Martedì 12 Dicembre 2017
Aula B, DIFC, Via Archirafi 36, ore 15.00

Fluctuation-induced phenomena: the interface between atoms, photons and solids

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An introduction to the theory of fluctuation-induced interactions

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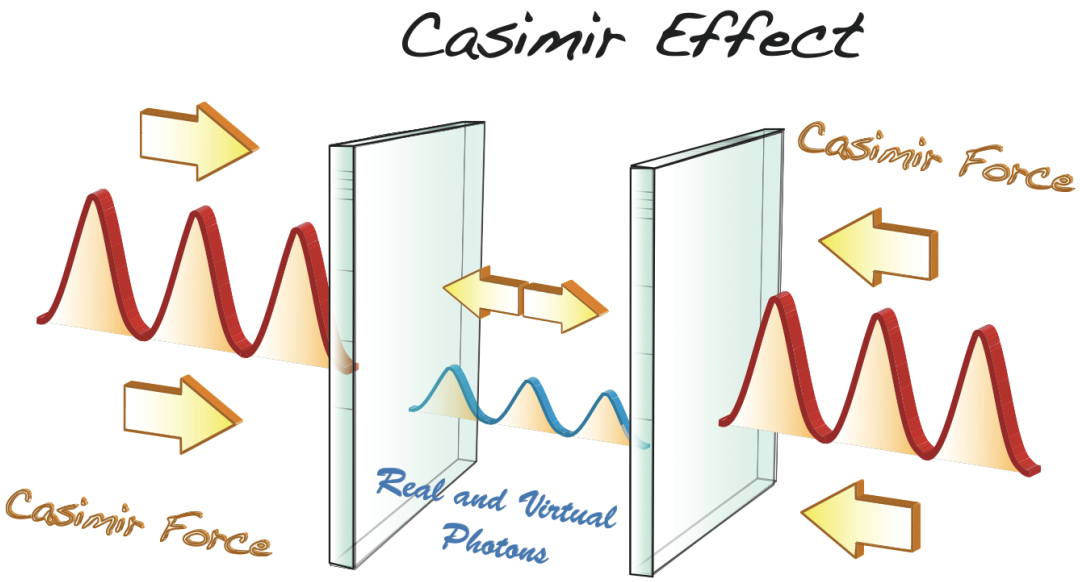

An introduction to fluctuation-induced phenomena

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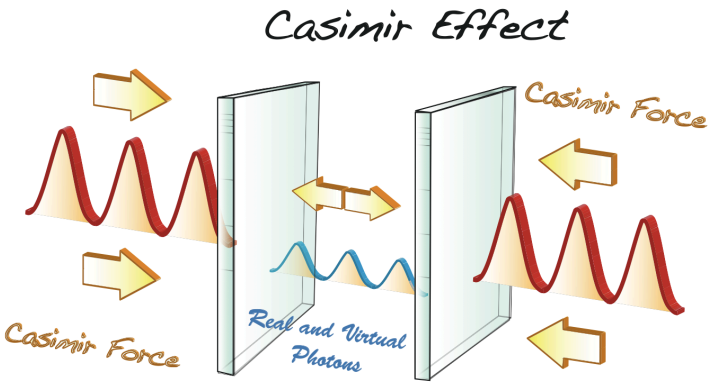


Fluctuations are omnipresent in both the classical and the quantum world and they are connected with a panoply of phenomena in different areas of physics, ranging from biophysics to gravity, from chemistry to cosmology. They play a key role in fundamental processes like decoherence, thermal transport, and they lead to the appearance of forces between atoms, molecules (van der Waals) and extended bodies (Casimir effect). These phenomena govern biological processes and are relevant for colloidal matter, cell membranes, proteins and, in general, the structure of molecules and solids. Their exact understanding is therefore rapidly becoming important for the characterization of modern experimental set-ups.

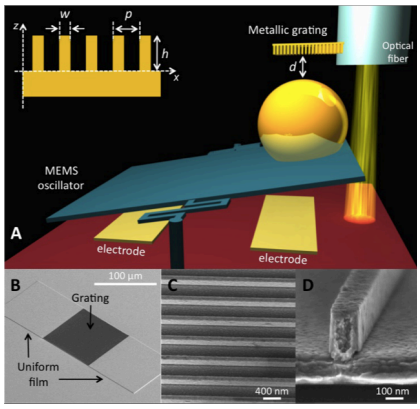
The study of fluctuation-induced phenomena is intrinsically multidisciplinary and touches upon a wide range of topics among which (nano)plasmonics, (nano)photonics, quantum electrodynamics, statistical mechanics, optomechanics, nonlinear optics, cold and ultra-cold gases, condensed matter physics, and new and engineered materials.

In this series of lectures I will review the physics behind these interactions, showing how they impact on recent experiments and are relevant for future technologies.

The plan of the lecture is:

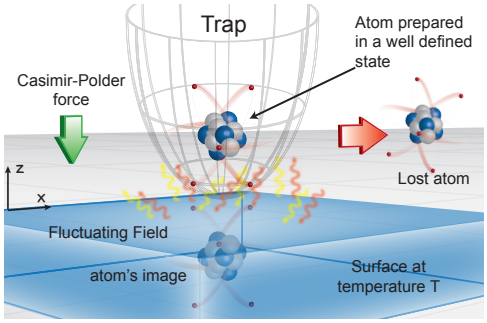
1. **Equilibrium and non equilibrium fluctuation-induced interactions between solids**

In this first lecture I will focus on extended bodies, giving a simple overview of the theory and describing the experiments that, in some cases only very recently, allowed for a measurement of these phenomena. I will show how these phenomena have strong implications in fundamental research topics like high precision test of gravity and dynamics of black holes, but also strong impact on technologically relevant systems like optomechanical and micro-electro-mechanical systems (NEMS and MEMS). These interaction can be used as a contactless way to mechanically actuate devices, and/or these systems can also be used as accurate sensors to detect and study the physics behind these interactions.



2. **Fluctuation-induced phenomena the interface between atoms, photons and solids**

In this lecture I will consider fluctuation-induced phenomena that influence the dynamics of atomic or hybrid atom-field-condensed matter systems (e.g. atom-chips). This includes effects like decoherence, non-Markovianity and the Casimir-Polder/van der Waals force between atoms or atoms and objects. We will discuss why the role of these interactions is ambivalent: They are sometimes perceived as a nuisance one wants to get rid of, or as the key mechanism behind the performance of the setup.



3. **The theory of fluctuation-induced interactions: Relevant aspects and controversies**

This lecture will address the theoretical aspects considered in the previous two lectures, providing further details, establishing connections and presenting a general theoretical framework for the description of fluctuation-induced phenomena. It will put in evidence the overlap of the theoretical background with concepts coming from different areas of physics, such as the theory of open systems, statistical mechanics and quantum electrodynamics.
We will also discuss the "shadow areas" and the controversies that remain unsolved so far