The Universe Speaks

Building Devices to Listen

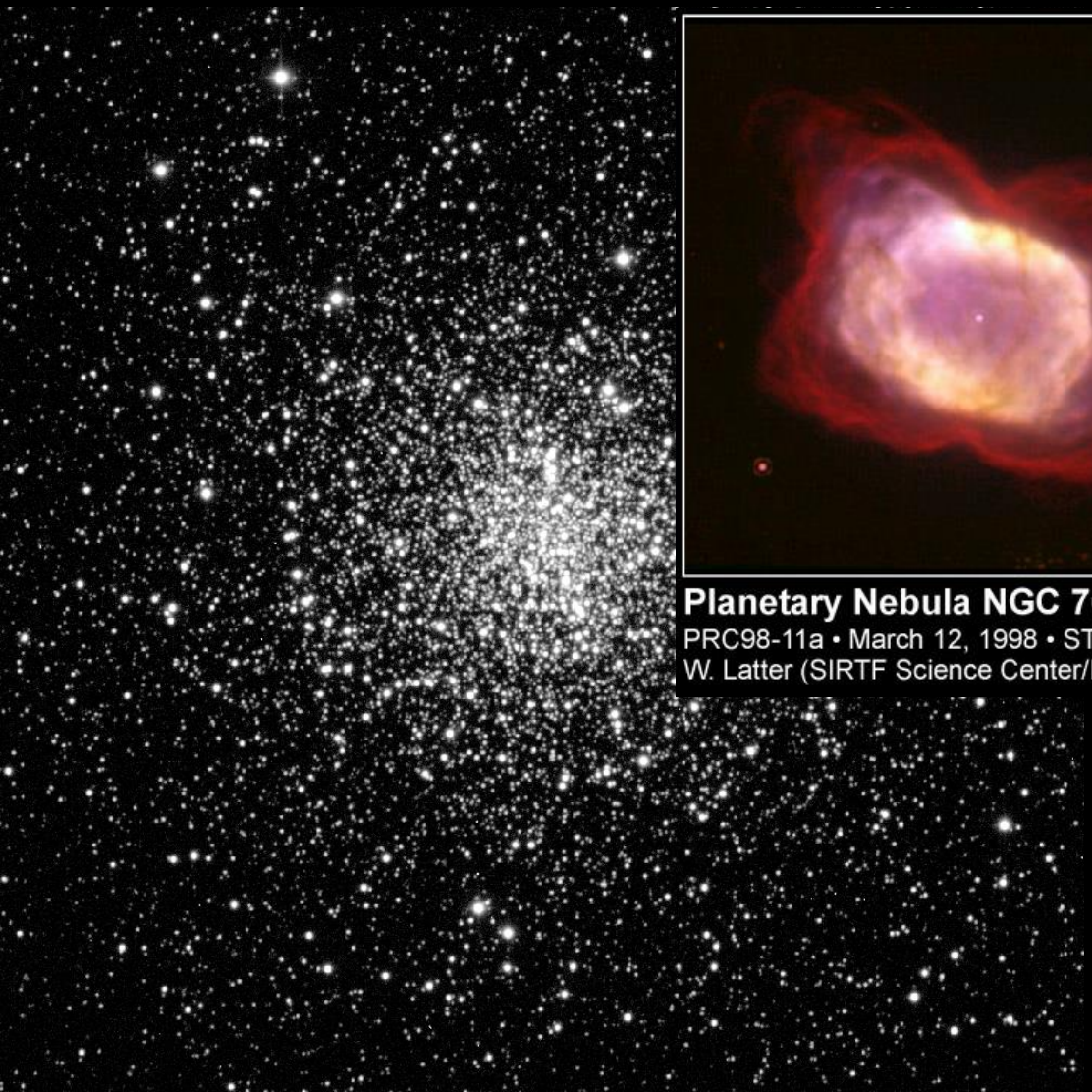
By William Katzman, with funding by the National Science Foundation PHY-0757058

LIGO

- An award winning Observatory
  - Nobel Prize awarded to founders
  - Physics Historic site (APS designation)
  - Physics Breakthrough award
  - Global Thinker
  - Princess of Asturia
  - Einstein Medal
- Pushing technology
- Federal dollars flowing to state
  - 50 employees in LA (200 employees in US)
  - Maintenance contracts, LN2 delivery, partial local fabrication
- International Collaboration
  - 1000+ people working on LIGO worldwide
  - Sharing data with Virgo (Italy) and Geo (Germany)

Speaking through light

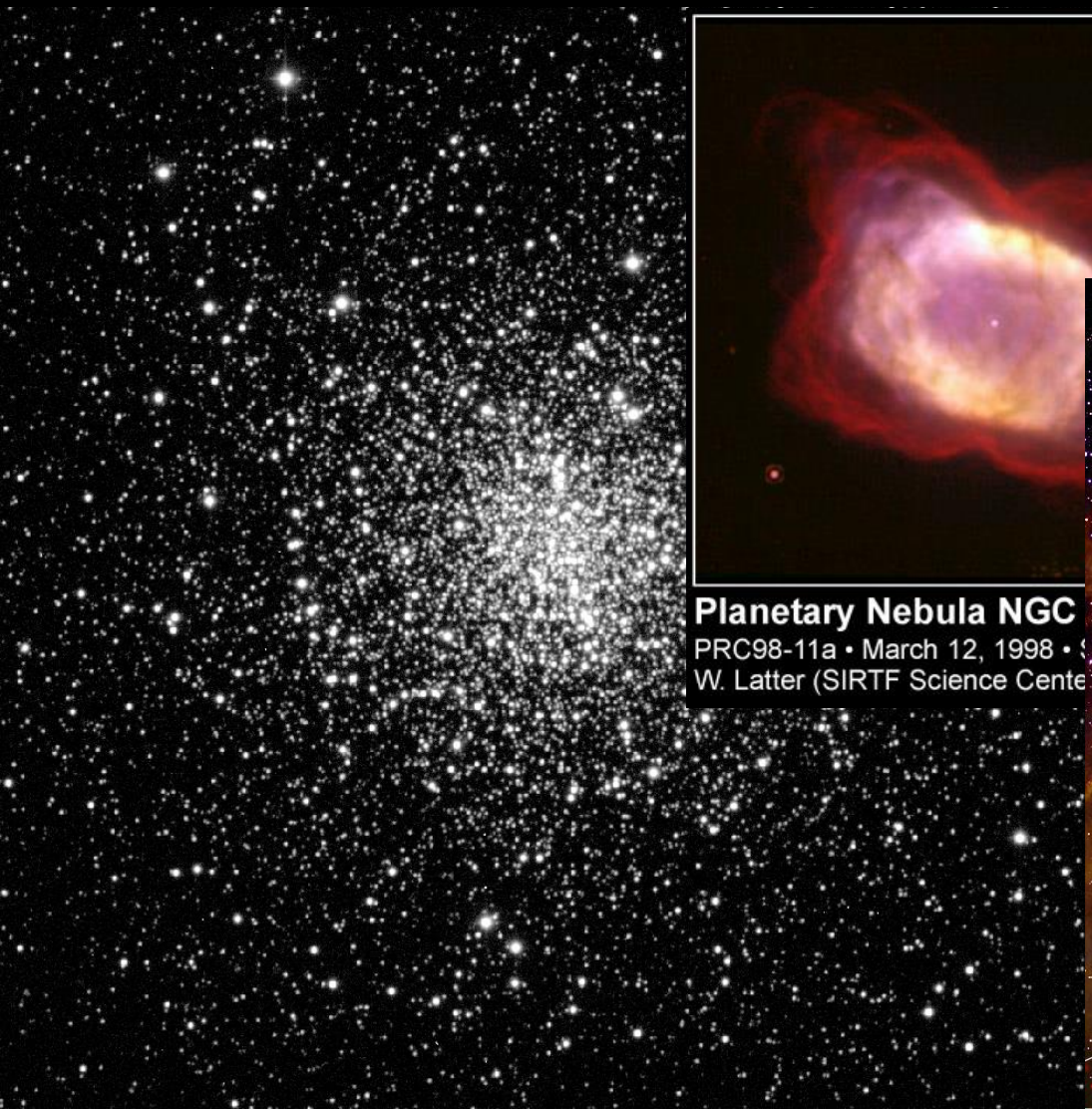
Speaking through light

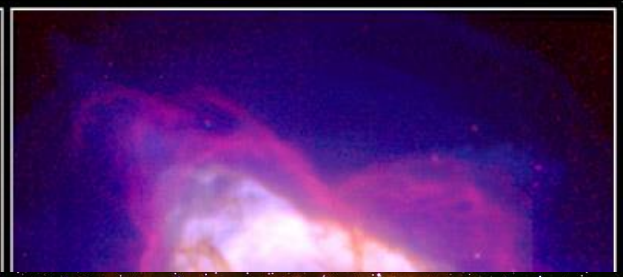


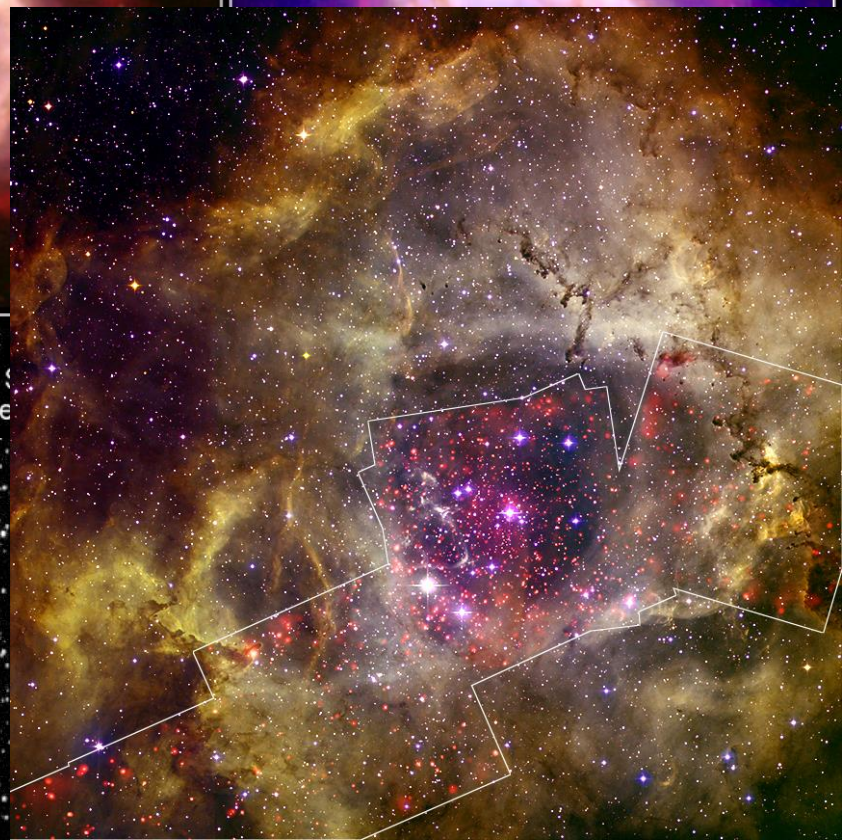
Planetary Nebula NGC 7027
PRC98-11a • March 12, 1998 • ST ScI OPO
W. Latter (SIRTF Science Center/IPAC/Caltech) and NASA

HST • NICMOS • WFPC2

Speaking through light







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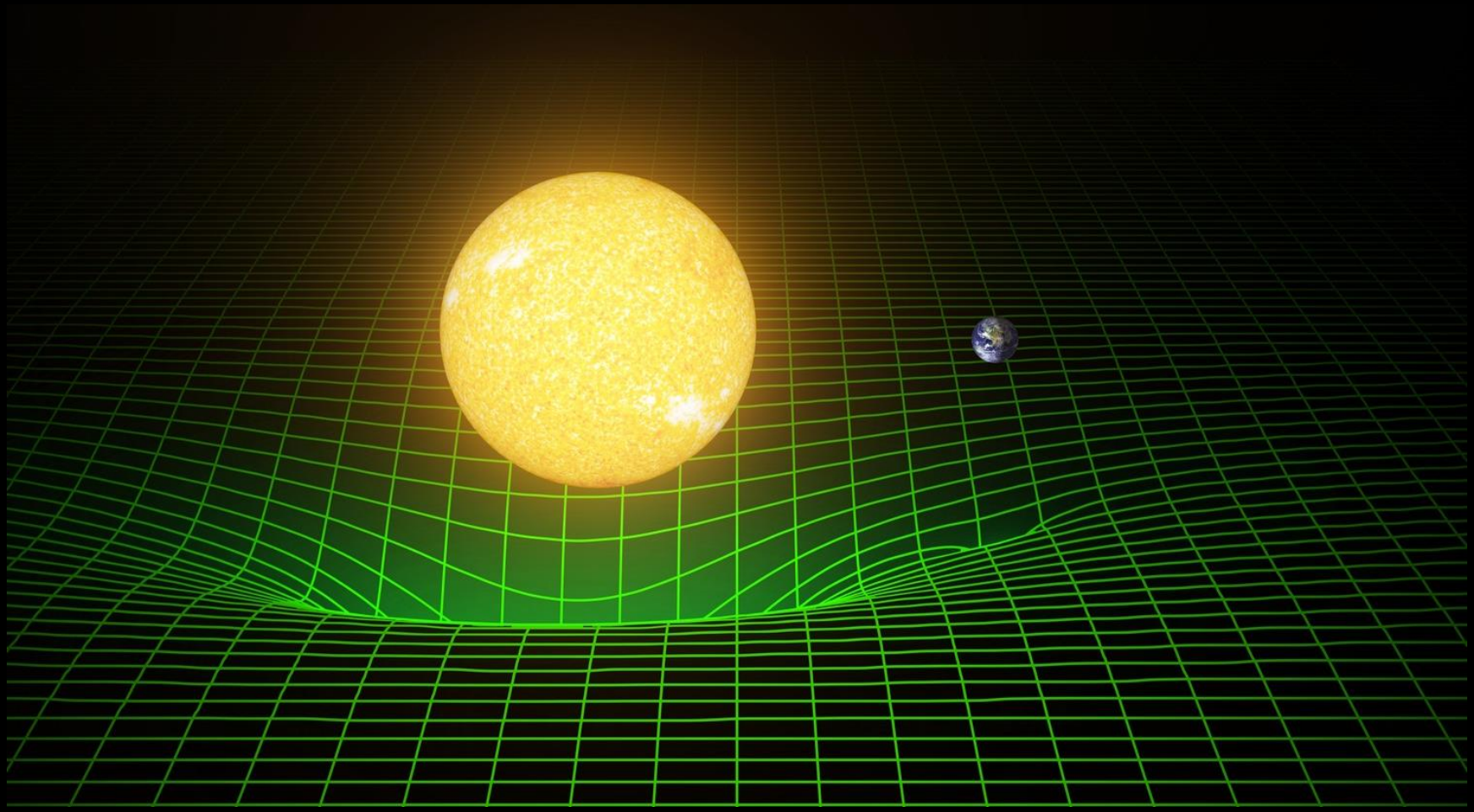
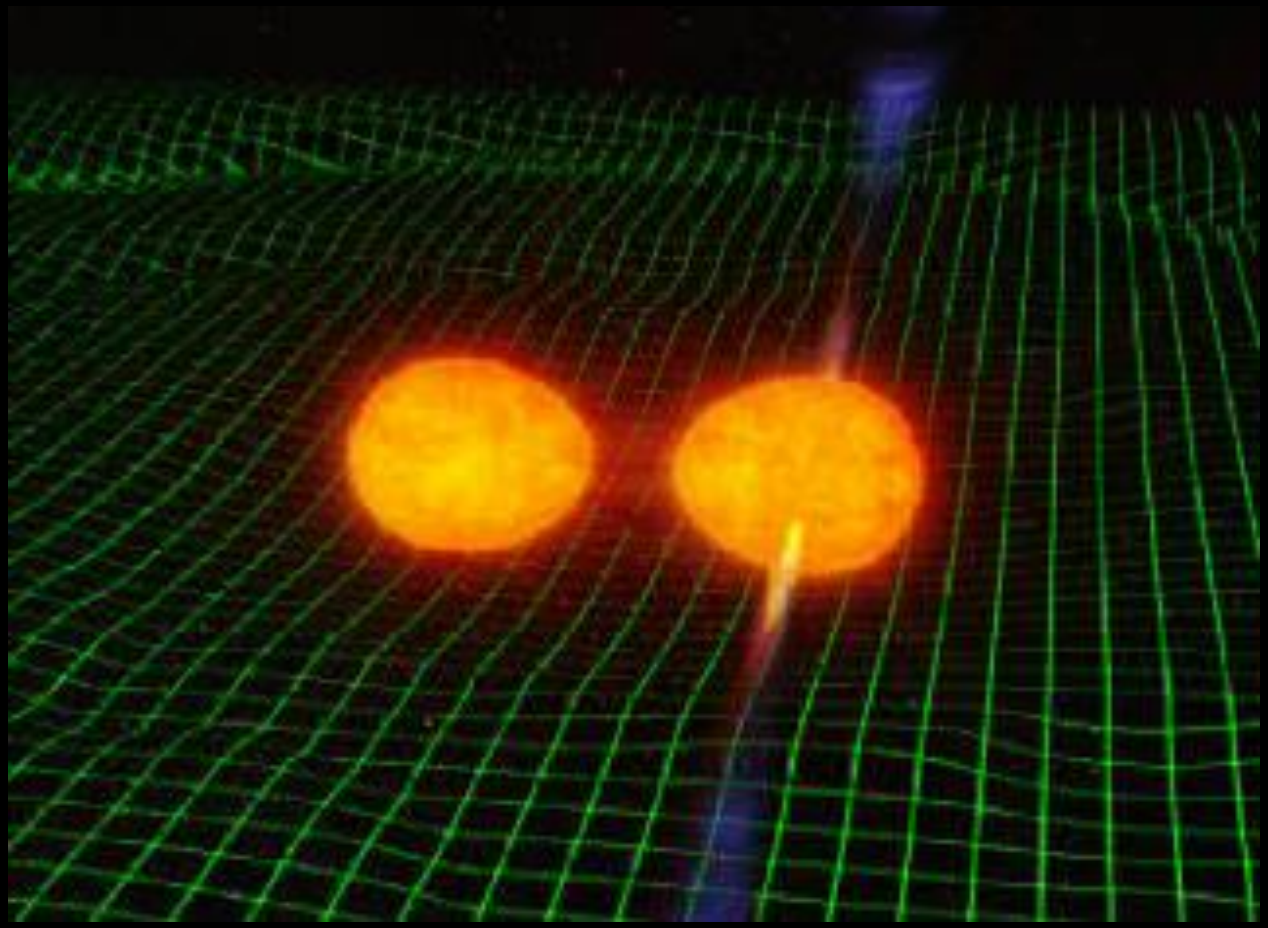
Speaking through light

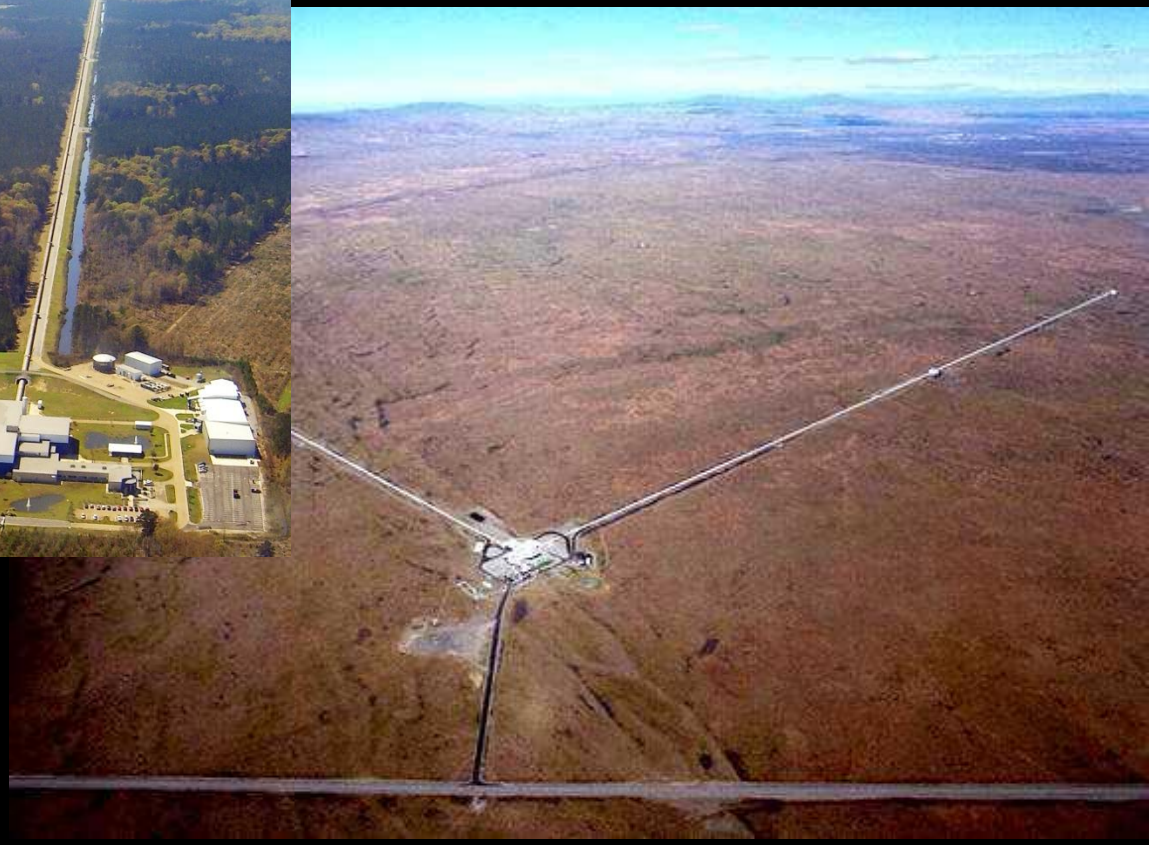


Gravitational Waves



The Observatory

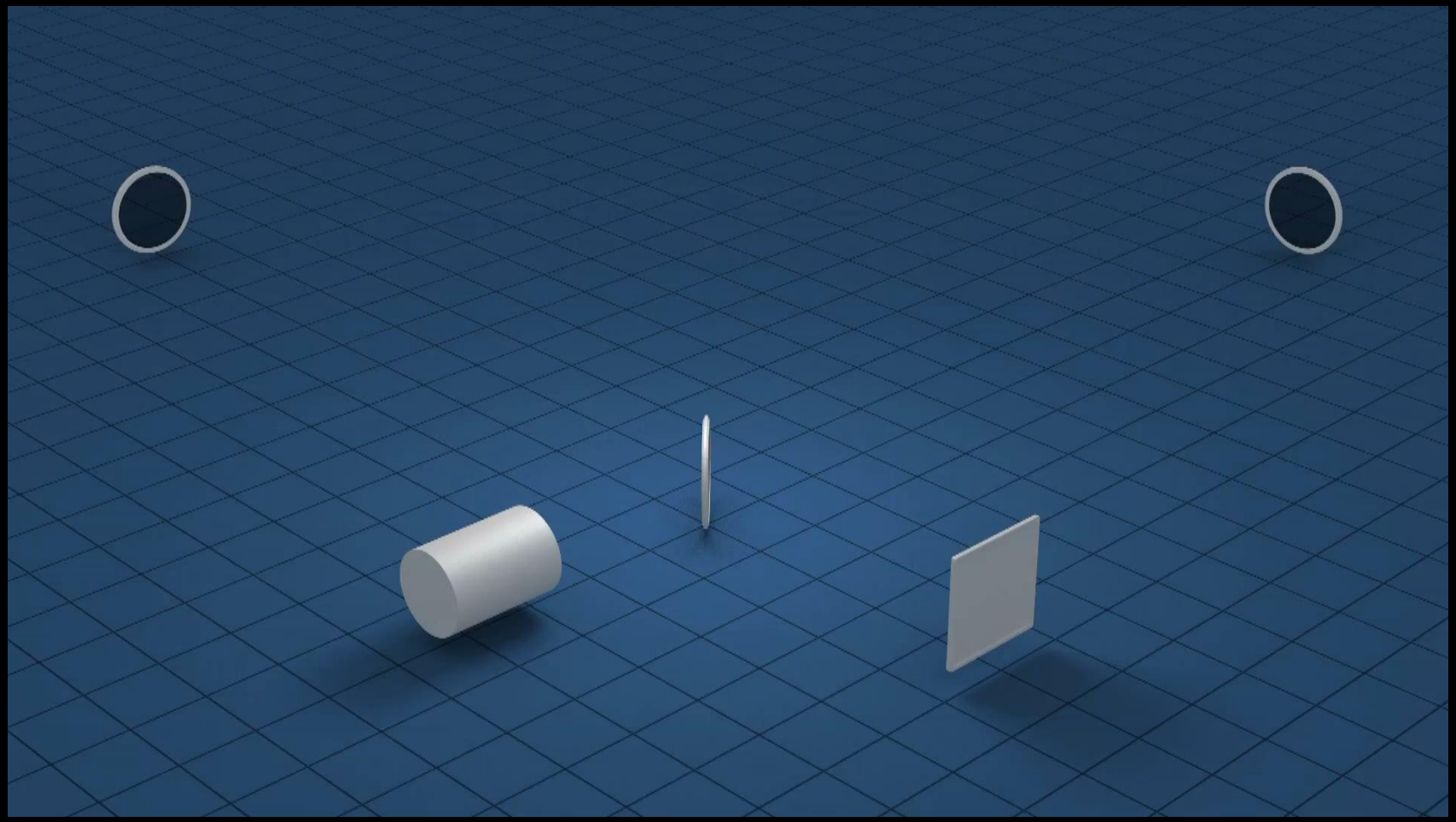
← Livingston, Louisiana



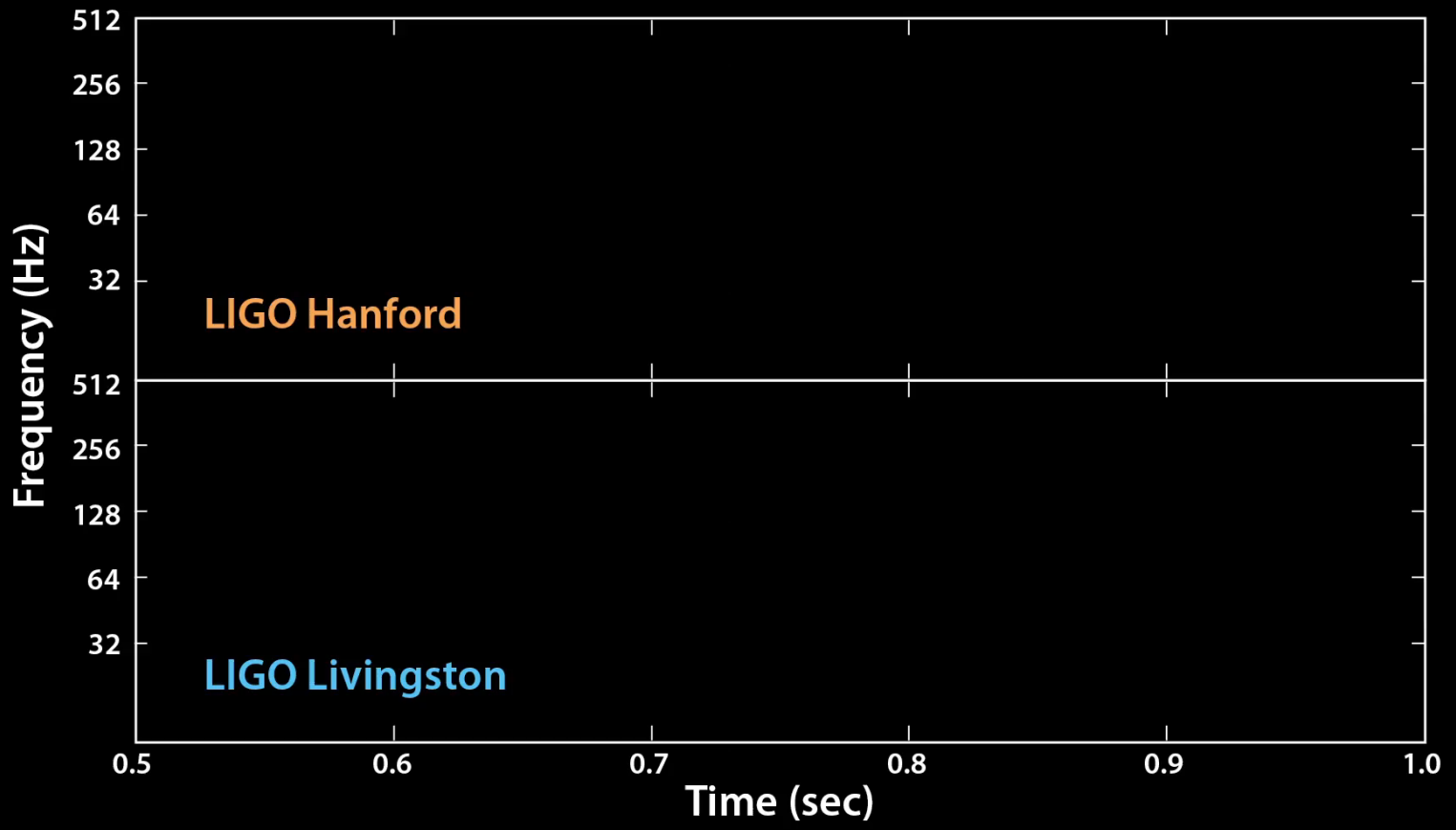
Hanford, Washington →

Supported by NSF grants PHY-0917587, PHY-1506037, PHY-0757058

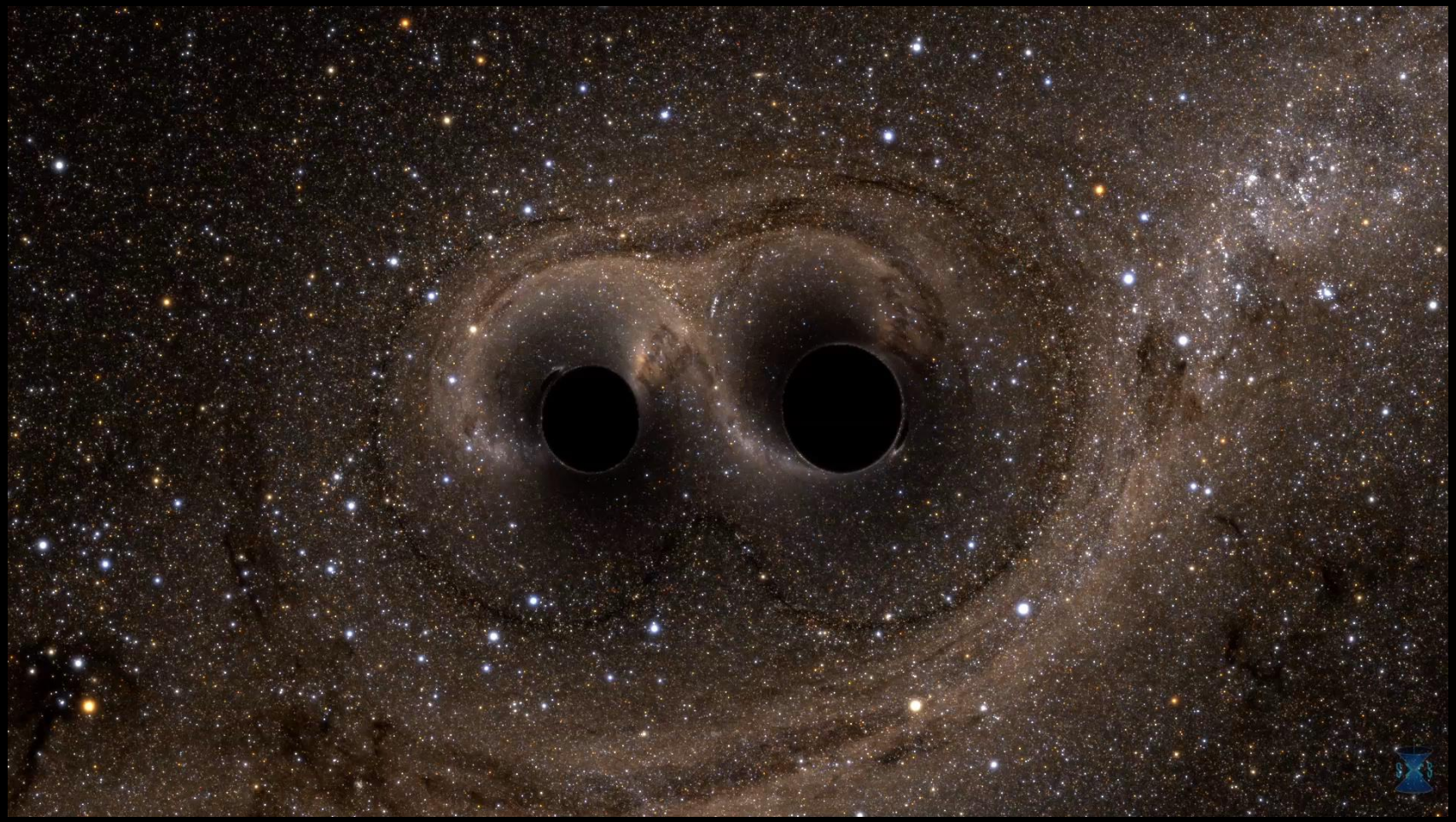
Laser Interferometer



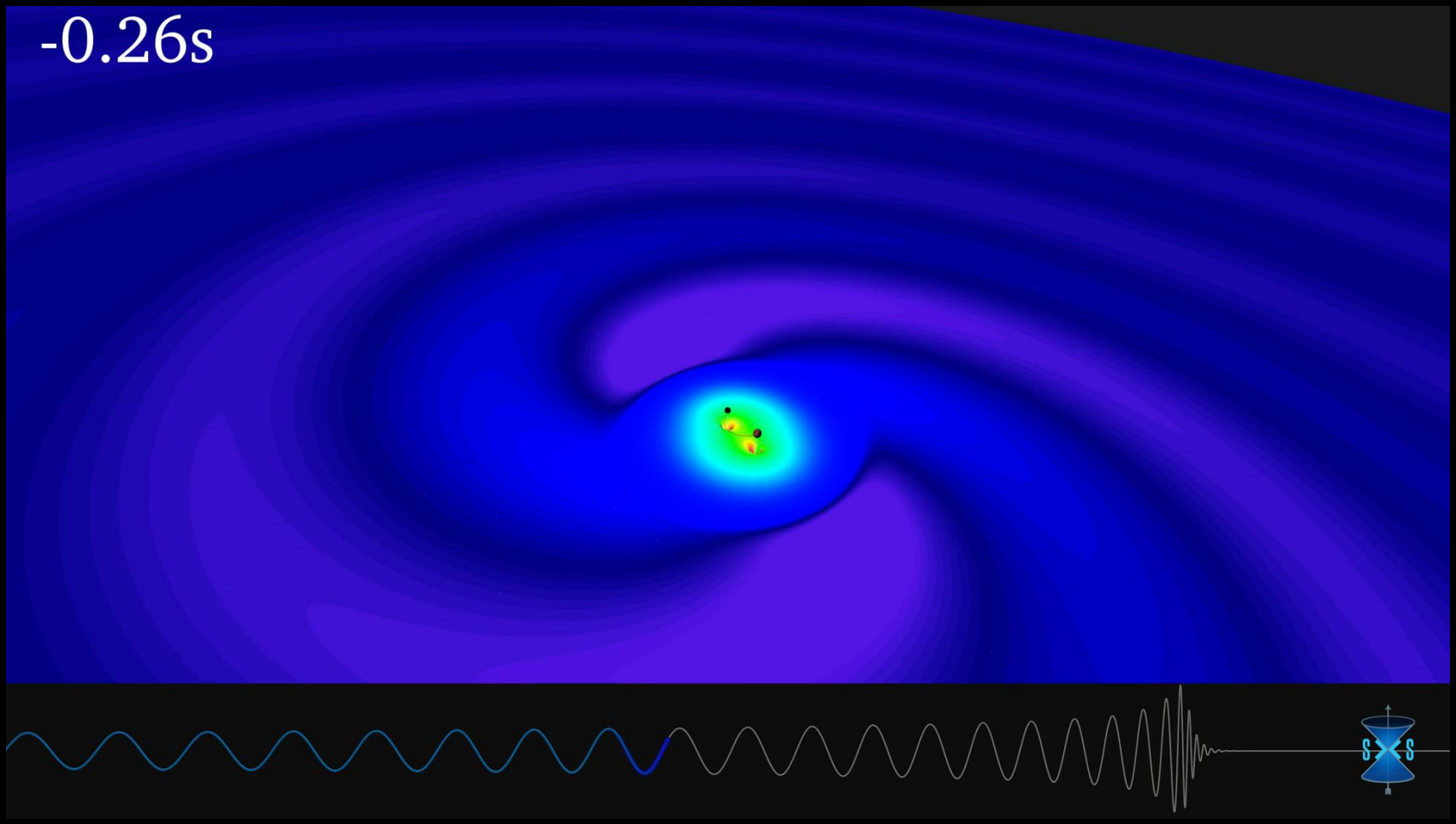
GW150914


512
256
128
64
32
LIGO Hanford
512
256
128
64
32
LIGO Livingston
Frequency (Hz)
0.5
0.6
0.7
0.8
0.9
1.0
Time (sec)

What if we were there?



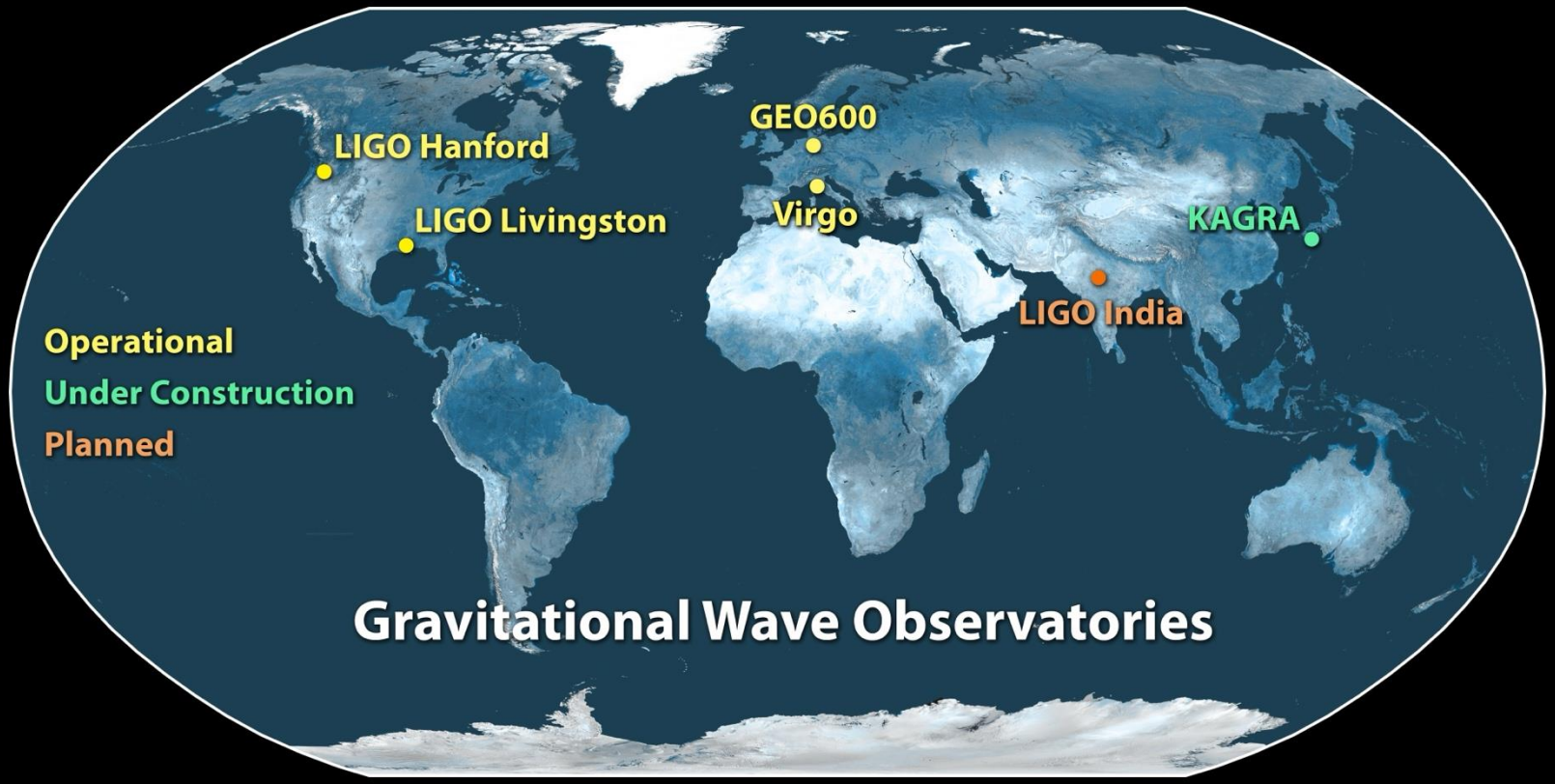
If we could see space-time…



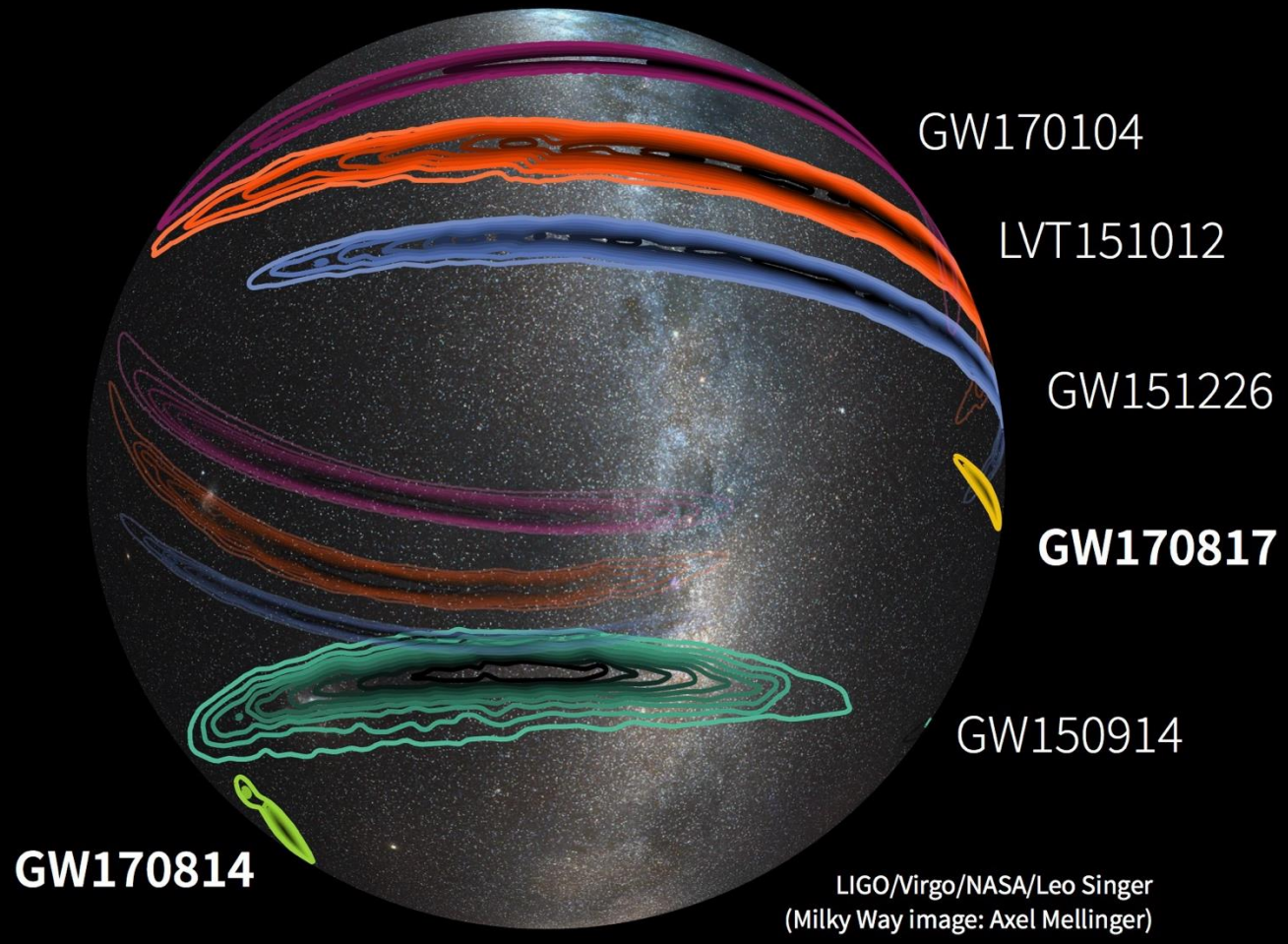
First Detection of Black Hole collision

- Over a billion years ago
- 2 black holes (36 solar mass and 29 solar mass)
- 36 + 29 = 62 + 3 solar mass radiated
  - Equivalent to 1 million earth's energy
- More power than all the stars in the universe
- Just the beginning…more earth-bound instruments, other types of instruments such as LISA and the Pulsar Timing Array - Engineers, Scientists & Makers are working on these!
- Scientific Discoveries are just BEGINNING!

Gravitational Wave Detectors

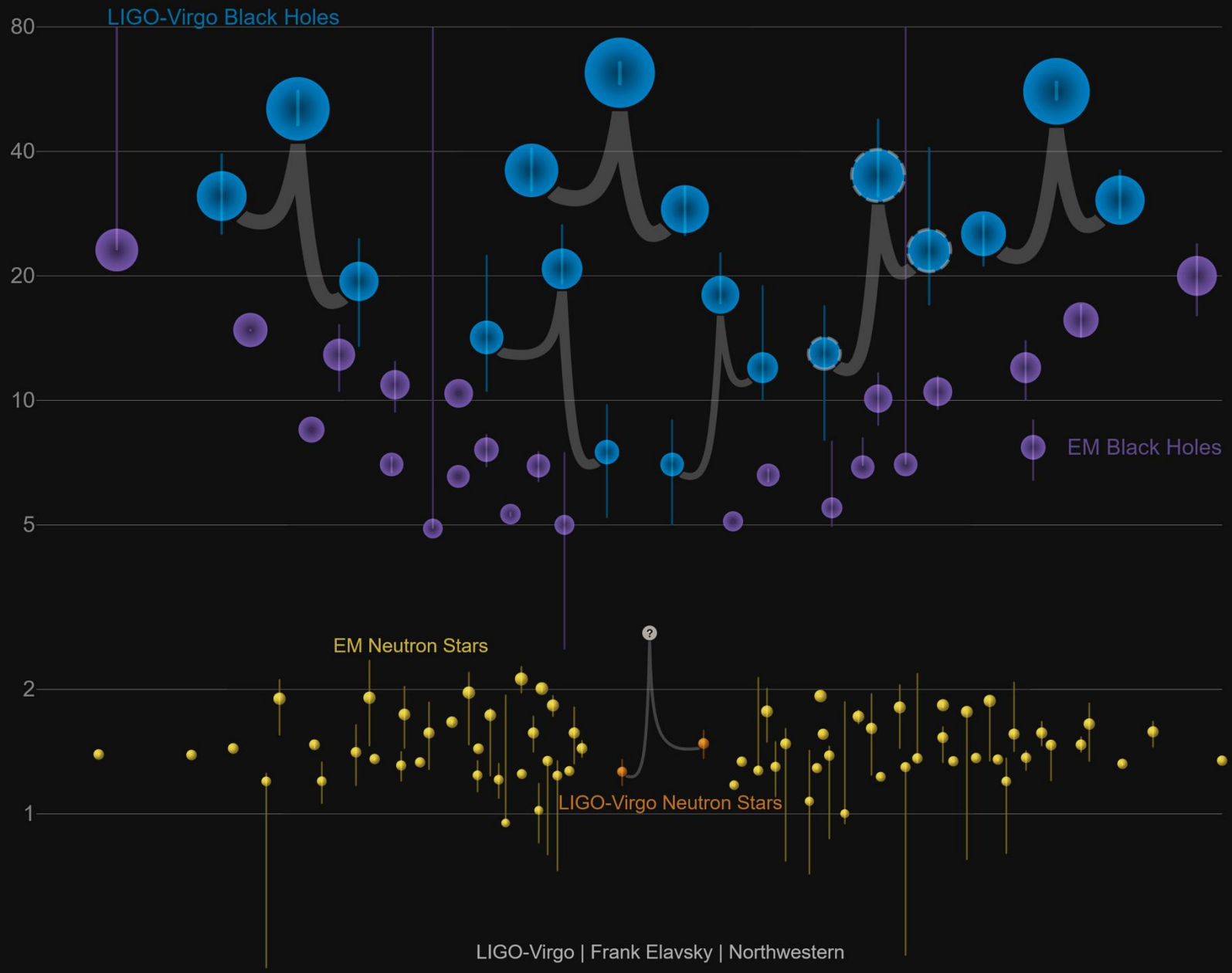


More observatories, better results

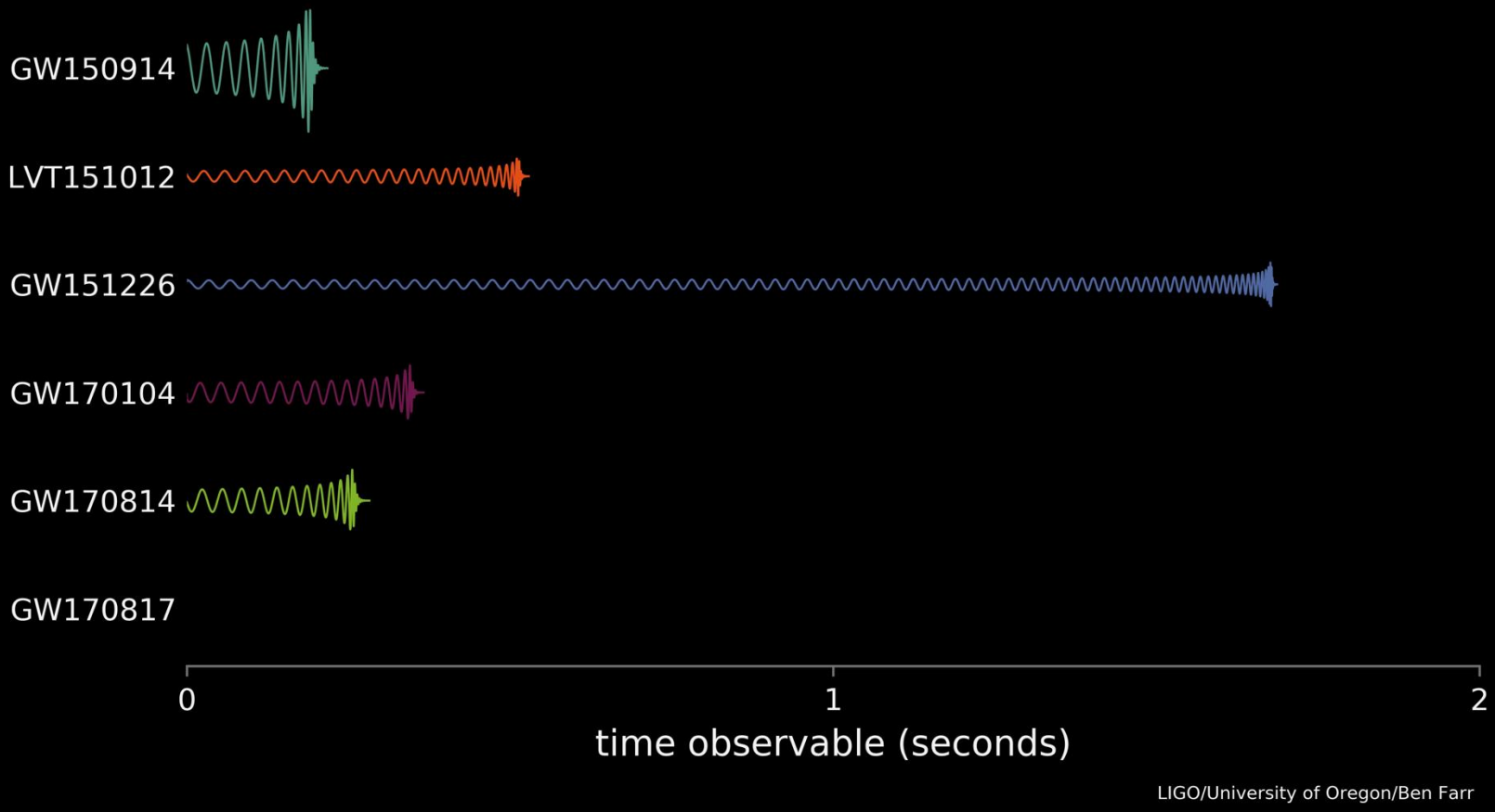


Masses in the Stellar Graveyard

in Solar Masses



Neutron Star Wave Comparison

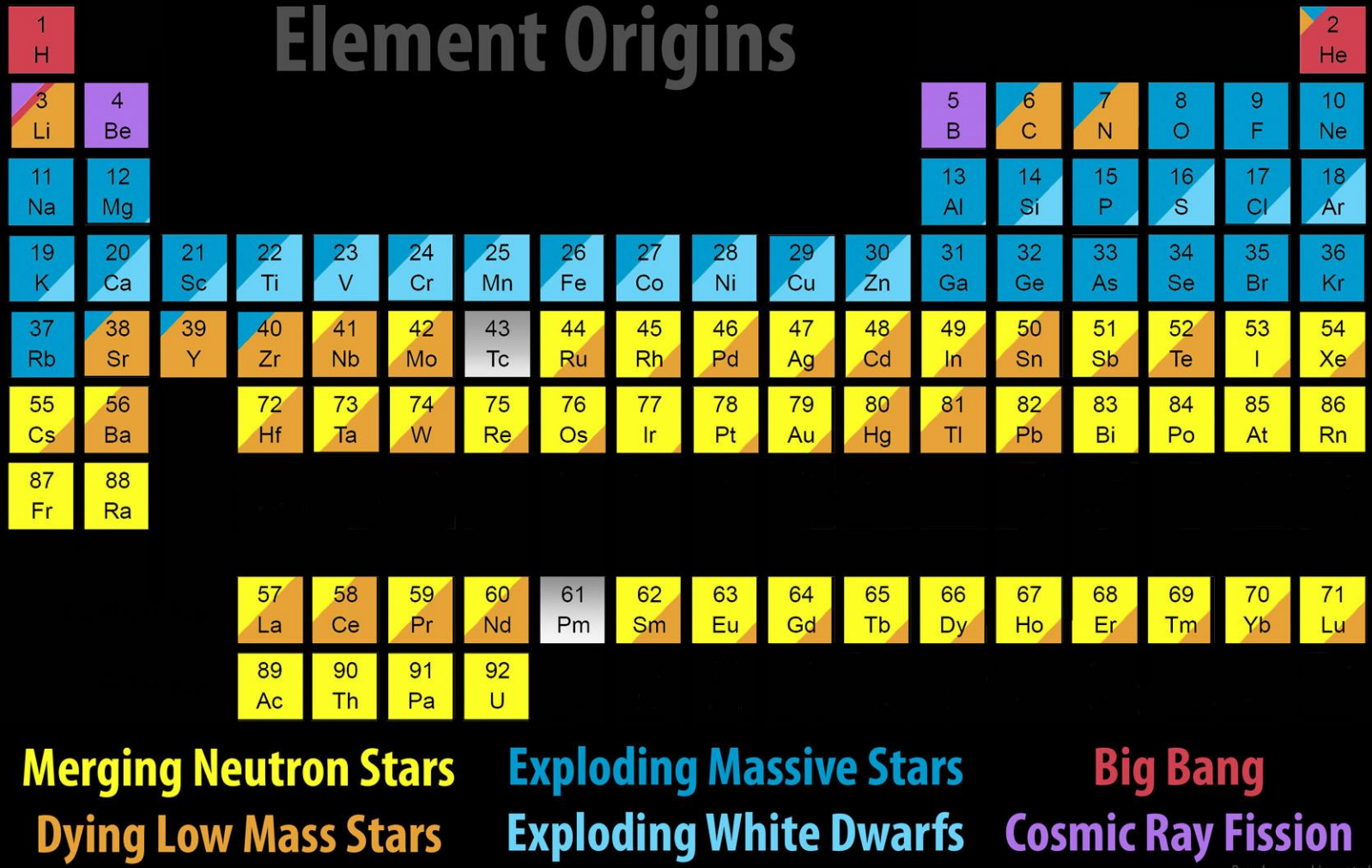


Neutron Star Collision

More observatories, better results

The Observatories

The Elements



Why?

Why?

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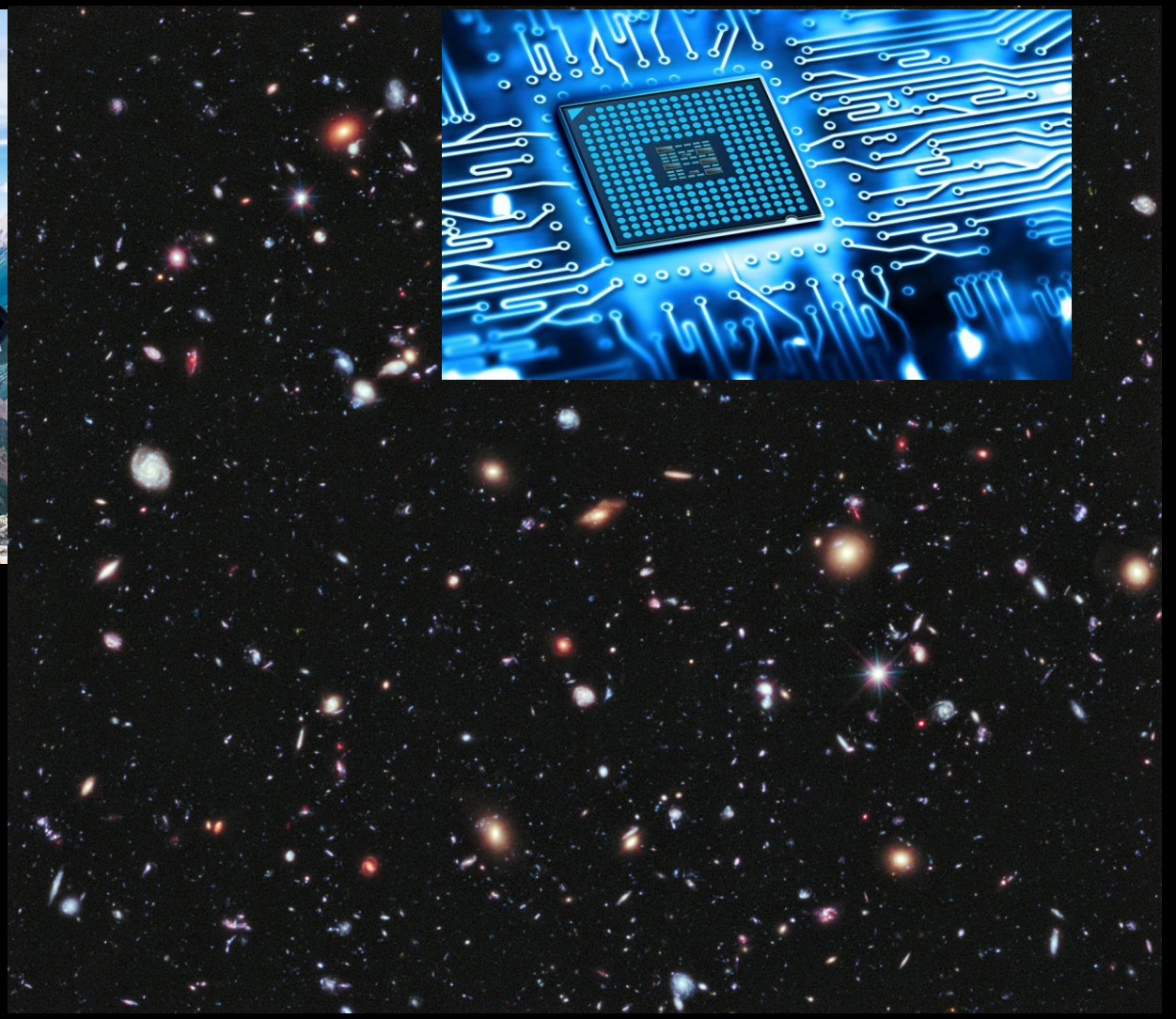

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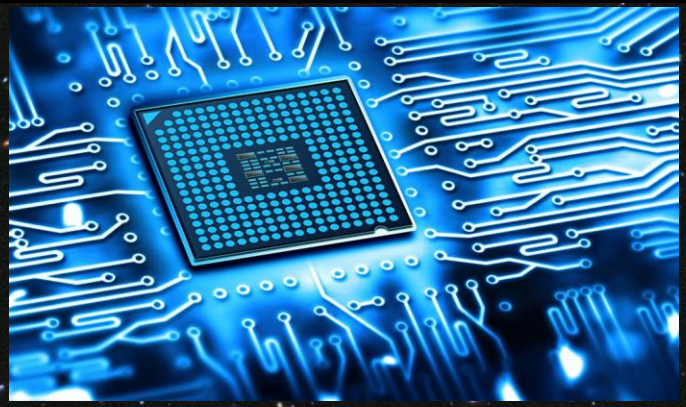

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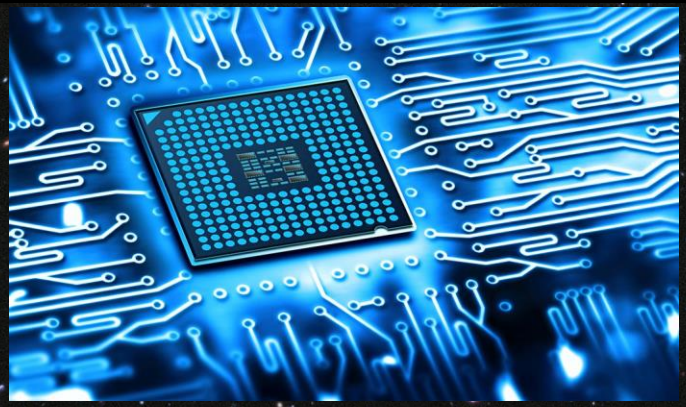
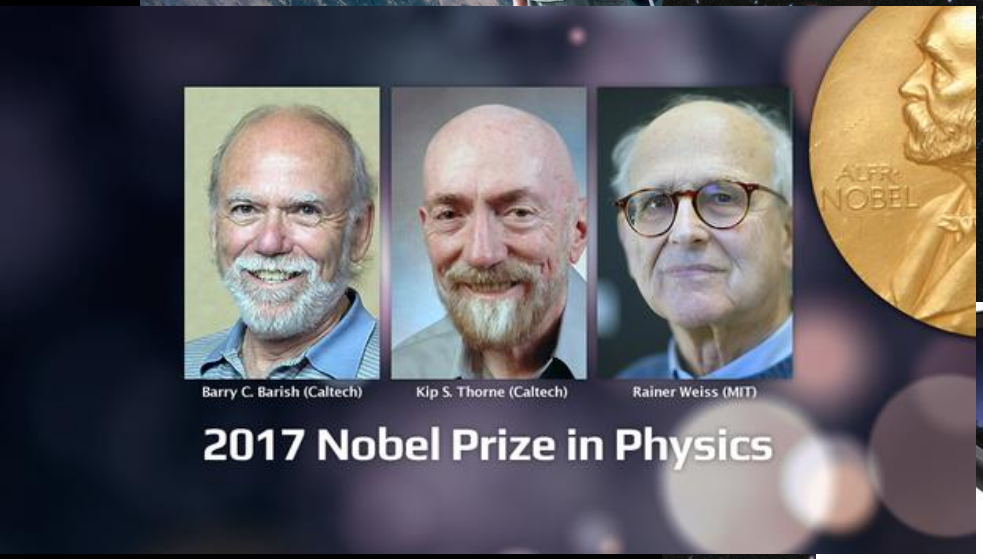
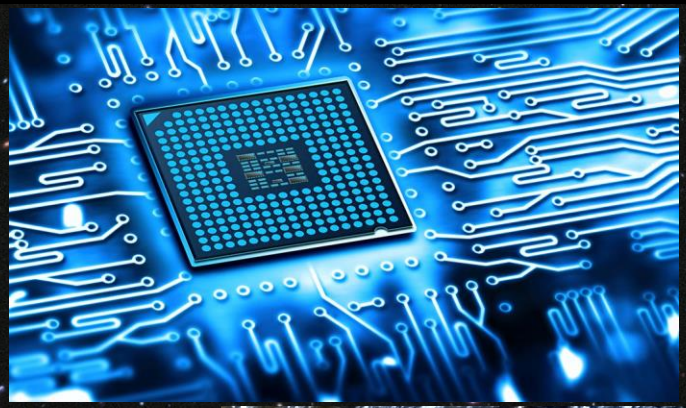
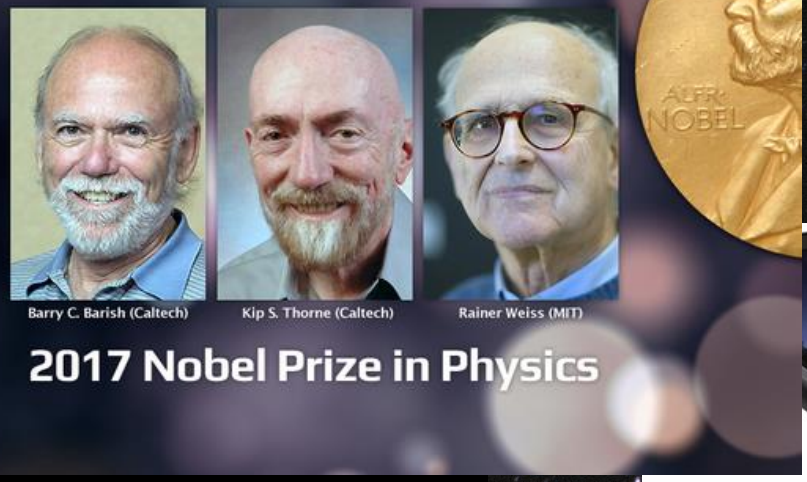



Barry C. Barish (Caltech)
Kip S. Thorne (Caltech)
Rainer Weiss (MIT)
2017 Nobel Prize in Physics

Why?

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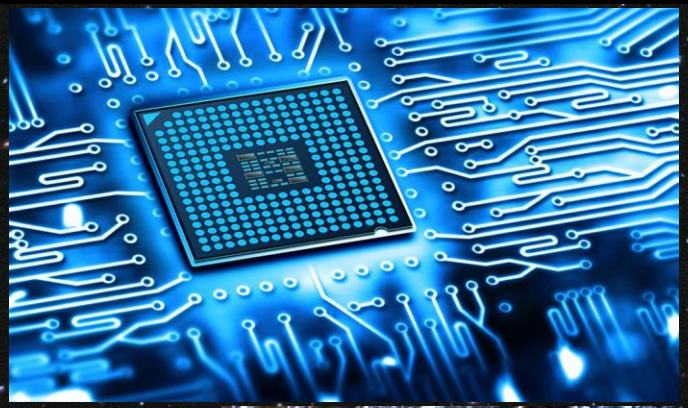
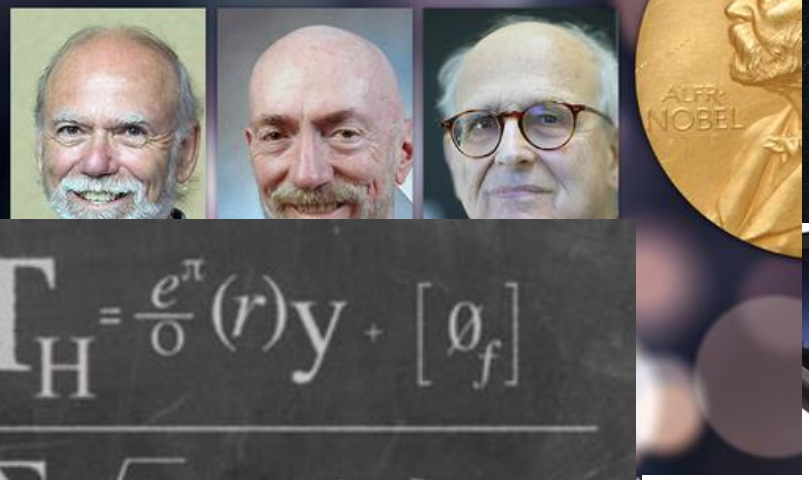
12
45

Why?

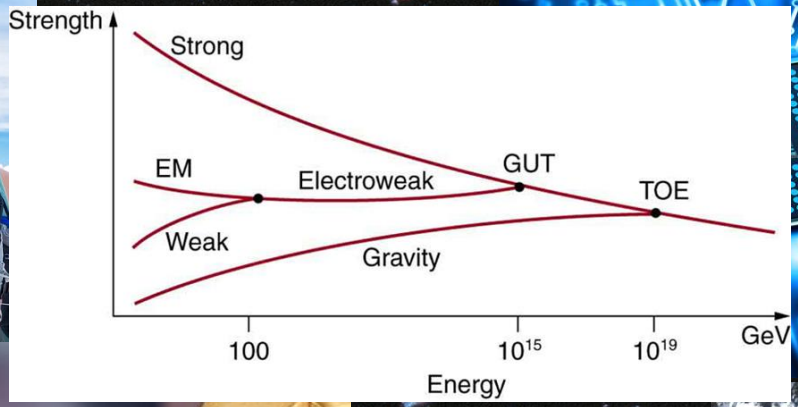


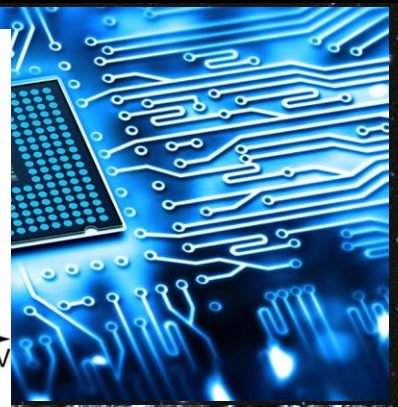

AUFR
NOBEL

$T_H = \frac{e^{\pi}}{o}(r)y + [\emptyset_f]$
$\Sigma\sqrt{e^r} + y^{\tau}\{h_i\} i \frac{n}{g}$

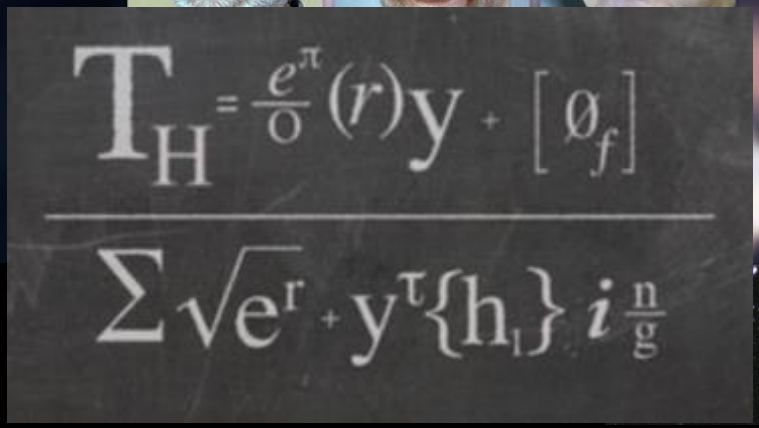

12
45

Why?


Strength
Strong
EM
Electroweak
GUT
TOE
Weak
Gravity
100
10^{15}
10^{19}
GeV
Energy




NOBEL



Find out more

- ligo.caltech.edu/LA
- ligo.org
- Livingston Observatory open the 3rd Saturday of each month… where you can experiment with exhibits & lobby activities & tour our experiment.