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LISA and LISA Pathfinder: Laser Interferometry in Space

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The direct detection and investigation of gravitational waves are among the greatest challenges of modern physics. The observation of the universe with gravitational waves would give us insights not obtainable in any other way. We could for the first time see black holes directly, discover dark objects that are not emitting electromagnetic radiation, observe the mergers of binary neutron stars in distant galaxies and black holes in the complete universe, and maybe even observe the gravitational radiation from the early universe, fractions of a second after the big bang.

The low-frequency part of the gravitational wave spectrum, from 100 micro-Hertz up to 1 Hz, contains the most spectacular sources of gravitational waves. Really high precision measurements are possible here, making this frequency range very interesting for both Astronomy and Fundamental Physics. To open this window for observations, we need an observatory in space!

LISA, the **L**aser **I**nterferometer **S**pace **A**ntenna, will comprise three satellites at the corners of an equilateral triangle with 5 Million km armlength. The constellation is inclined against the ecliptic by 60 degrees, following behind the earth in a distance of 50 Million km. Each satellite contains free-flying test masses on almost perturbation-free geodesic lines. Changes in the distances between the test masses will be measured by heterodyne laser interferometry with picometer resolution to detect the spacetime curvature caused by passing gravitational waves. LISA as a collaborative ESA/NASA mission is the most promising candidate for the L1 slot in the Cosmic Visions program of ESA with a launch in 2018. The Beyond Einstein Program Assessment Committee of NASA has just recently recommended LISA as a flagship mission for NASA.

Key technologies for LISA will be demonstrated on the precursor mission LISA Pathfinder, to be launched by ESA in 2010. Among these are, in particular, lasers, interferometry, ion thrusters, and drag-free spacecraft control. Flight hardware manufacture for LISA Pathfinder has begun. These technologies will be useful for a variety of other missions, ranging from Fundamental Physics to Geodesy and even telecommunications.