

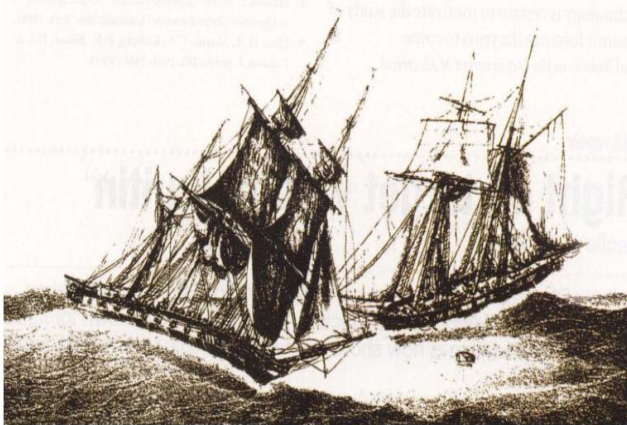
INSTITUT NEEL Grenoble

Bourse de thèse

Acoustic quantum Analogues for Casimir Forces

Context :

In 1948, Hendrik Casimir showed that fluctuations of an electromagnetic field, so-called zero-point fluctuations, give rise to an attractive force between objects. Casimir's calculations were idealized - he considered two perfectly conducting parallel plates at absolute-zero temperature - but there are implications for more realistic objects. Although the Casimir effect is deeply rooted in the quantum



theory of electrodynamics, there are analogous effects in classical physics. A striking example was discussed in 1836, in P. C. Caussée's *L'Album du Marin* (*The Album of the Mariner*). Caussée reported a mysteriously strong attractive force that can arise between two ships floating side by side — a force that can lead to disastrous consequences (see Figure). A physical explanation for this force was, however, offered only recently, by Boersma [1], who suggested that it originates in the radiation pressure of water waves acting differently on the opposite sides of the ships. Analogous

arguments can be employed for the Casimir effect itself. In this case, the radiation pressure is due to quantum electromagnetic waves rather than classical fluctuating water waves.

Historically, the Casimir effect has been considered to be an exotic quantum phenomenon, but now it is starting to take on technological importance. Because of its relatively short range, it has only a very small effect on the dynamics of macroscopic mechanical systems. But the Casimir force has a major role in modern micro and nanoelectromechanical systems (MEMS and NEMS), where the distances between neighboring surfaces are typically far less than 1 μm . In tiny devices such as these, the Casimir force can cause mechanical elements to collapse onto nearby surfaces, resulting in permanent adhesion - an effect called 'stiction', which often proves to be an important factor in the malfunction of NEMS.

Project:

In this thesis, we propose to address the Casimir effect with **an hydrodynamic approach** based on an **acoustical analogy**: the acoustic Casimir force. Here, when two plates are immersed in a fluid insonified by ultrasound radiation, a force arises from the acoustic radiation pressure difference between the inner and outer domain delimited by the plates.

As we have recently shown, this configuration is very promising for manipulating micro particles in a liquid medium by acoustic waves and could be further extended to the case of submicron particles and use of acoustic metamaterials. We also believe this approach could help understanding its electromagnetic counterpart.

Required Skills : Acoustics / optics, Interest for experimental problems in fundamental and applied Physics,

Formation / Compétences : Master 2 ou équivalent.

Période envisagée pour le début du contrat : starting 09/2018

Durée : 3 years

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