A LONG JOURNEY OF GRAVITATIONAL WAVES

Gravitation and Astrophysics Group

Y.Xu, C.García-Quirós, S.Tiwari, P.Jetzer

Universität Zürich[UZH]

SCAN ME

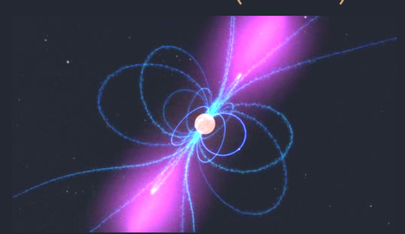
A long time ago in a galaxy far, far away ...

Strong gravitational waves can be produced by catastrophic events, such as colliding black holes and neutron stars, pulsars, supernovae, or gravitational radiation left over from the Big Bang.

Coalescing Compact Binaries

Credit: Dana Berry, SkyWorks Digital, Inc.

Rotating Stars (Pulsars)

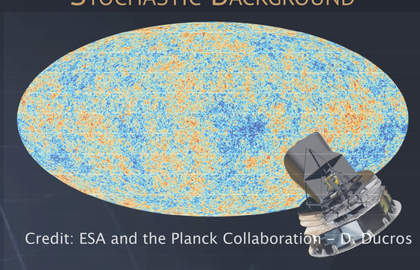


Credit: NASA/Goddard Space Flight Center CIL

Supernova Explosions

Credit: NASA, ESA, J. Hester and A. Loll

Stochastic Background



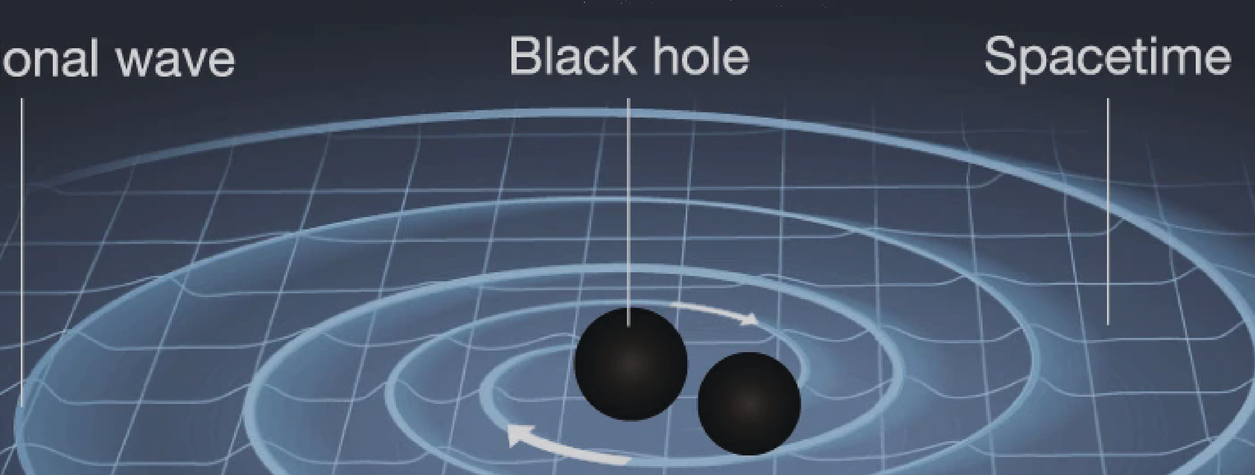
Credit: ESA and the Planck Collaboration - D. Ducros

Gravitational wave

Gravitational waves are ripples in spacetime, traveling at the speed of light. They will disturb the spacetime thus any object in the path will get squeezed and stretched as the waves pass by.

Black hole

Spacetime



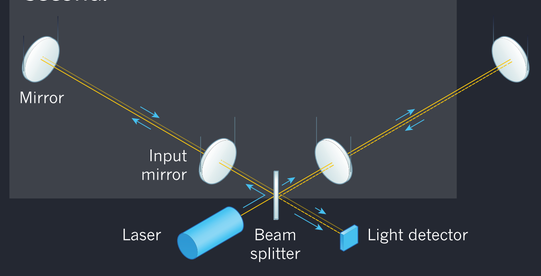
Credit: ©Johan Jarnestad

When gravitational waves reach us from billions of light years away, they distort spacetime by an almost negligible amount. This distortion is many times smaller than the size of a proton nucleus. However, with the detectors targeting different frequency bands, they can still be measured...

1 $M_\odot$–10^2 $M_\odot$	$10^4 M_\odot$–$10^7 M_\odot$	$10^7 M_\odot$–$10^{10} M_\odot$	Primordial Gravitational Waves
1000 Hz – 10 Hz	100 mHz – 0.1 mHz	320 nanoHz – 1 nanoHz	10^{-13} Hz – 10^{-16} Hz

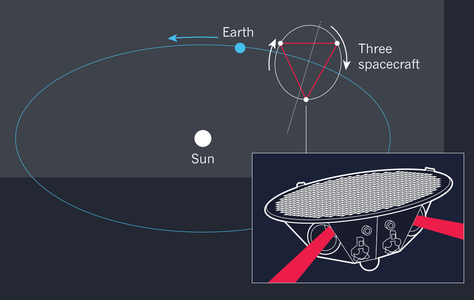
Ground Based Detector

Current and future ground based observatories such as LIGO, Virgo, and Einstein Telescope can detect longer wave-lengths than the detectors' lengths (a few kilometres), corresponding to periods of a few hundredths to a few thousandths of a second.



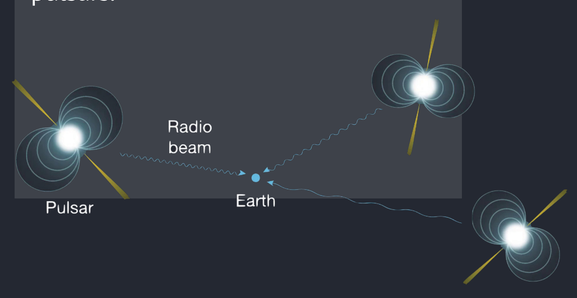
Space Detector

LISA, a trio of probes scheduled to launch in 2034, will have virtual arms millions of kilometres long, making it sensitive to waves with periods of a few seconds up to several hours. This will allow us to detect gravitational waves from supermassive black holes.



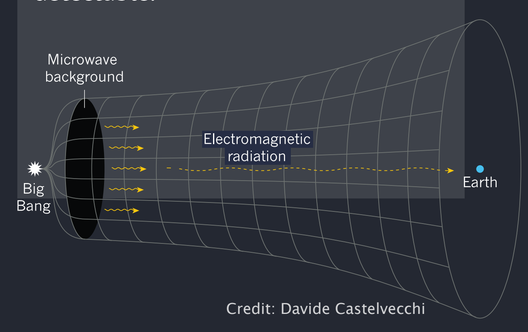
Pulsar Timing Array

Gravitational waves from distant galaxies perturb the distance between Earth and stars in the Milky Way. The goal is to detect waves of periods lasting years by examining delays in the radio signals from spinning neutron stars known as pulsars.



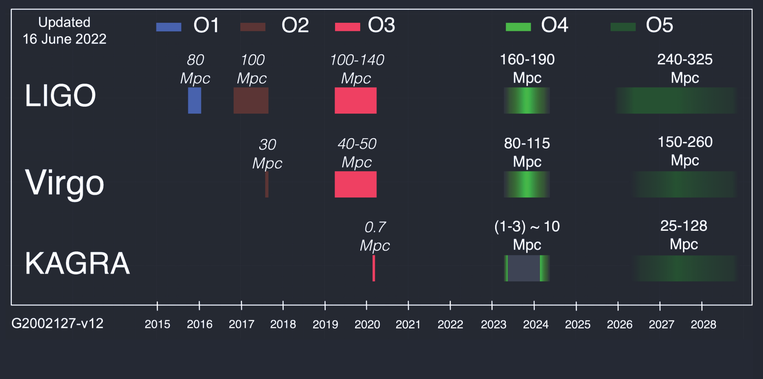
Microwave Background

The Universe's oldest measurable radiation could carry evidence of gravitational waves from the Big Bang. Those waves would not be detectable directly. However, their stretch across a significant fraction of the observable Universe could be detectable.

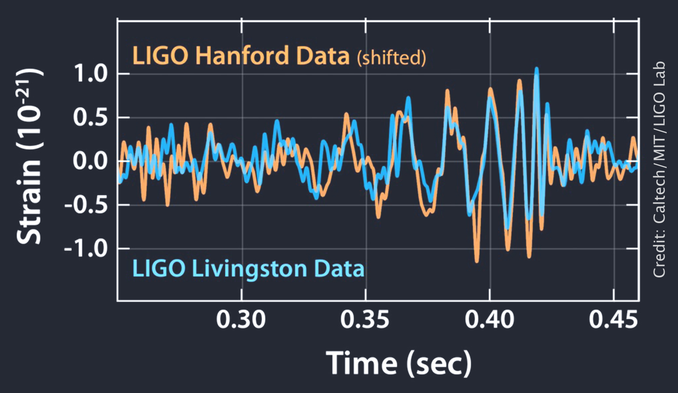


Credit: Davide Castelvecchi

Global Gravitational Waves Detector Network



"Sounds" from space



Gravitational Waves Detections: Masses in the Stellar Graveyard