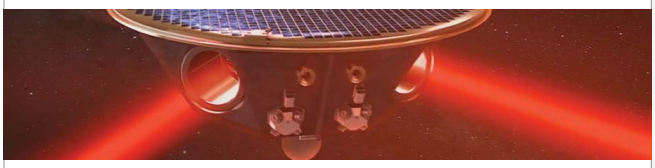
A New Astronomy
The Gravitational Universe Science Theme

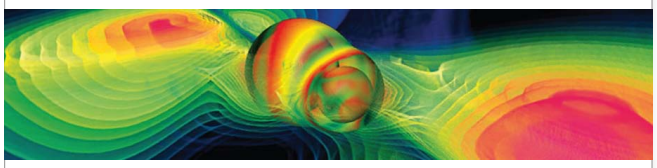
eLISA Mission Concept



Gravity is the dominant force in the universe. With eLISA, we propose the first ever mission to **survey the entire universe directly with gravitational waves**, to tell us about the formation of structure and galaxies, stellar evolution, the early universe, and the structure and nature of spacetime itself. **Most importantly, there will be enormous potential for discovering the parts of the universe that are invisible by other means.** Today we can see the beauty of the universe with modern telescopes in many wavelengths. Observing the universe with gravitational waves—which are analogous to acoustic waves—will allow us to hear the universe for the first time.

eLISA will measure the relative displacement of free-falling test masses, one million kilometers apart, by means of laser interferometry. This will enable us to determine parameters like mass, spin, orbital elements, and luminosity distance of the sources with unprecedented precision. Large parts of the technologies necessary for such a mission have already been developed, and will be **tested in space by LISA Pathfinder in 2015**.

Sources for Gravitational Waves



There is a huge number of known low frequency gravitational wave sources for eLISA.

- **Coalescing massive black holes** out to redshift z~20.
- **Small black holes captured by a massive black hole** out to z~1.
- **Relativistic compact binaries** like white dwarfs, neutron stars, and stellar mass black holes (~10^8 sources in the Milky Way alone)

As the first observatory for low frequency gravitational waves, there is enormous potential for the discovery of as yet unknown sources. Since the propagation of gravity is not blocked by matter it could even be possible to observe Cosmic Strings and the Big Bang itself.

The eLISA mission is a milestone project that has the potential to revolutionize our understanding of physics and cosmology. By directly observing gravity—the only field that couples with all known forms of matter and energy—**eLISA will test one of the most fundamental laws of nature, open a new window on astronomy, and unravel our Gravitational Universe.**

What eLISA can do for you

Illuminate
our understanding of the clustering of pre-galactic haloes and discover the first seed black holes in the universe.

Provide
invaluable information on the nature of central black holes in 'under-luminous' dwarf galaxies and unveil the nature of the stellar remnants skimming the hole's horizon, providing clues about their dynamics.

Increase
our knowledge of the ultra compact binaries in our galaxy which are on the verge of transforming into heavier objects. This will shed light into the nature of Type Ia supernovae and short gamma-ray bursts.

Map
the spacetime around black holes in galactic nuclei, testing whether they are the Kerr black holes predicted by general relativity.

Discover
how gravitational information propagates and whether the graviton has a mass.

Explore
energy scales and epochs as close as 10^{-18} to 10^{-10} seconds after the Big Bang and answer outstanding questions on the origin of the universe well before the Cosmic Microwave Background radiation.

LISA Pathfinder

LISA Pathfinder is **a mission designed to demonstrate the technologies necessary for eLISA**. It will be able to test all disturbances that act locally inside an eLISA satellite. All of the most relevant hardware was designed to meet eLISA requirements.

- **Gravity Reference Sensor** (vacuum chamber, test masses, and electrode housing)
- **Launch-lock** and **test-mass-release-into-orbit mechanisms**
- **Optical Readout** (hydroxide-bonded monolithic optical bench)
- **Nd:Yag laser** and **local laser interferometer**
- **Cold gas micro-thrusters** (for drag-free control)

Almost all of the sophisticated and complex systems of LISA Pathfinder have been delivered and successfully tested.

All technical problems have been solved and **the final flight hardware will be available in fall 2013**. LISA Pathfinder will launch in 2015 and perform its experimental schedule within three months. Results will be available immediately, through real-time data analysis.

After a successful LISA Pathfinder Mission, there will be a four year phase to build and test a complete eLISA payload. **LISA Pathfinder technology can be transferred as-is.** Additional technology necessary for eLISA, such as laser frequency noise suppression and satellite-to-satellite ranging, is already being developed and tested on ground. **Industrial construction of the three eLISA spacecraft will begin in 2020 with an expected launch date in 2028.**

http://support.elisascience.org