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Gravitational wave detection from space

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Abstract. We review the expected science performance of the satellites eLISA (evolved Laser Interferometer Space Antenna) for the detection of gravitational waves.

The proposal ("The gravitational Universe" [1]) for a space mission dedicated to the detection of gravitational waves based on the eLISA concept has been selected in November 2013 as a science theme of the European Space Agency (ESA), which is foreseen to be implemented as the L3 mission in the framework of ESA's Cosmic Vision Programme. eLISA will survey the low-frequency gravitational-wave sky (from 0.1 mHz to 1 Hz), detecting and characterising a broad variety of systems and events throughout the Universe [2, 3], including the coalescences of massive black holes brought together by galaxy mergers [4, 5]; the inspirals of stellar-mass black holes and compact stars into central galactic black holes; several millions of ultracompact binaries, both detached and mass transferring, in the Galaxy; and possibly unforeseen sources such as the relic gravitational-wave radiation from the early Universe. eLISA's high signal-to-noise measurements will provide new insight into the structure and history of the Universe, and they will test general relativity in its strong-field dynamical regime.

eLISA is a space-based mission designed to measure gravitational radiation over a broad band of frequencies ranging from $\sim$ 0.1 mHz to $\sim$ 1 Hz. The basic principle of gravitational wave detection for eLISA is based on a laser interferometer designed to detect the passage of a gravitational wave by measuring the time varying changes of optical path length between free-falling test masses. The two measurement arms are defined by three spacecraft orbiting the Sun in a triangular configuration. A key feature of the eLISA concept is that the test masses are protected from disturbances as much as possible by a careful design and the "drag-free" operation. Several of the needed technologies, in particular the drag-free operation will be soon tested in space with the satellite LISA-Pathfinder, which is scheduled to be launched in 2015. LISA-Pathfinder is a ESA mission with a contribution from NASA [6]. For more details on eLISA and LISA Pathfinder we refer to the homepage: https://www.elisascience.org .

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