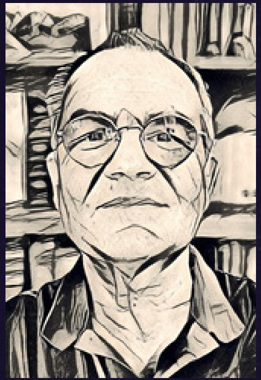
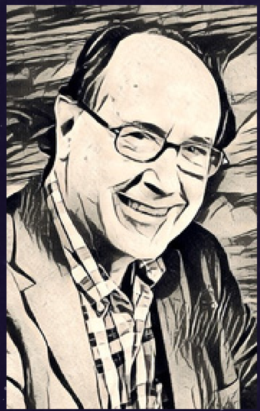


Stefano Vitale

P.I. of LISA Pathfinder (2015-2017), which was designed to test the innovative technology necessary to observe gravitational waves in space, leading to outstanding results.

Bernard Schutz



During the last 40 years his research focused on the physics behind GW sources . In 1994 he was part of the team that proposed the LISA project. His group laid the foundations for the data analysis methods that LISA will use.

Alessandra Buonanno

In the last 20 years, she focused her studies on theoretical modeling of gravitational waves emitted by binary systems of compact objects, to deepen our knowledge of the nature of black holes and gravity.

image credits: https://www.elisascience.org

Getting together
9:00-9:30

"LISA IN THE CONTEXT OF ESA's SPACE MISSIONS"
9:30-10:45
Stefano Vitale
"LISA Pathfinder" Principal Investigator,
Trento University

"GRAVITATIONAL-WAVE SOURCES WITH LISA"
11:00-12:15
Bernard Schutz
Max Planck Institute for Gravitational Physics founding Director,
Potsdam

"THE FUTURE OF GRAVITATIONAL-WAVE ASTROPHYSICS"
14:30-15:45
Alessandra Buonanno
Max Planck Institute for Gravitational Physics Director,
Potsdam

Round table discussion
15:45 - 16:30
with the speakers and some professors of the Astrophysics group.

Book a seat here!

Red Shift

THE GRAVITATIONAL UNIVERSE

LISA AND BEYOND

FEBRUARY 27th 2023
UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA
ROOM: L. Sironi U4-08

GRAVITATIONAL WAVES

During most of astronomy history, sky observations have almost solely relied upon electromagnetic spectra emissions. Light kept being the primary known medium carrying information across the Universe until 2015, when the LIGO interferometers first detected gravitational waves (GWs).

Einstein's prediction

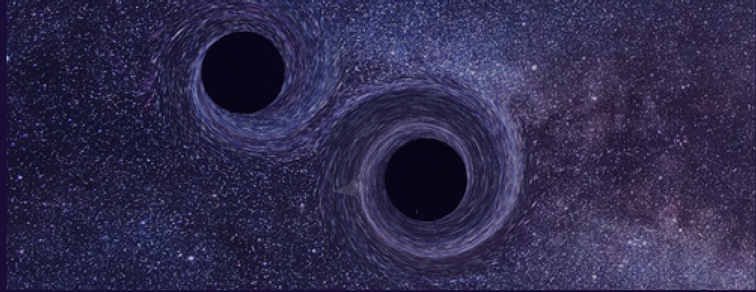
Their detection gave one of the first strong proofs of Einstein's theory of General Relativity, our current most accurate description of gravity, that is conceived as a manifestation of the mutual interaction between the geometry of spacetime and the matter therein embedded.

$$G_{\alpha\beta} = \frac{8\pi G}{c^4} T_{\alpha\beta}$$

"MATTER TELLS SPACETIME HOW TO CURVE, AND SPACETIME TELLS MATTER HOW TO MOVE"

GWs emerge within the theory as distortions of spacetime caused by accelerating massive objects. As they stretch and squeeze the space along their way, these ripples modify the distances traveled by light, making them detectable on earth as changes in the arm length of laser interferometers.

image credits: https://www.quantamagazine.org



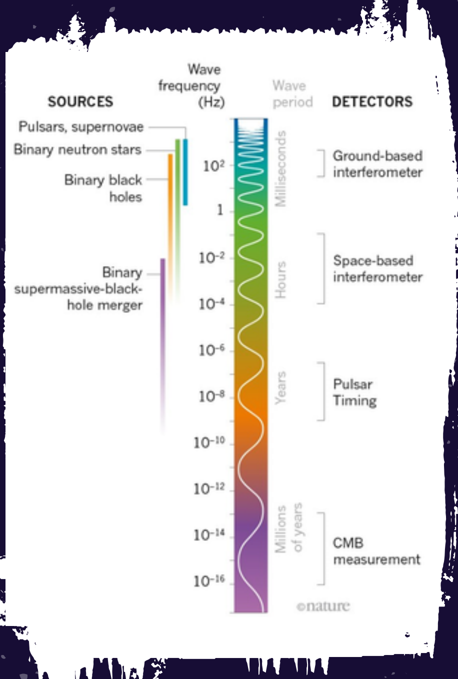
GW SOURCES

Among the candidate sources, **black-hole binaries** have been the most hunted since the first detection of GW150914 by the LIGO interferometers.

As the binary radiates GWs, they carry away orbital energy, forcing the objects to shrink their separation and eventually merge, producing one of the most powerful known events in the Universe. The signal detected on earth encodes several details on the binary properties and history, that provide astronomy with a new perspective on the observable universe.

GW FREQUENCIES

Because they can be emitted by a great variety of sources that have originated at different times during the cosmic history, GWs reach the Earth with a broad range of frequencies, just as in the case of electromagnetic radiation.
Different detectors are needed to cover the whole GW spectrum.



Our current best tools to measure GWs on Earth are ground-based laser interferometers, which are sensitive to frequencies within 10 Hz to 1000 Hz, corresponding to small wavelength GW signals, produced by binaries of compact objects like stellar-mass black holes, neutron stars and white dwarfs.

NEVERTHELESS, THERE IS STILL MUCH MORE OUT THERE!

Among the most fascinating hidden sources there are binaries of supermassive black holes, whose detection has the potential of uncovering many of the unresolved mysteries about the Universe. Targeting these and other longer wavelenght GW sources requires to break the current sensitivity limitations imposed by the ongoing ground-based detectors, which is the present-day challenge of gravitational wave astronomy.

LASER INTERFEROMETER SPACE ANTENNA (LISA)

Among the upcoming projects there is LISA, the space mission designed by ESA, expected to launch in the mid-2030s. LISA is a laser interferometer consisting of three spacecrafts in a triangular configuration that will follow the Earth in orbit around the Sun. With an arm length of 2.5 million kilometers, LISA will be able to detect signals with frequencies within 0.1 mHz and 1 Hz.