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Virtual photons in imaginary time: Computing Casimir forces in new geometries[1]

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One of the most dramatic manifestations of the quantum nature of light in the past half-century has been the Casimir force: a force between neutral objects at close separations caused by quantum vacuum fluctuations in the electromagnetic fields. In classical photonics, wavelength-scale structures can be designed to dramatically alter the behavior of light, so it is natural to consider whether analogous geometry-based effects occur for Casimir forces. However, this problem turns out to be surprisingly difficult for all but the simplest planar geometries. (The deceptively simple case of an infinite plate and infinite cylinder, for perfect metals, was first solved in 2006.) Many formulations of the Casimir force, indeed, correspond to impossibly hard numerical problems. We will describe how the availability of large-scale computing resources in NSF's Teragrid, combined with reformulations of the Casimir-force problem oriented towards numerical computation, are enabling the exploration of Casimir forces in new regimes of geometry and materials.

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