Virgo



Guidorzi, et al 2017



But the story goes on...