PHYSIKALISCHES KOLLOQUIUM

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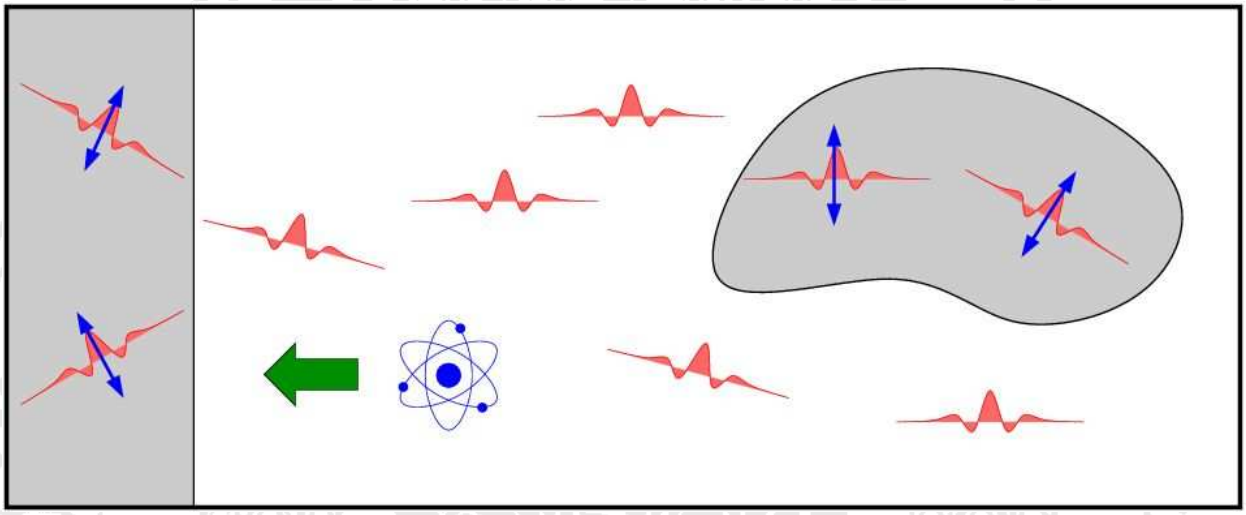

DISPERSION FORCES BEYOND THE QUANTUM VACUUM: FROM QUANTUM PRECISION TO QUANTUM CONTROL IN NANOTECHNOLOGY

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Heisenberg's uncertainty relation predicts the existence of virtual photons even in the quantum vacuum. Their behavior in realistic environments of absorbing bodies can be studied via macroscopic quantum electrodynamics. I will show how virtual photons lead to very real dispersion forces between polarizable objects. These spurious forces are just as difficult to control as the virtual photons creating them. They place severe limits on the miniaturization of atom chips. Non-additive by nature, their calculation is highly non-trivial for chips with a complex surface-structure.

I will present strategies to manipulate dispersion forces by going beyond the quantum vacuum: By introducing excitations, these forces can be engineered to address current challenges in nanotechnology. For instance, repulsive Casimir forces can be used to overcome the notorious stiction problem. Atom–surface interactions can be enhanced via a perfect meta-material lens. Quantum friction of an atom moving along a smooth surface can be utilised for cooling or even reversed into quantum acceleration.