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Quantum Gravitational Force Between Polarizable Objects
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— Since general relativity is a consistent low energy effective field theory, it is possible to compute quantum corrections to classical forces. Here we compute a quantum correction to the gravitational potential between a pair of polarizable objects. We study two distant bodies and compute a quantum force from their induced quadrupole moments due to two graviton exchange. The effect is in close analogy to the Casimir-Polder and London-van der Waals forces between a pair of atoms from their induced dipole moments due to two photon exchange. The new effect is computed from the shift in vacuum energy of metric fluctuations due to the polarizability of the objects. We compute the potential energy at arbitrary distances compared to the wavelengths in the system, including the far and near regimes. In the far distance, or retarded, regime, the potential energy takes on a particularly simple form: $V(r) = -3987\,\hbar\,c\,G^2\alpha_{1S}\,\alpha_{2S}/(4\,\pi\,r^{11})$, where α_{1S}, α_{2S} are the static gravitational quadrupole polarizabilities of each object. We provide estimates of this effect.

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