Hybrid Atom-Optical Interferometry for Gravitational Wave Detection and Geophysics

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Position fluctuations of the optics limit the sensitivity of ground-based gravitational wave detectors based on optical interferometry at low frequencies ($f \lesssim 10$ Hz). They prevent from investigating a large bandwith of various potential astrophysical sources. In terrestrial experiments, these fluctuations are mainly due to seismic noise of the interferometer optics and to gravitational noise caused by fluctuations of the mass distribution in the surrounding of the instrument.

In this presentation, we will describe a new type of instrument which strongly rejects position fluctuations of the optics and can extend the sensitivity of ground-based gravitational wave detectors to the milli-Hertz range. Our proposition uses light-pulse atom interferometry combined with optical interferometry. We will show how the instrument can be used as a high sensitivity sensor of the local gravity and present its potential applications in geophysics. Then, we will describe the measurement protocol to extract a gravitational wave signal, with expected strain sensitivities lower than 10^{-19} in the $[0.01-1]$ Hz frequency domain, at 100 s integration time.

The proposed instrument is under realization in the framework of the MIGA consortium [1]. It will consist of 200 meter long optical cavities hosting three atom interferometer inertial sensors, and will be set up in 2016 at the low noise underground laboratory LSBB situated in France. We will present the status of its design and of the realizations of the atom interferometers.

References

[1] `https://sites.google.com/site/migaproject/home`