Stellar Corpse Collisions

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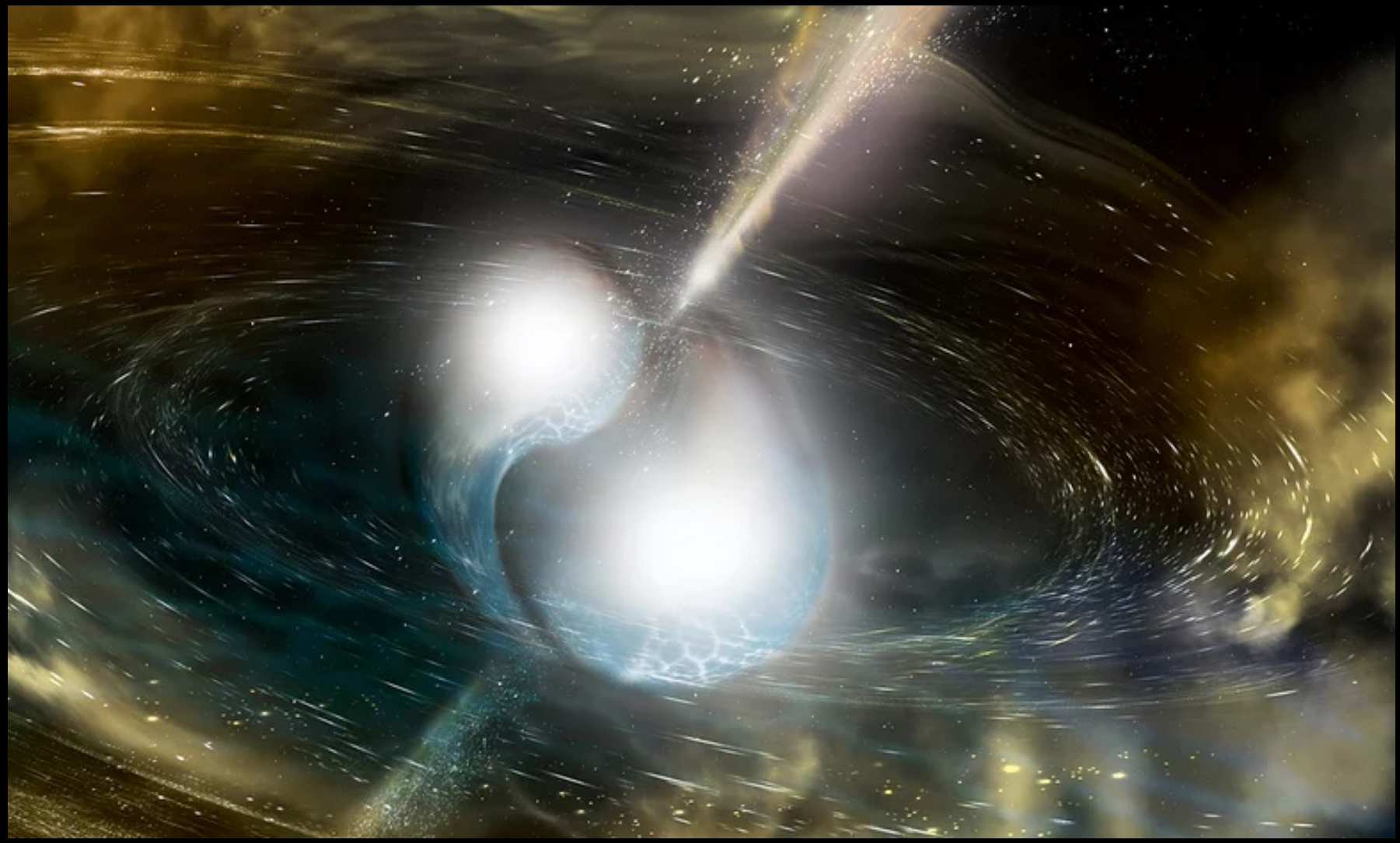
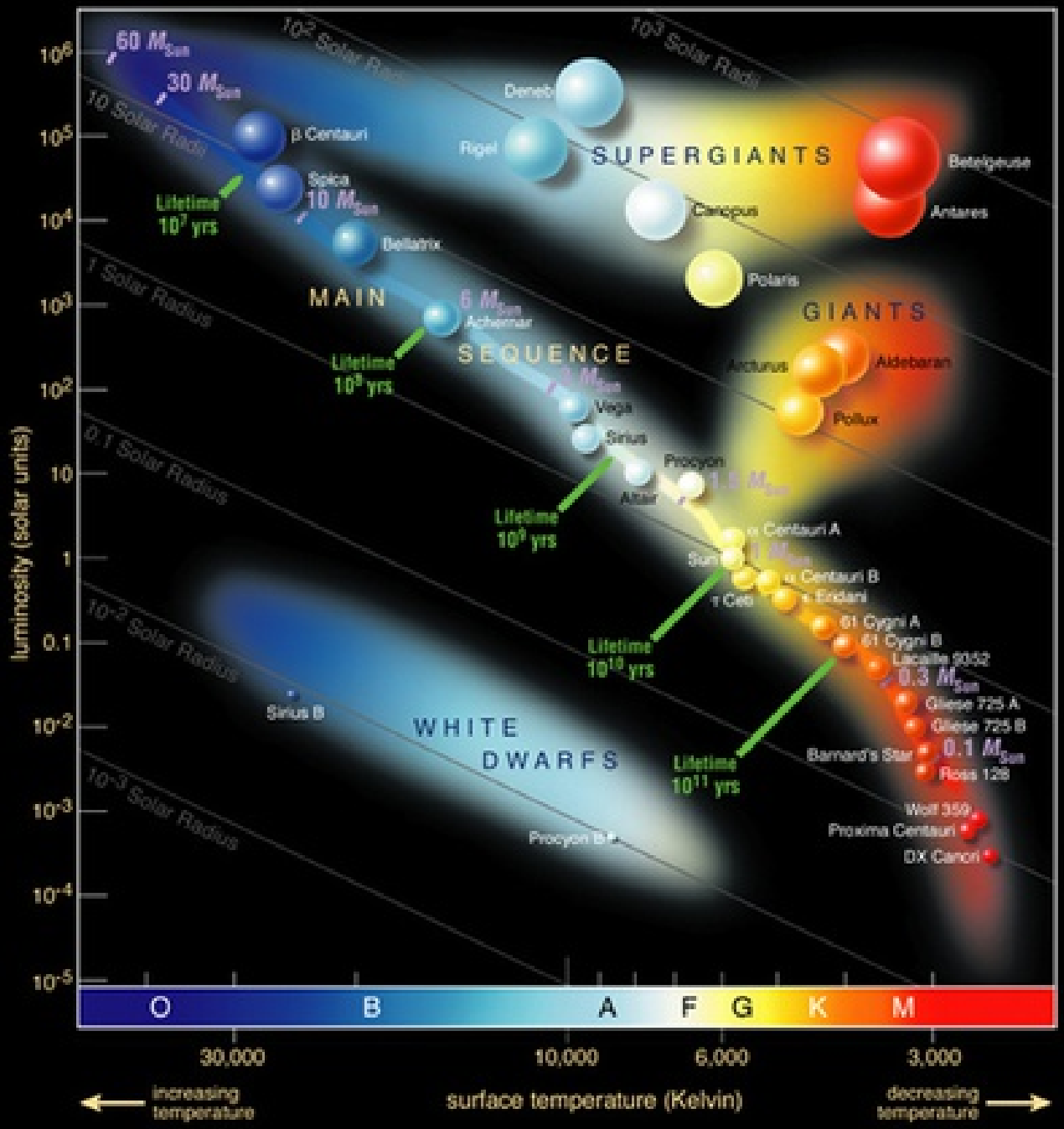


Illustration: A Simonnet/AFP/Getty Images



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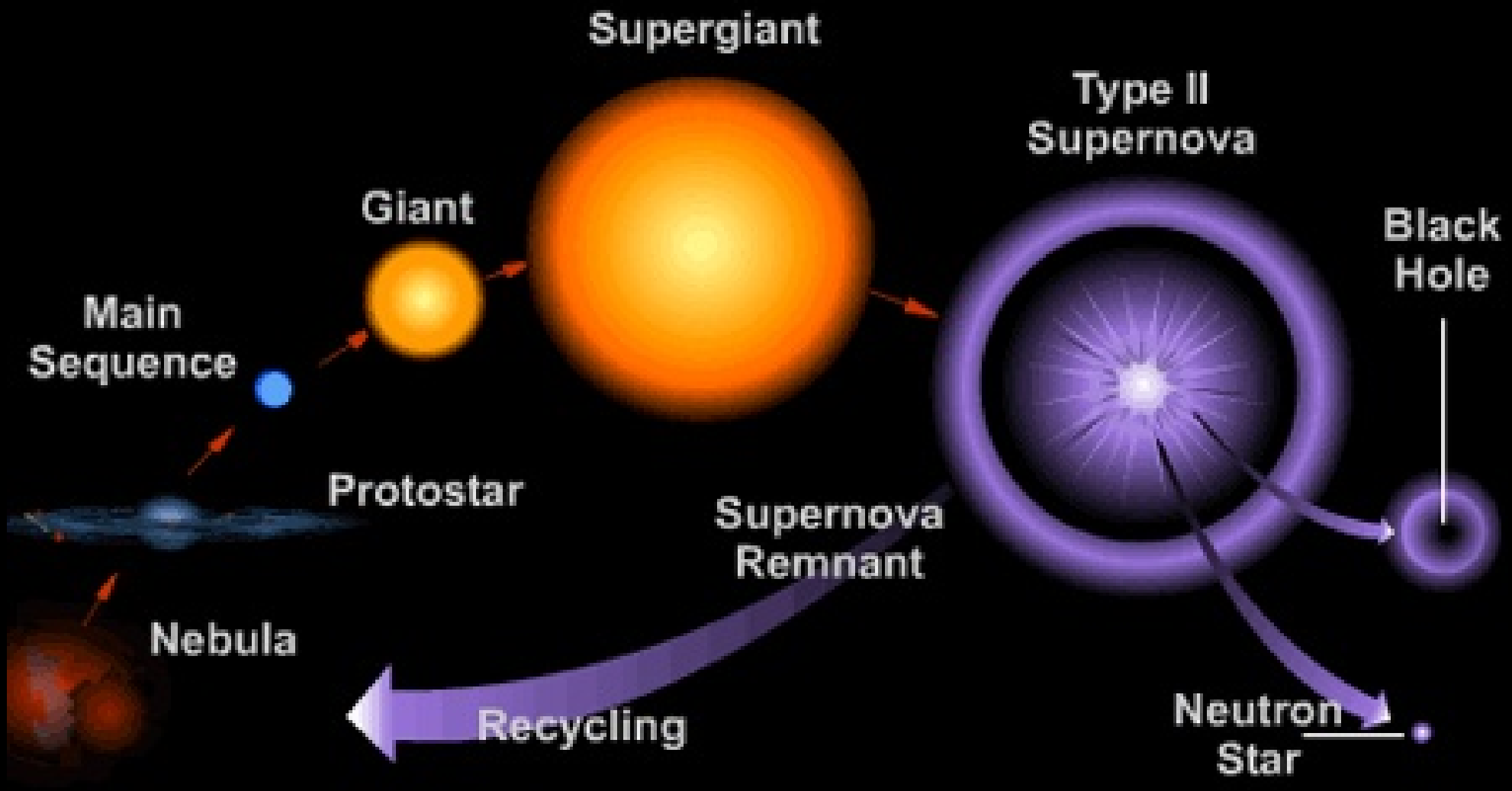
Life Cycle of Massive Stars



Astronomy Online

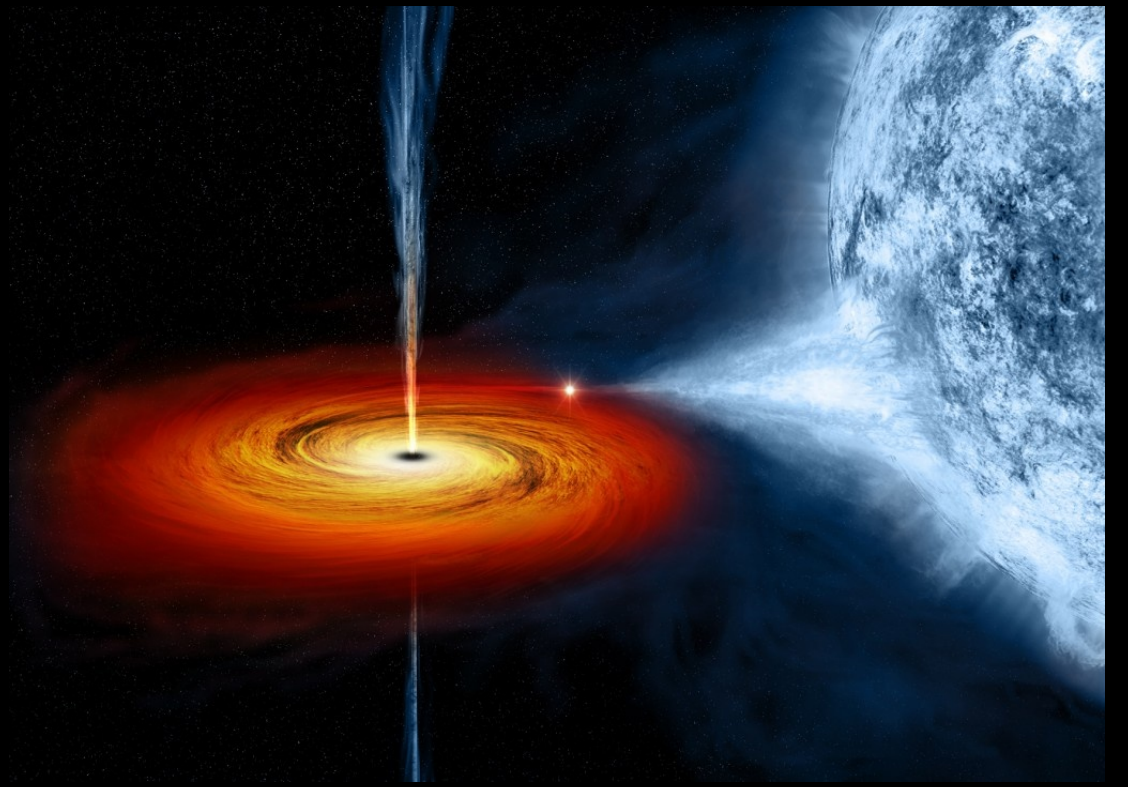
Big Stars Love Binaries!

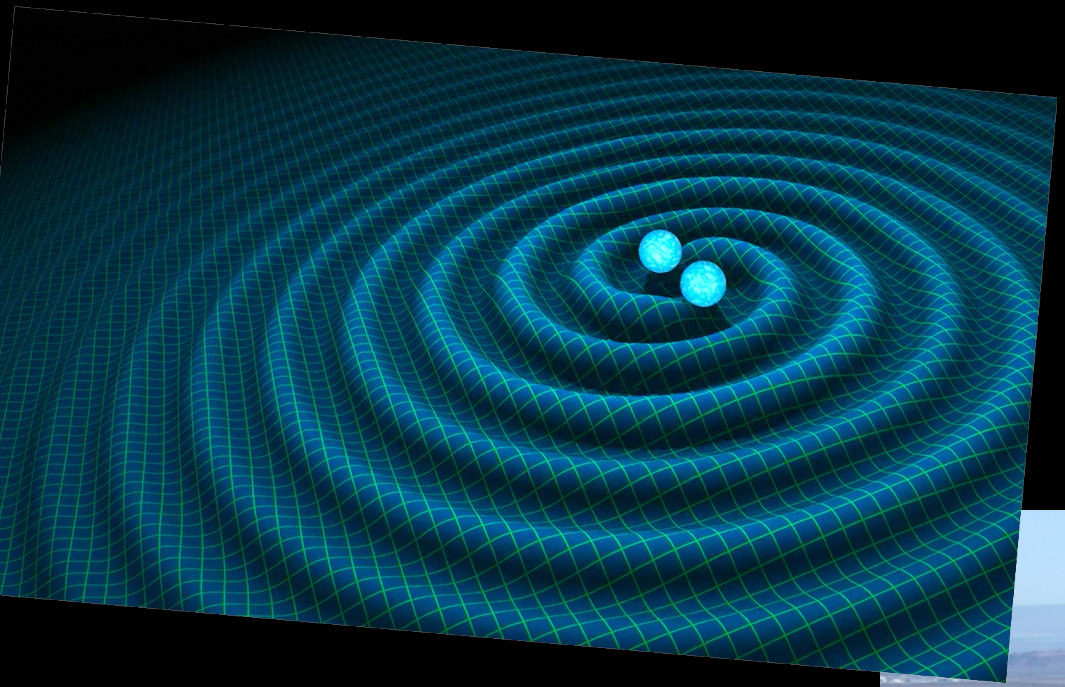
- Most massive stars are in binaries.
- These binaries are close (a <0.25 AU)
  - Mercury's closest approach = 0.31 AU
- Twins are common.

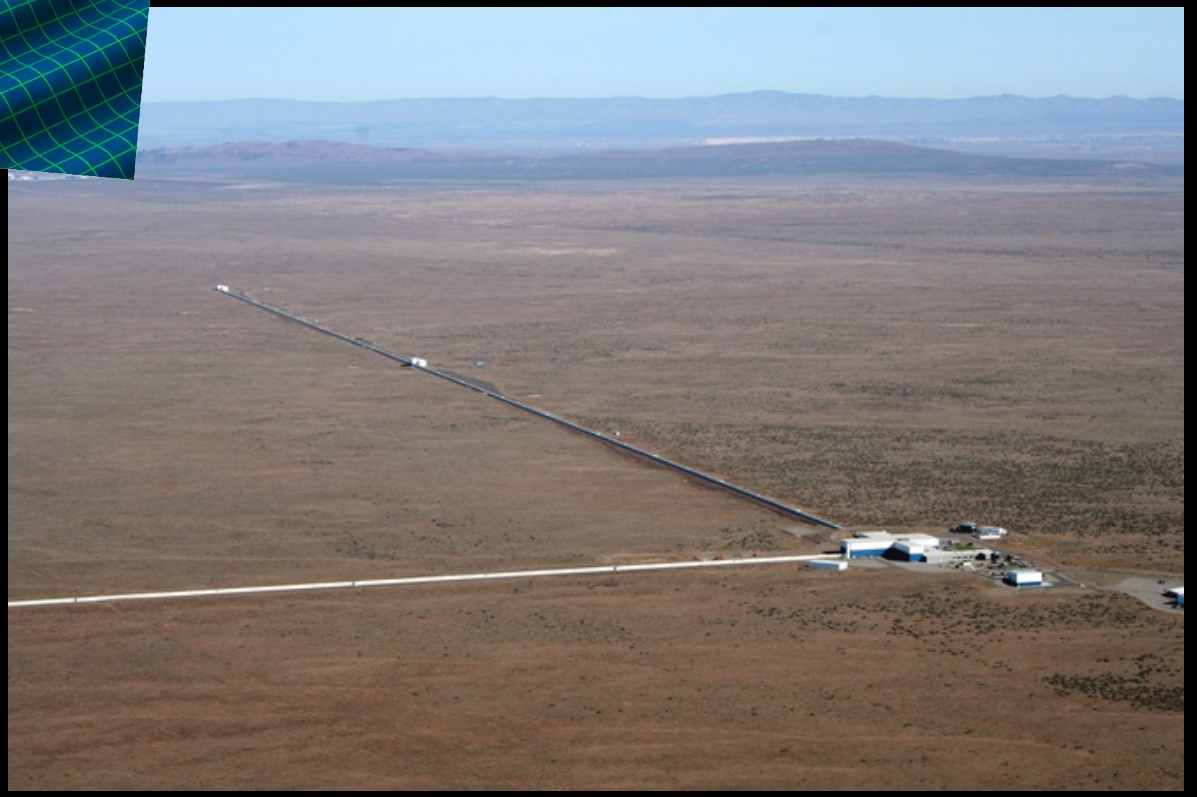
An artist depicts the binary system LH54-425 in the Large Magellanic Cloud
Credit: NASA illustration by Casey Reed.

3 Million years old
Orbit in 2.25 days
64 and 37 Msun

Corpses in Binaries







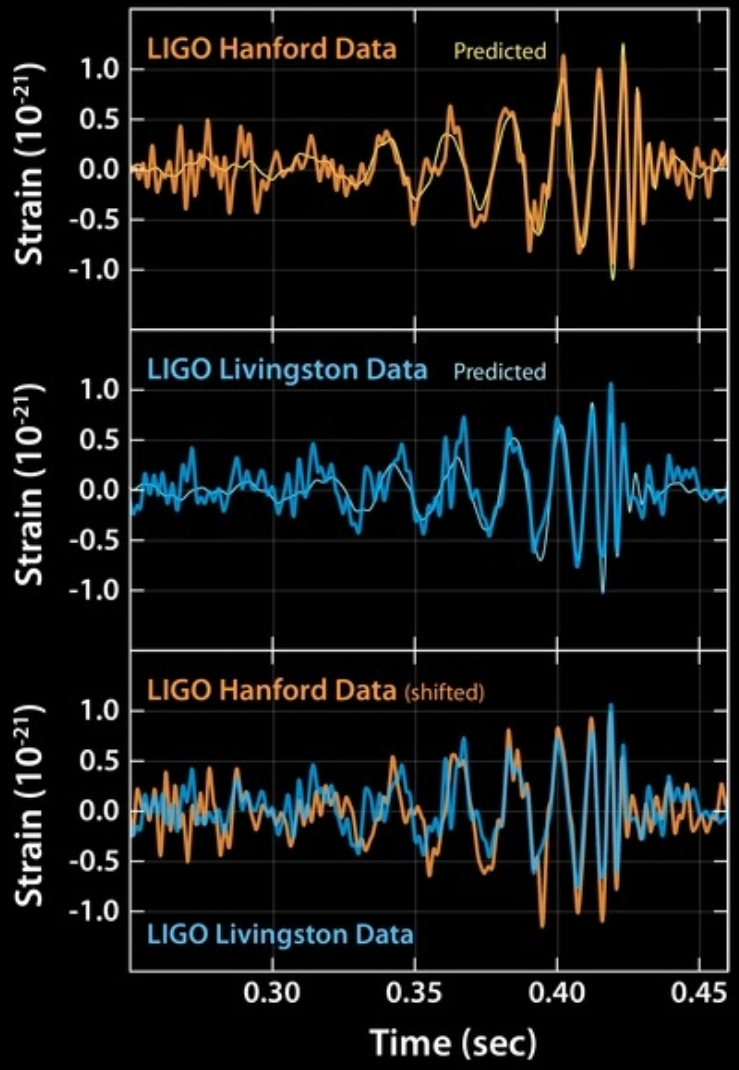
2.5 m long arm of the LIGO Lab in Hanford, WA

Sept. 14, 2015

Suspected “fake” injection.

Black holes with masses of 35 and 30 Msun => 62 Msun

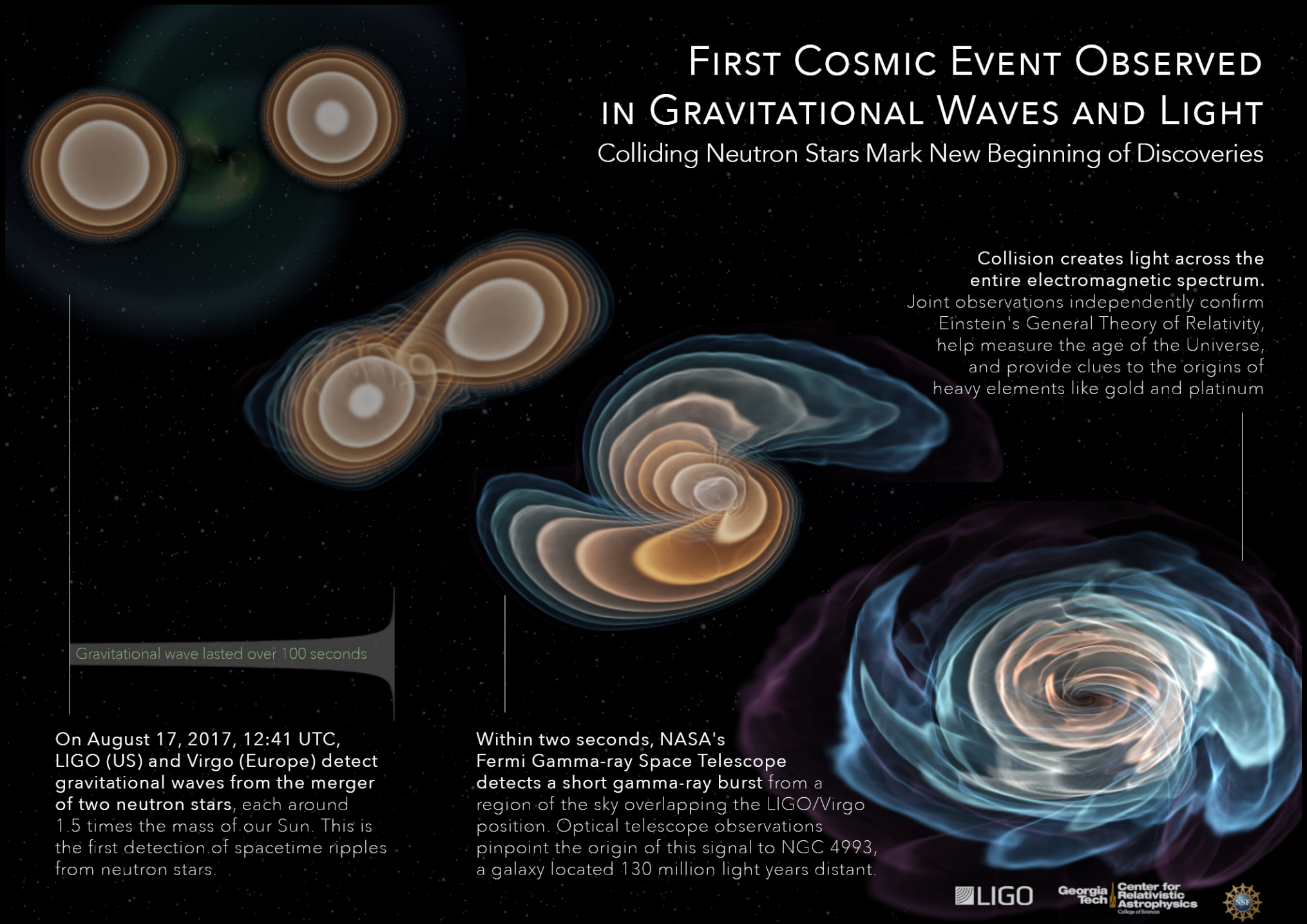
Strain= change in distance/ separation.



Decades of planning and you win a nobel prize in under half a second.

First Cosmic Event Observed in Gravitational Waves and Light

Colliding Neutron Stars Mark New Beginning of Discoveries



Collision creates light across the entire electromagnetic spectrum. Joint observations independently confirm Einstein's General Theory of Relativity, help measure the age of the Universe, and provide clues to the origins of heavy elements like gold and platinum

Gravitational wave lasted over 100 seconds

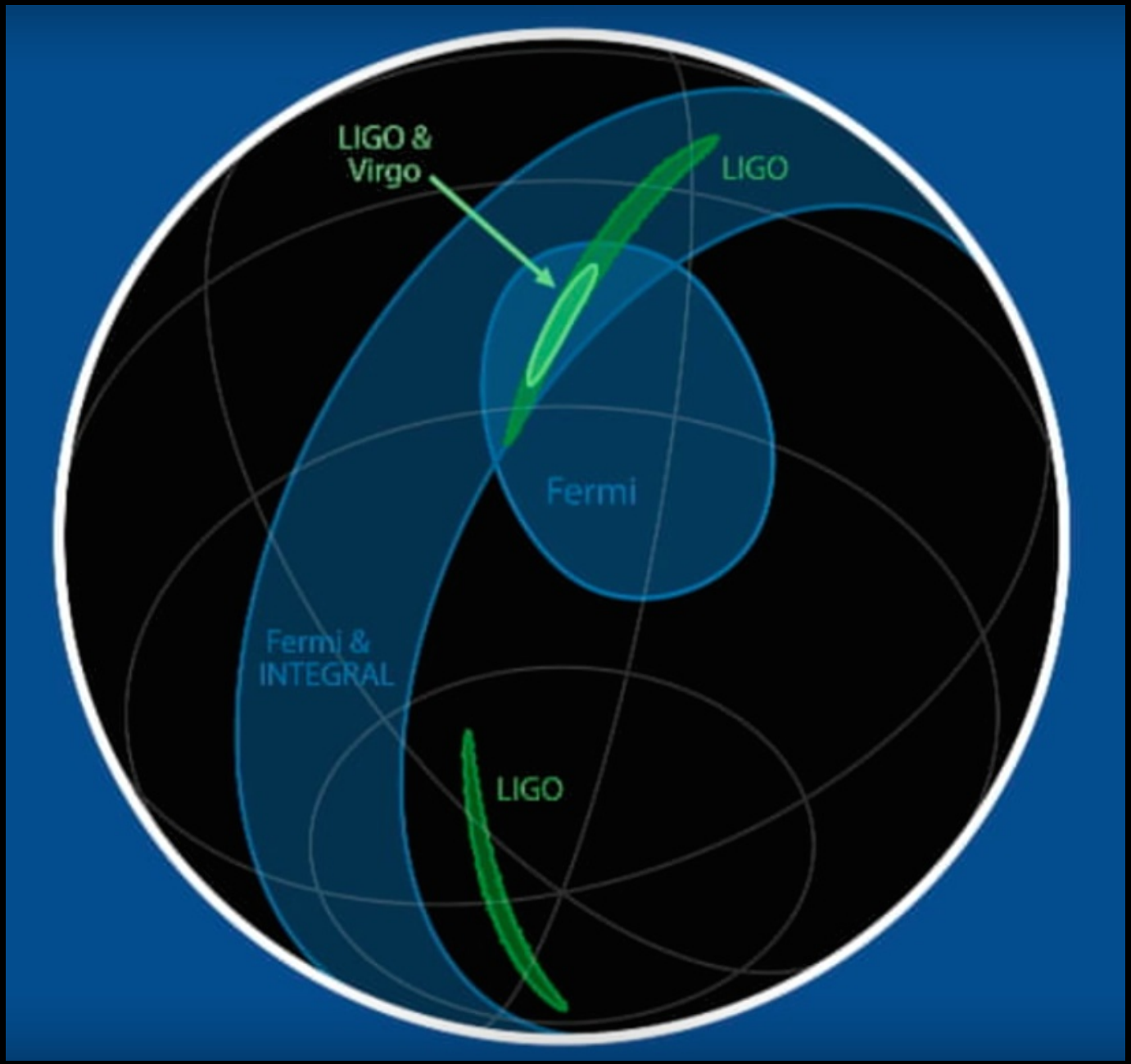
On August 17, 2017, 12:41 UTC, LIGO (US) and Virgo (Europe) detect gravitational waves from the merger of two neutron stars, each around 1.5 times the mass of our Sun. This is the first detection of spacetime ripples from neutron stars.

Within two seconds, NASA's Fermi Gamma-ray Space Telescope detects a short gamma-ray burst from a region of the sky overlapping the LIGO/Virgo position. Optical telescope observations pinpoint the origin of this signal to NGC 4993, a galaxy located 130 million light years distant.

LIGO

Georgia Tech Center for Relativistic Astrophysics College of Sciences

NSF

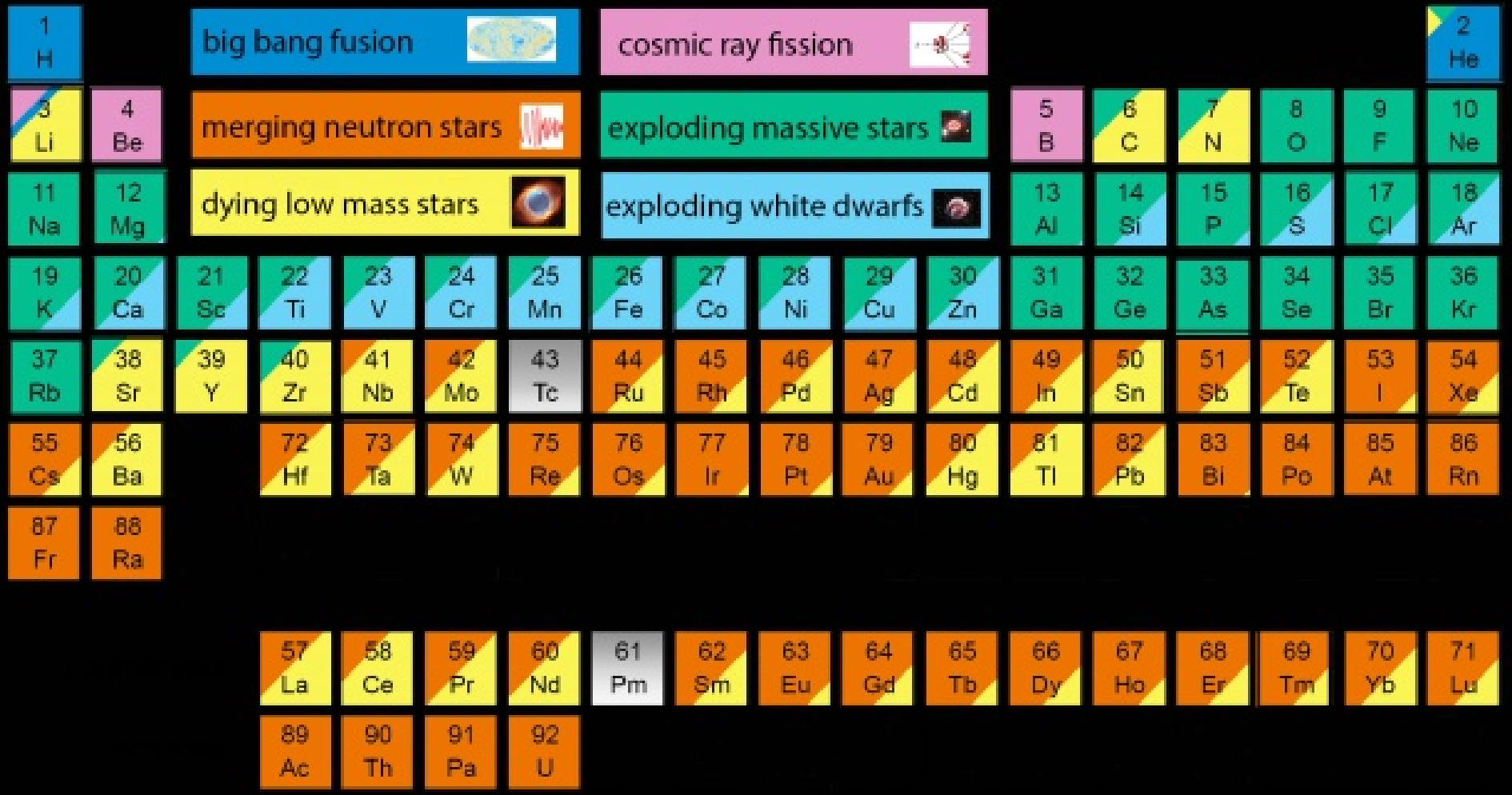


Source: Veritasium; YouTube

On August 17, 2017 ,LIGO detected gravitational waves from a neutron star collision. Within 12 hours, observatories had identified galaxy NGC 4993 as the source. Hubble observed that flare of light fade over the course of 6 days, as shown in these observations taken on August 22, 26, and 28 (insets).

Credits: NASA and ESA
Acknowledgment: A. Levan (U. Warwick), N. Tanvir (U. Leicester), and A. Fruchter and O. Fox (STScI)

The Origin of the Solar System Elements



Graphic created by Jennifer Johnson

Astronomical Image Credits:
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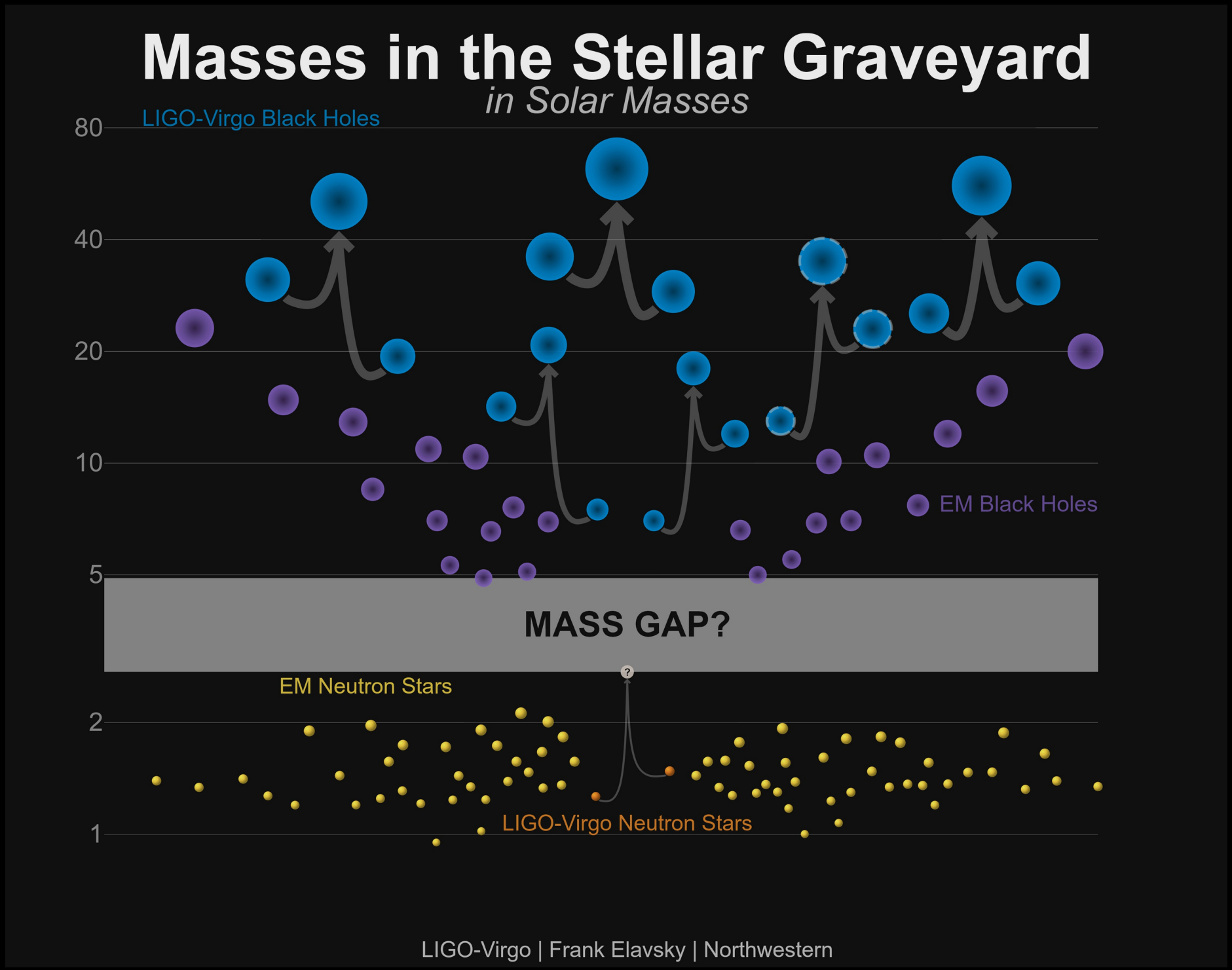
Masses in the Stellar Graveyard
in Solar Masses
LIGO-Virgo Black Holes
80
40
20
10
5
2
1
EM Black Holes
MASS GAP?
EM Neutron Stars
?
LIGO-Virgo Neutron Stars
LIGO-Virgo | Frank Elavsky | Northwestern