Casimir Forces That Attract Or Repulse A Pair Of Neutral Plates Simply Do Not Exist

Recent experiments suggesting the attractive Casimir force can be changed to repulsion and allow levitation not only falsely presuppose the attractive Casimir force exists, but then extend that falsity to conclude the repulsive Casimir force exists

Jan. 18, 2009 - *PRLog* **-- Background** Over 50 years ago, Casimir extended the short range van der Waals force between atoms and molecules separated by a few angstroms to the attractive force between a pair of macroscopic flat plates in a vacuum. Usually, macroscopic bodies interact with each other only by electrostatic attractive forces, but since then Casimir's force has and continues to gain much scientific interest because the attraction occurs between electrically neutral bodies.

Casimir assumed a pair of plates in a vacuum were immersed in electromagnetic (EM) radiation from the zero point energy (ZPE) thought to pervade all of space. With the plates separated by gap G, Casimir concluded that EM radiation having half-wavelengths > G is excluded from the gap, leading to a force unbalance that pushes (or attracts) the plates together. Casimir then proceeded with a mathematical derivation of the attractive force based on the ZPE, although there is no physical evidence that the ZPE exists.

The existence of the ZPE aside, there is a more fundamental problem with Casimir's derivation. The EM radiation Casimir excluded from the gap does not lead to an unbalanced force because Nature requires any EM radiation in the gap to spontaneously adjust to a disturbance of the plates by a change in frequency. Absent a frequency change, the plates would be attracted to each other by the unbalance in EM radiation, but the response would not be instantaneous because of plate inertia.

Casimir ignored the fact the excluded EM radiation in the gap G is spontaneously conserved by a change in its frequency. Nature always minimizes the time to for a system to reach equilibrium. Compared to a spontaneous change in frequency, waiting for the Casimir's plates to move in response to the excluded EM radiation simply does not occur. Simply stated, Casimir's mathematical derivation of the attractive force is unphysical.

If Casimir would have conserved the EM radiation by a change in frequency, he would have concluded the EM energy is constant for all gaps G, and therefore the Casimir force given by the gradient of the EM energy with respect to the gap G vanishes.

But if so, what are the attractive and repulsive forces being measured in Casimir experiments?

What is being measured are electrostatic forces produced by charges caused by the photoelectric effect from QED induced VUV radiation in the gap Here, QED stands for quantum electrodynamics. Unlike stray charges that are removed by touching mirrors or electrical grounding, the QED forces cannot be removed, and therefore have been erroneously interpreted as Casimir forces.

Unlike the ZPE, the thermal kT energy of the atoms in the surface of the plates is real and exists in the far infrared (FIR) at ambient temperature. But Casimir would have even found the EM radiation in the gap increases from the FIR at large gap G > 25 microns to vacuum ultraviolet (VUV) as the gap G
But this is an old story. In 2004 and 2005, Prevenslik showed the attractive Casimir force did not exist because Casimir did not conserve EM energy in the gap G between the plates. Instead, the attractive QED induced electrostatic force based on the photoelectric effect was shown to reasonably estimate Casimir's force. *See www.nanoqed.net at link "Casimir."*

Recent Experiments and the Casimir-Lifshitz Theory

In 2009, Munday et al. reported experimental evidence suggesting that the attractive Casimir force between a gold coated sphere and a silicon plate may be made repulsive by simply immersing them in liquid bromobenzene. *See www.nanoqed.net at link "Nature."*

Given the unresolved question of whether the attractive force that has been measured over the past 50 years is that predicted by Casimir or due to some other mechanism is not yet resolved, it is somewhat premature to conclude the attractive Casimir force may be changed to repulsion simply by immersing the structures in a liquid.

Paradoxically, the repulsive Casimir force derived by immersion in a liquid may not support, and in fact may disprove Casimir's theory proposed in 1948. However, Munday et al. have claimed the measured repulsive Casimir force is consistent with a generalized theory for real materials by Lifshitz in 1956 and later extended by Dzyaloshinskii et al. in 1961 called the Casimir-Lifshitz (C-L) theory. *Ibid*

The C-L theory claims a repulsive force occurs if the ordering of the permittivity of the materials: the gold coated sphere greater than bromobenzene which is greater than the silicon plate. By the C-L theory, the repulsive force works so that the bromobenzene is attracted into the gap thereby forcing them apart.

QED Theory

The QED theory assumes VUV radiation is produced in the gap G See www.nanoqed.net at link "Casimir." Hence, the force measured in the experiment has nothing to do with Casimir, but rather is electrostatic caused by the charging by the photoelectric effect from VUV radiation. The usual attractive force between gold and silicon found in a vacuum is changed to repulsion upon immersion in bromobenzene because the latter is an electron scavenger that alters the charge distribution.

Conclusions

Casimir and C-L theories lack the important parameter of VUV radiation in their formulation and may not be at all related to the repulsion measured with bromobenzene.

The ordering of permittivity from gold to bromobenzene to silicon is an artifact of C-L theory and has nothing to do with repulsion. The sensitivity of Casimir repulsion to the photoelectric effect may be easily verified by irradiating the gap with or without bromobenzene using a UV flash lamp.
QED theory that depends on photoelectric yield suggests the quest for frictionless contact in MEMS devices would be better directed to zero electron yield materials. Levitation would not be possible, but friction from the attractive QED force would be significantly reduced. There is no apparent need for immersing MEMS devices in bromobenzene or any other electron scavengers to avoid friction.

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About QED induced EM radiation: Classically, thermal EM radiation conserves heat by an increase in temperature. But at the nanoscale, temperature increases are forbidden by quantum mechanics. QED radiation explains how heat is conserved by the emission of nonthermal EM radiation.

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