Kilonova:
A New Era in Astronomy

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Multi-Messenger Astronomy using Gravitational Wave Observatories

Large Interferometric Gravitational Wave Observatory

LIGO – Hanford, WA

LIGO – Livingston, LA

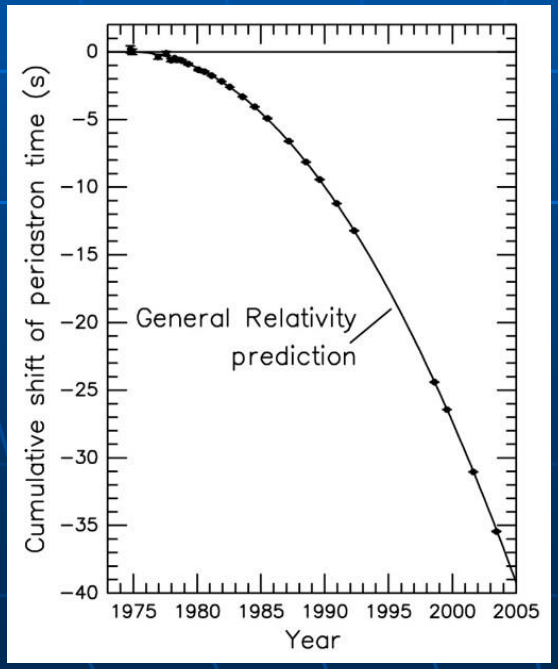
Virgo Observatory

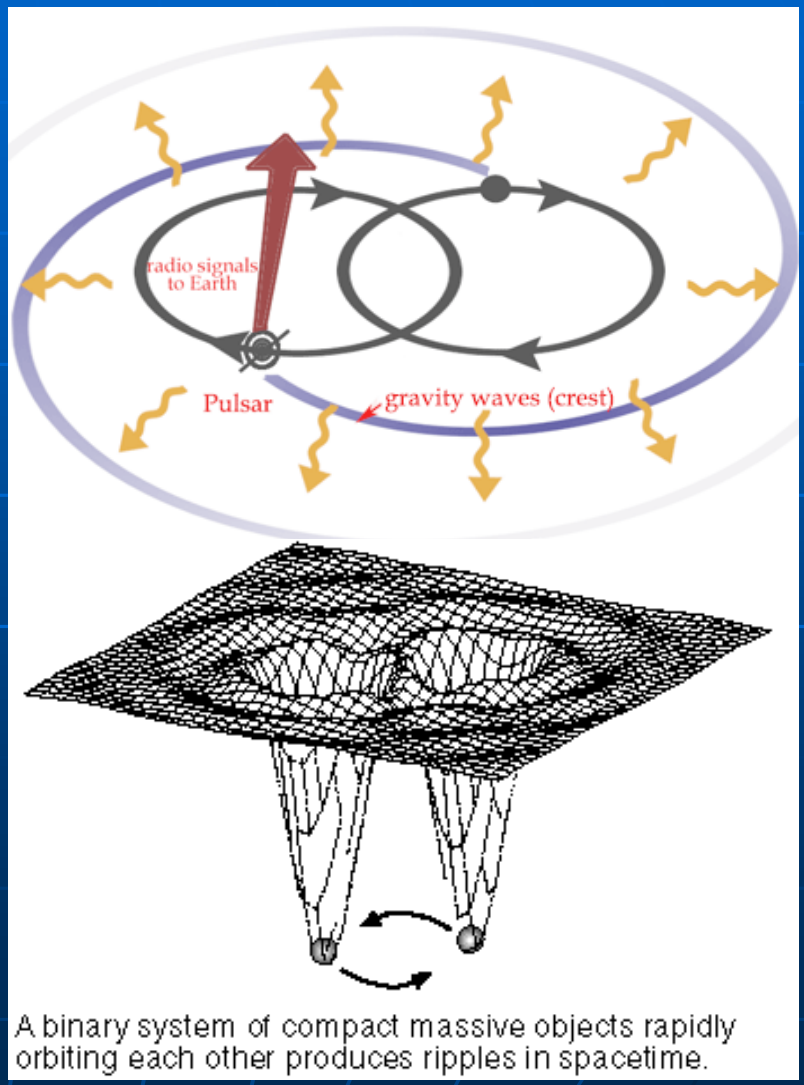
Pisa, Italy

Sources of Gravitational Waves (GW)

General Relativity predicts GW emitted by Accelerated Mass, e.g. rapidly orbiting binary neutron stars (pulsars), producing orbital decay.

Taylor & Hulse, Nobel Prize 1993

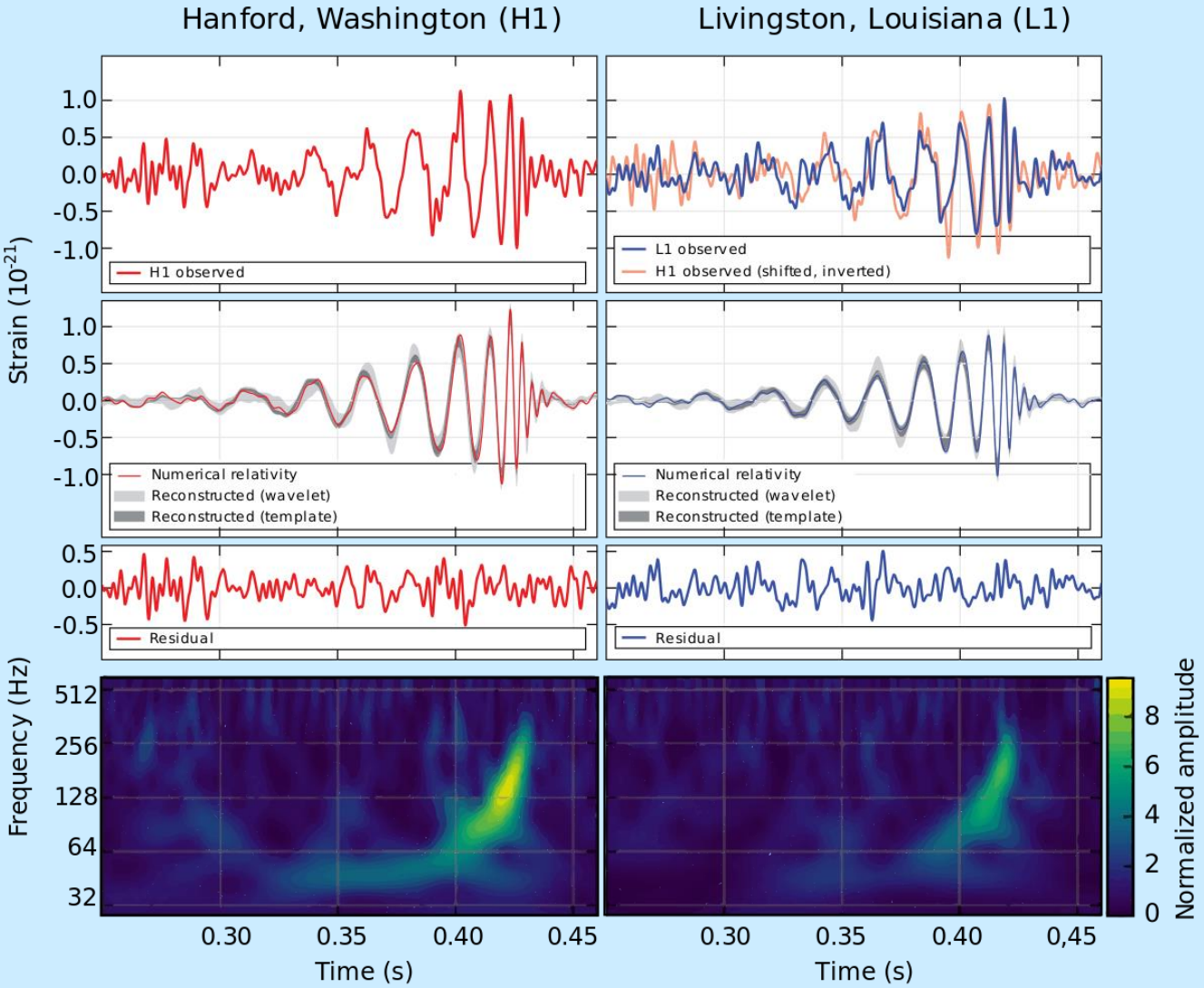




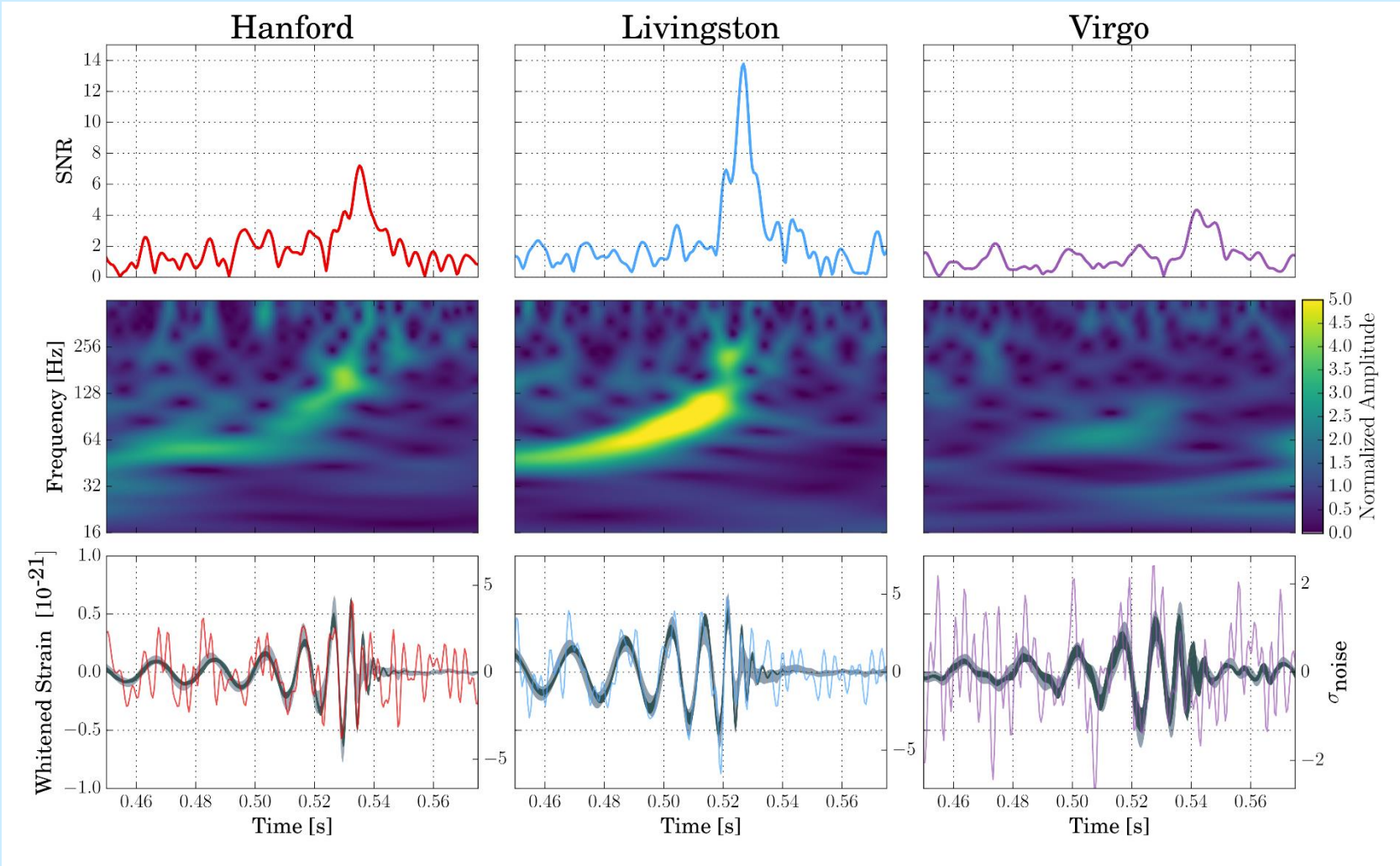
A binary system of compact massive objects rapidly orbiting each other produces ripples in spacetime.

GW Strength & Frequency Increase as Binary System Approaches Merger

LIGO Signals on Sept. 14, 2015 implied Distant Black Hole Merger

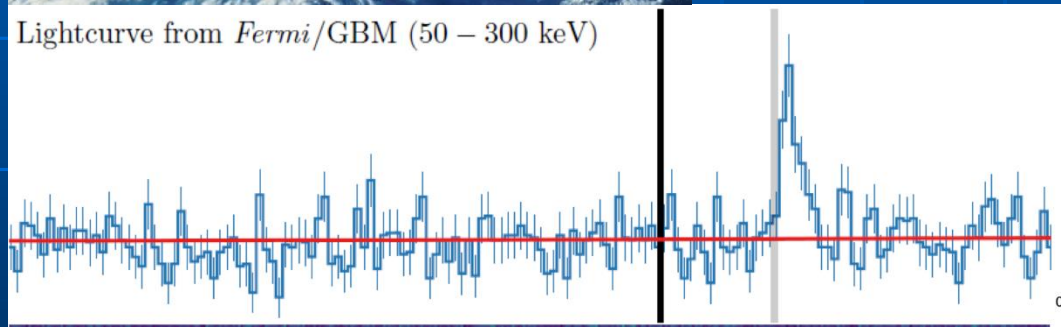


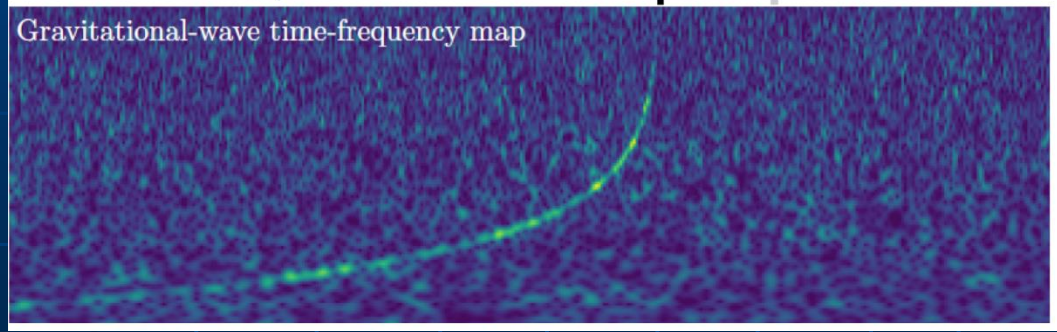
LIGO – Virgo Signals on Aug 17, 2017

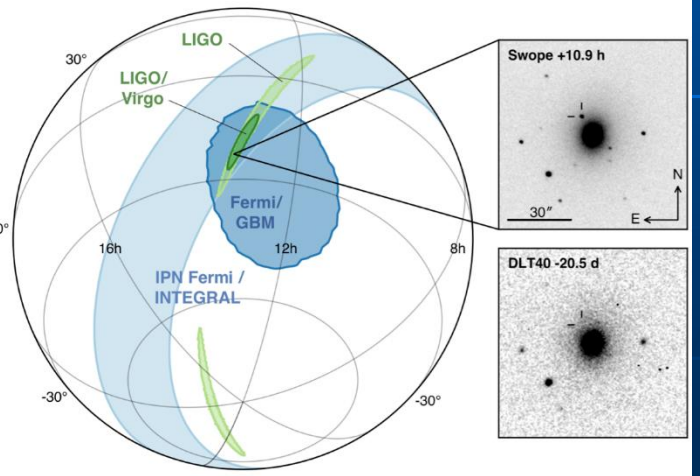


Fermi Gamma Space Telescope sees Signal just 1.7 sec later!

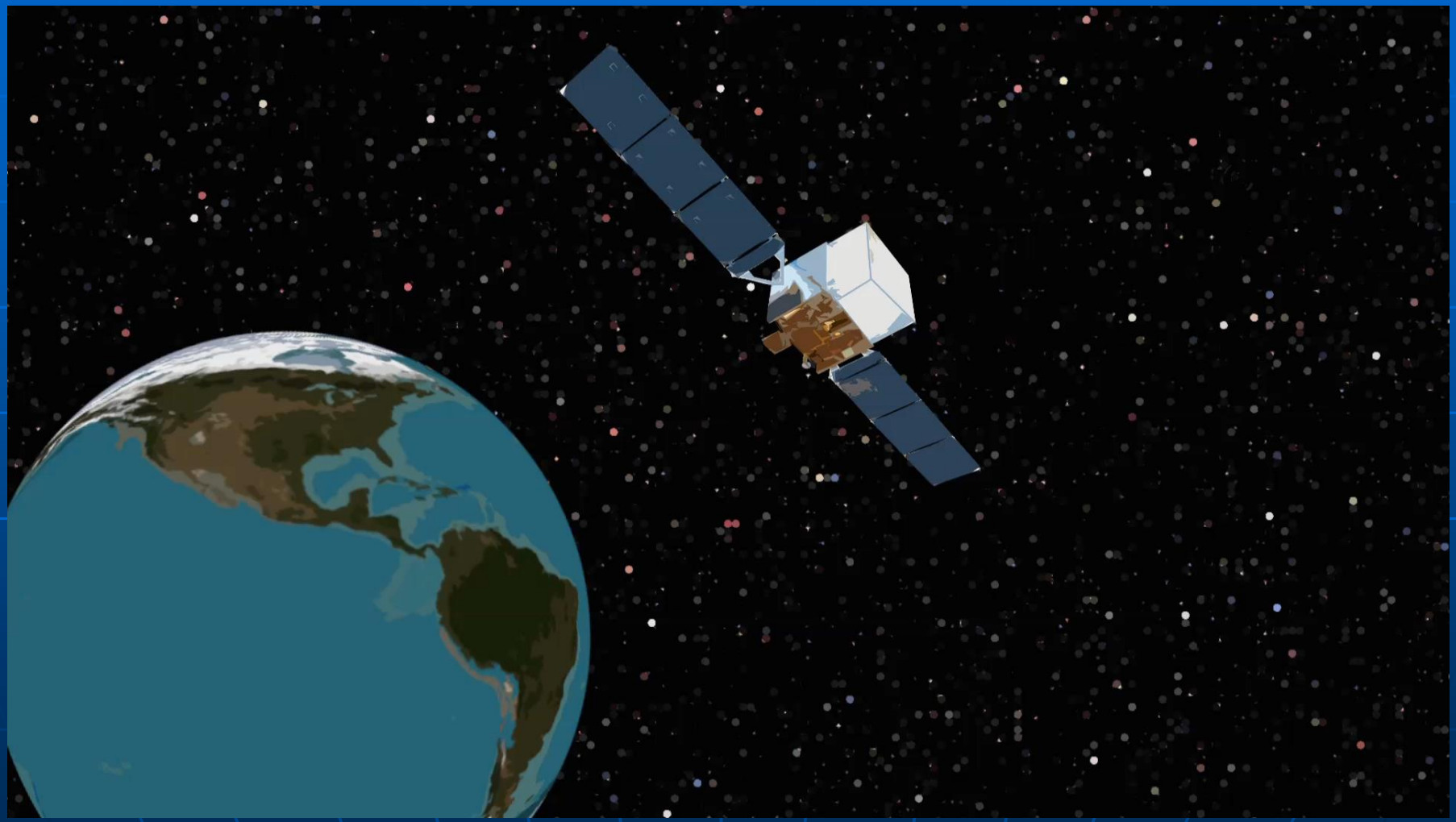
Fermi localizes gamma signal to same region of sky as LIGO/Virgo GW signal – likely same source!



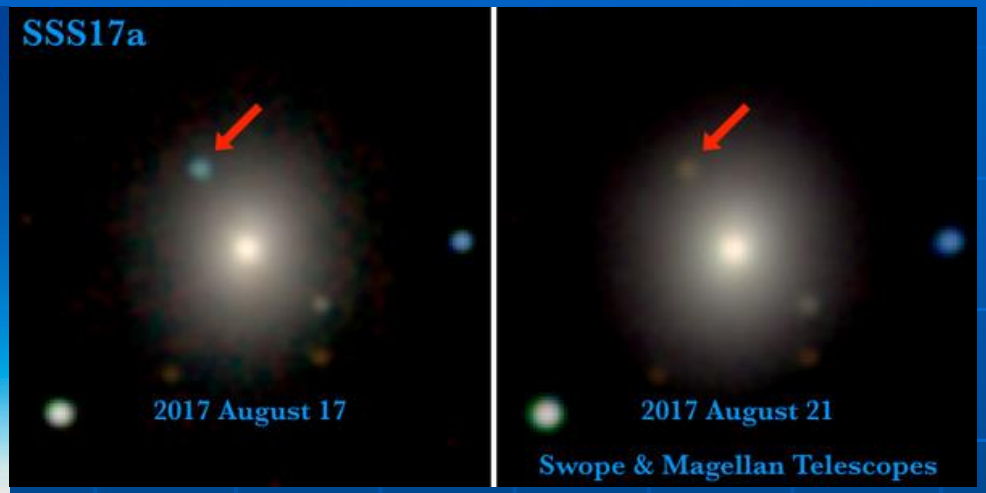




The Era of Multi-Messenger Astronomy



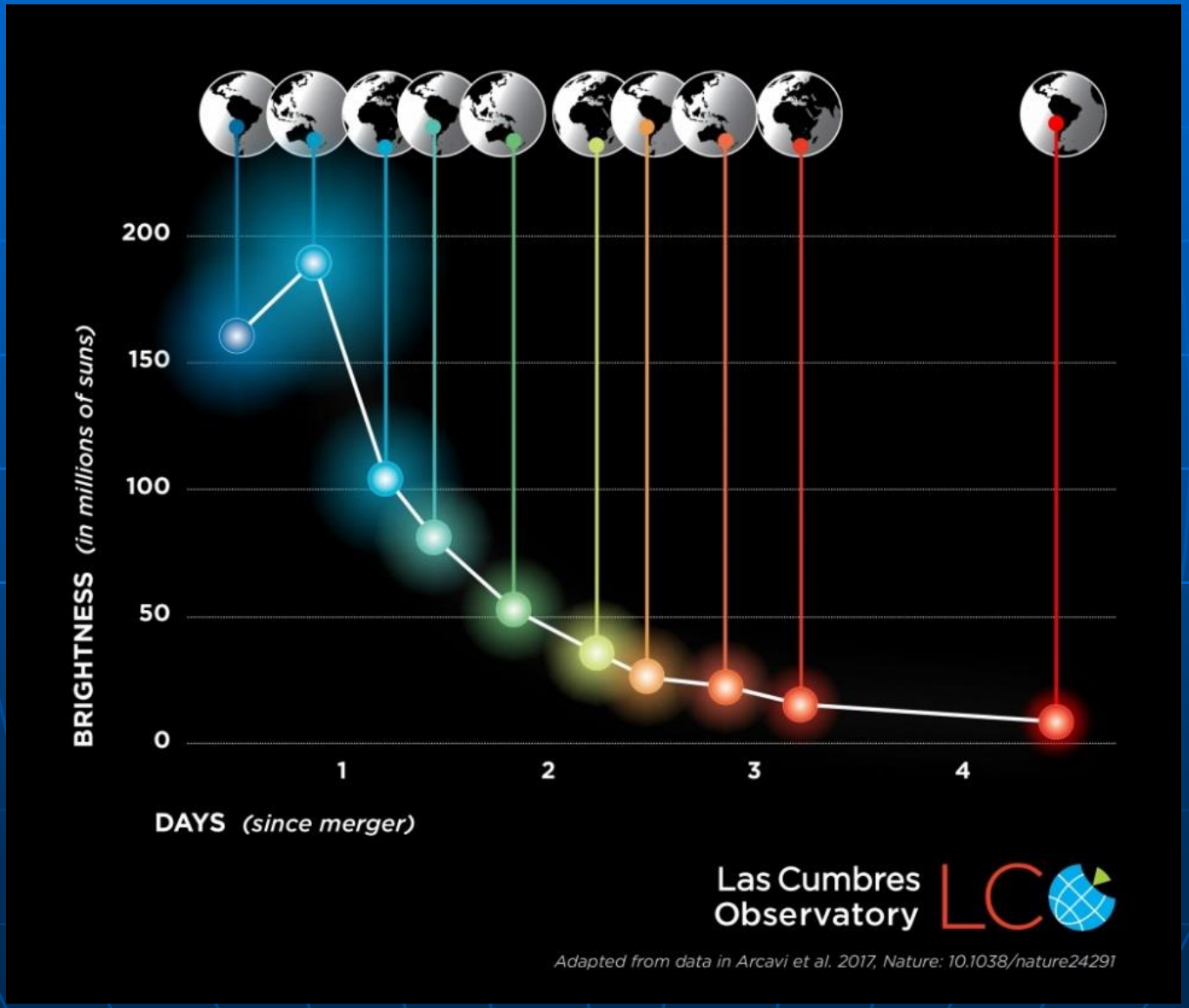
Swope Telescope in Chile Finds New Light Source



After 10 hours a new light source is found in the constellation Hydra on the outskirts of galaxy NGC 4993

Accompanying Light Signals in addition to the lengthy 100 second long GW Signals strongly suggest Merging Binary Neutron Star System – Kilonova!

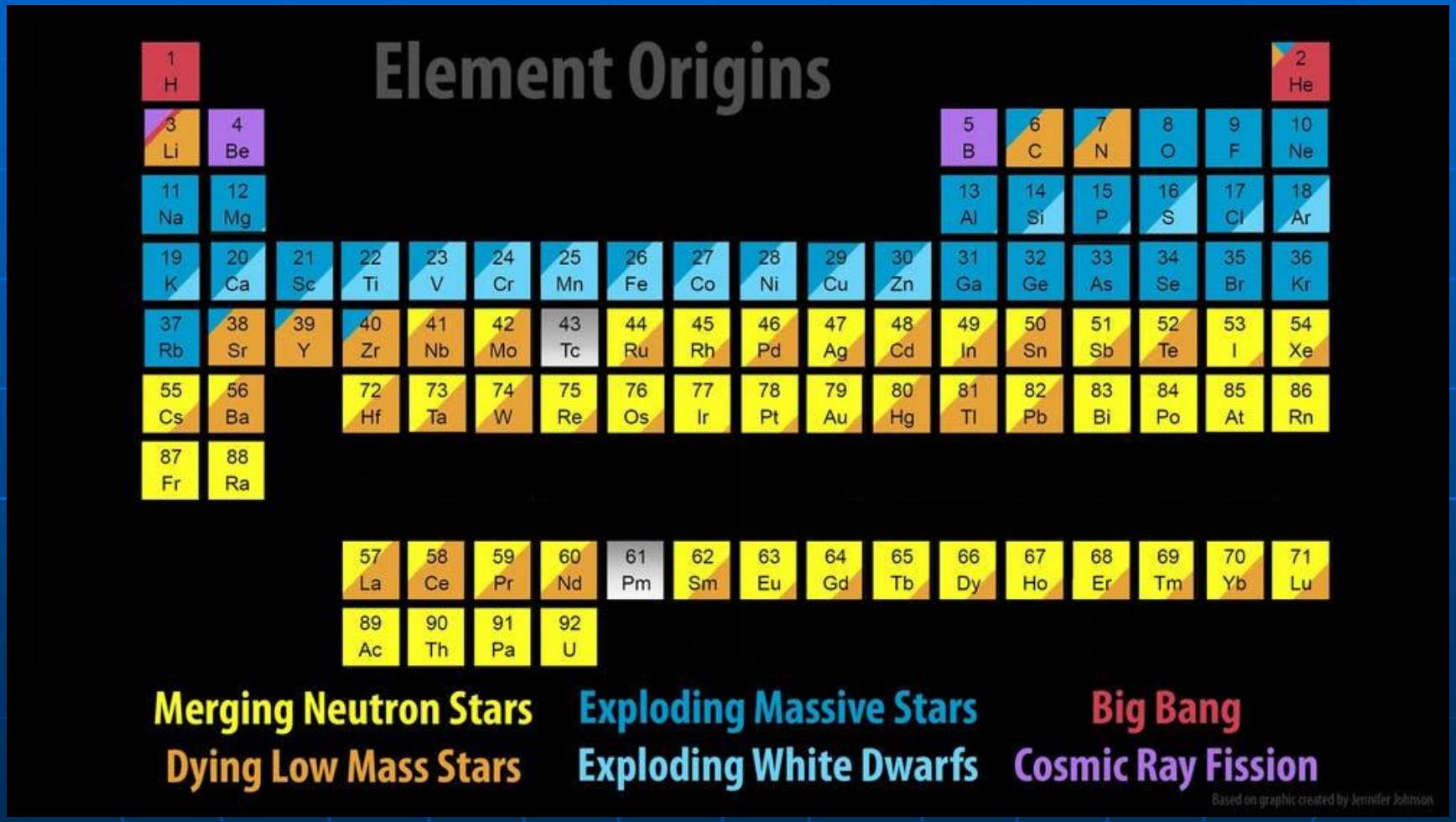
Ground-Based Observatories



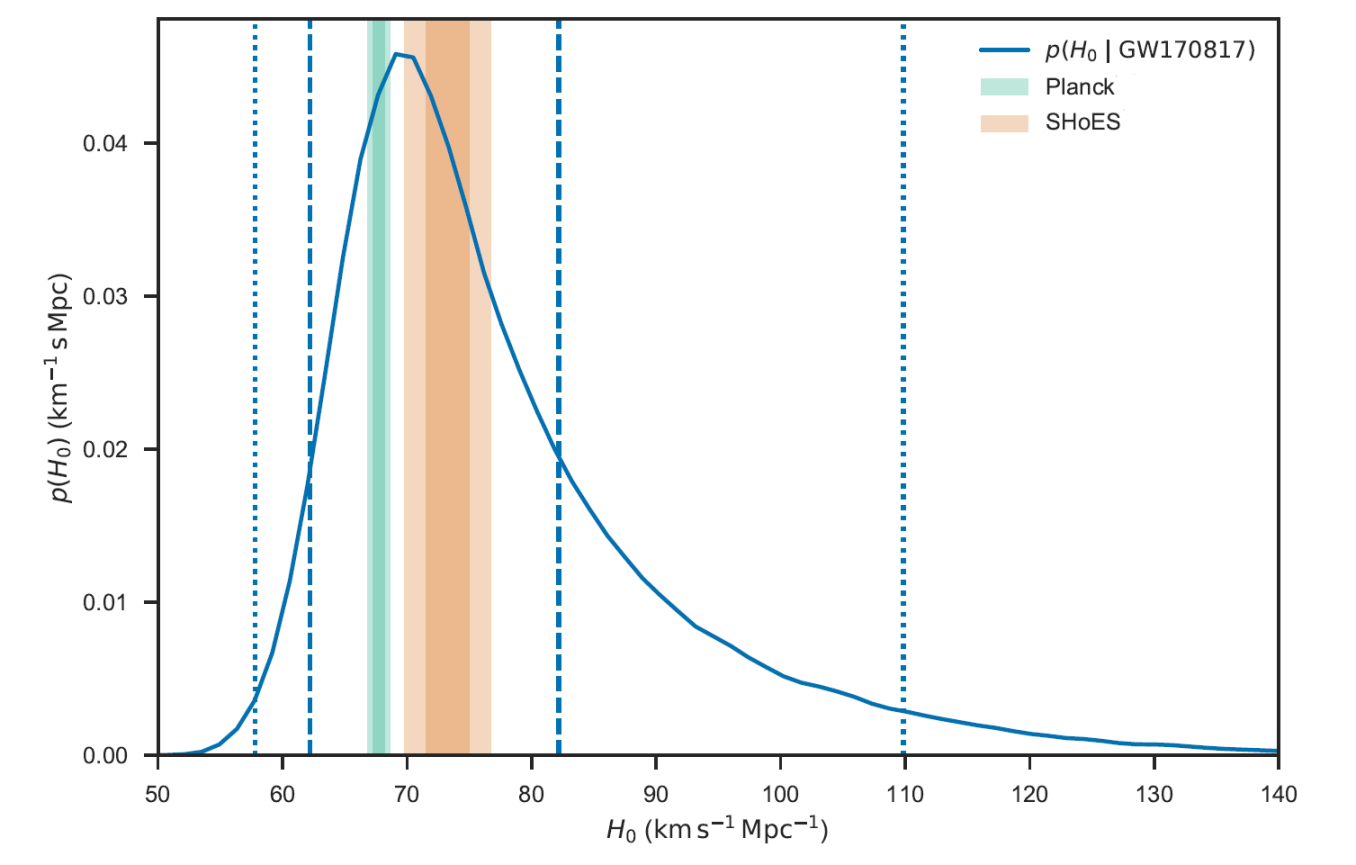
Modeling the Kilonova Event

Kilonova – Site of R-Process Nucleosynthesis of Heavy Elements

New Version of Origin of Elements



Hubble Expansion Rate Using GW Signal Strength



Conclusion: Kilonova
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