

PhD Thesis - *advanced-KWISP* - Dottorato in Fisica - UniTS

G. Cantatore - 10/5/2019

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Experimental study of short-distance interactions with a double-membrane opto-mechanical sensor (*advanced-KWISP*)

Abstract

The experimental study of Short Range Interactions (SRIs) between macroscopic bodies might open a window on a range of microscopic processes involving the exchange of exotic particles (for example axions, chameleons, moduli) which are not included in the Standard Model of particle physics. In addition, under special conditions, the hitherto unobserved Topological Casimir might appear beyond the known Casimir effect. The basic concept in SRI studies is setting two bodies at a given separation distance, exciting one of the two (the “source mass”) in order to change the distance, and observing the response of the second body (the “sensing mass”) to the excitation of the first in search of deviations from the standard Newtonian potential. The field presents a rich panorama of experiments, down to separation distances of the order of a few microns, while at shorter distances the arena is open for investigation. Based on the experience and techniques matured with the KWISP opto-mechanical force sensor, *advanced-KWISP* envisions reaching separation distances of 100 nm or less by using a double-membrane device, dubbed the Double Membrane Interaction Monitor (DMIM), where one membrane acts as the source mass, and the second as the sensing mass. The first membrane is excited with the radiation pressure of a laser beam, while a second laser beam interferometrically detect the displacements of the second one.

Specific thesis topic

Designing, building and testing a first prototype of the opto-mechanical apparatus needed to excite and monitor a DMIM device, starting at room temperature, with a view on subsequently moving to sub-Kelvin temperatures. Initial work will take place locally, while cryogenic operation will move on to an external laboratory, possibly CERN.

Participating Institutions

UniTS

UniRijeka (HR)

UniCAM (Camerino)

CERN

UniPatras (GR)

UniFreiburg (D)

Bilgi University (TR)

CAPP-IBS (Korea)

People locally involved

G. Cantatore (UniTS and INFN Trieste) - supervisor

M. Karuza (INFN Trieste and UniRijeka (HR))