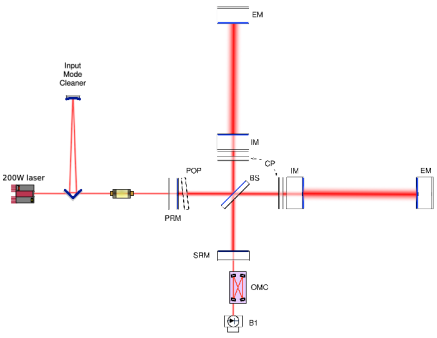
Laser Interferometer Gravitational Wave Detector

Gravitational waves are ripples in the curvature of spacetime that propagate as waves, generated by accelerated masses such as black holes binaries. The METEOR presents the principle of the gravitational wave detection. It develops the understanding of the physical phenomenon which define the sensitivity of the instrument and the technical aspects of the instrument.

Theory

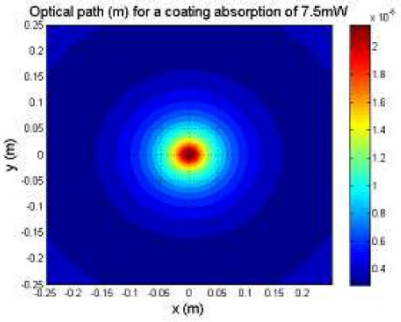
by W. Chaibi, F. Kéfélian



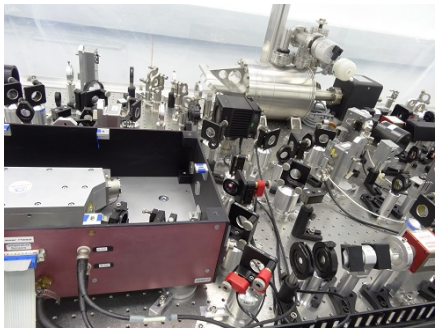
The module will provide an introduction to the principle of gravitational wave detection with giant laser interferometer. We will see how it is possible to be sensitive to relative length fluctuation of 10^{-22} and then able to detect gravitational wave emissions by black hole or neutron star binaries located one billion light-years away. The theoretical part will start with an introduction to gravitational wave physics and some complements of optics on gaussian beam and Fabry-Perot cavity. We will then present the oscillating nature of the laser source and it's noise characteristics. The principle of detection of gravitational waves with optical interferometer will then be detailed and the sensitivity spectrum will be derived by taking into account the different limiting physical effets such as Newtonian noise, shot noise, thermal noise.

Applications

by W. Chaibi, F. Kéfélian, M. Pichot



The notion introduced in the theoretical section will be illustrated first by an introduction to numerical simulation of the optical aspects of the interferometer. Different elements of the interferometer and propagation of the laser beam will be simulated by spatial Fast Fourier Transform. The students will develop their own simulation software and will compare it with a professional tool developed specifically for the VIRGO project. The students will also have the opportunity to be trained on experimental use of Fabry-Perot cavity, in particular for mode filtering and laser frequency stabilization, and laser characteristic metrology.



See also

The VIRGO collaboration website
THe LIGO scientific collaboration website

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