The Famous Casimir-Effect Figure is a Hoax

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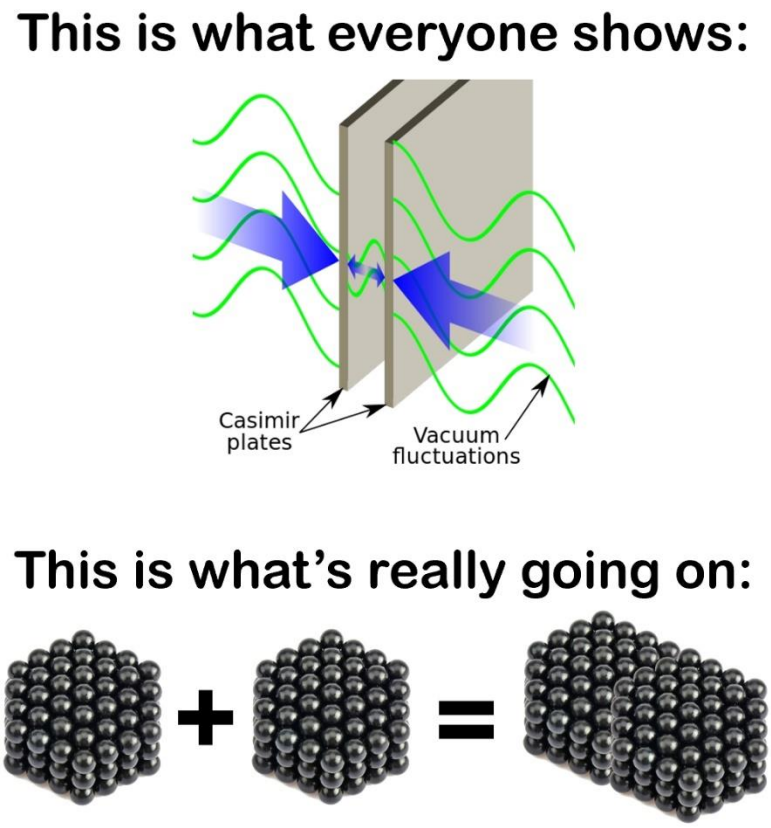

Fig. 1. *The "vacuum fluctuations" Casimir explanation was never anything more than a Bohr pipedream.*

The following began as a comment [1] on a members-only Medium.com post [2] by Tim Anderson, Ph.D.

Tim Anderson, to expand on my earlier "Yep!", thank you for what I believe is the first physically realistic discussion of the Casimir effect I've seen on Internet media.

Bohr came up with all of this, not Casimir. He put Casimir in an almost impossible situation, elevating to international fame what Casimir otherwise would have attributed to mundane van de Waals forces. Bohr thus also elevated Casimir to unprecedented visibility for a "mere" condensed matter physicist.

What was Casimir to do — declare the incredibly more famous Bohr wrong? Casimir waffled instead, never disagreeing but never fully agreeing, either. Even years later, Casimir could never quite say Bohr was wrong.

Van der Waals energy is mundane stored energy, specifically the energy required to break apart any chunk of molecular matter that lacks strong intermolecular bonds. Metals add deceptive complexity and reach higher energy storage levels (think vacuum welding) due to their delocalized electrons, but again are nothing more than storing the (higher) energy put into breaking two lumps apart. Bohr was the one who wanted the more complicated metal case to be more than van der Waals forces. He used mathematical resemblances created by delocalized electrons (this is Terry talking on that point, not Jaffe) to persuade himself and others that something more was happening.

(Bohr hoped, a bit desperately, I would judge, for experimental support for his Copenhagen dualism of chopping the quantum world into perfect waves and particles, both of which are extremely classical concepts amenable to the math of that time (and now). The idea of "something else, something not classical, needing entirely new maths" seems not to have occurred to the Copenhagen group. This hyper-classical Copenhagen dualism — quantum is "just" particles and waves, both fully classical — persists to this day in nearly all quantum interpretations, not just Copenhagen. It is an unseen, largely unnoticed, and profoundly impactful consequence of Bohr's let's-keep-the-math-classical approach to quantifying quantum behaviors.)

Returning to the Casimir effect, here is my standard explanation of how it works. It is an experiment you can easily do at home.

Find or buy a few dozen small magnets, ideally spherical ones. Lump the magnets together, then break the lump into two pieces.

Separate the lumps by a few inches. Do they attract? No, not noticeably, because all the magnetic fields inside the lumps cancel each other at long distances.

Move the lumps closer. Any attraction at, say, an inch? Nope. But as you move the lumps to a point where their separation distance is comparable to the sizes of the magnets, something interesting happens. The magnets near the gap shift slightly, and the lumps suddenly pull together (Fig. 1). When this happens, there is a tiny release of energy — a return of the energy you applied to break the lumps apart. (A note of reassurance for anyone who may be concerned: The odds of the universe collapsing due to an infinite release of zero-point vacuum energy when the two lumps collide are extremely small… :)

What happened is that even though both lumps are approximately a zero-field when viewed from any large distance, they still contain profoundly strong magnetic fields that become visible at very short ranges. These short-range fields can cause the magnets to shift and cozy up to each other in a slightly lower energy configuration, but only at ranges comparable to the separation.

The same happens with atoms, which contain unbalanced but powerful electric charges visible only at short, near-atomic distances. Yes, a detailed analysis requires quantum mechanics, mostly because electrons in stable orbitals behave as charge clouds rather than as point charges, but even that is covered nicely by the "charge cloud" model used in chemistry. As with the magnets, the energy released when these charge nudges come into play is nothing more than a return of the energy stored when the two pieces were (in principle) "broken apart."

No matter what you've heard or read, I assure you that all variants of "zero-point energy" violate special relativity. The problem is always the same: One person's finite and measurable release of "free" energy from any non-material vacuum always becomes someone else's infinite release of energy. If the vacuum gives even a shred of energy, it gives up an infinite amount of energy and annihilates everything. No matter how popular it's been for decades, Bohr's Casimir concept is — and always has been — a complete dud regarding its respect for Einstein's very well-proven special relativity. Bohr neglected to notice that he had locked the entirety of his mathematical analysis into the inertial observer frame of the two plates. That inertial frame is not the identical-to-all vacuum of special relativity.

For anyone deeply interested in the Casimir effect, here is a list of Casimir references [3], including the early history (which is sometimes surprising) and Jaffe's papers. Please note that this article is on my Apabistia Press website, CC BY 4.0, and only for making information available. No tracking, no monitoring, no anything except articles and a simple index to them.

References

[1] T. Bollinger comment on [2] in Medium.com, 2024-05-10.10:05 EDT Fri: https://medium.com/@terrybollinger/tim-anderson-to-expand-on-my-earlier-yep-8178ad145386

[2] T. Anderson, *The Casimir effect may not come from vacuum energy*, Medium.com [Members only] **2024**, 0429 [Apr. 29] (2024). https://medium.com/the-infinite-universe/the-casimir-effect-may-not-come-from-vacuum-energy-f9aab583dcc4

[3] T. Bollinger, *Casimir Effect References List (with Links)*, Apabistia Notes **2023**, 10062130 [Oct. 6] (2023). https://sarxiv.org/apa.2023-10-06.2130.pdf