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The sign and magnitude of some semiclassical Casimir energies
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— A transparent physical definition of finite Casimir energies based on universal subtractions in the spectral density is given. We estimate so defined Casimir energies by contributions due to classical periodic orbits. In semiclassical approximation the latter are dual variables to the mode frequencies. For manifolds without boundary the sign of the semiclassical contribution to the Casimir energy is related to optical properties of short periodic rays. We demonstrate the accuracy and simplicity of this semiclassical analysis on torii and spheres in various dimensions. The results are compared to those of zeta-function regularization. For manifolds with boundaries on which a massless scalar field satisfies certain conditions, semiclassical contributions to the Casimir energy due to periodic rays that lie entirely within the boundaries have to be included. The semiclassical Casimir energy of a parallelepiped in arbitrary dimensions for periodic, Neumann, Dirichlet, and metallic, boundary conditions on pairs of opposing surfaces is shown to be the Casimir energy obtained by more conventional methods; a simple semiclassical estimate of the electromagnetic Casimir energy of an ideal metallic spherical cavity is accurate to 1%. It is finally shown how this semiclassical approach may be adapted to non- perturbatively include deviations from the ideal – such as finite conductivity, surface roughness, and finite temperature.

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