Monte Carlo Simulation Results for Critical Casimir Forces

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Forces induced by fluctuations, both thermal and quantal, commonly termed Casimir forces, are ubiquitous in nature. For the case of thermal fluctuations, these Casimir forces are of special interest because they become universal near continuous phase transitions; this makes them particularly suitable for experimental investigation and for practical applications. We have studied effective critical Casimir forces for film geometries and within the experimentally relevant Ising and XY universality classes by means of Monte Carlo simulations in three-dimensional systems. Several surface universality classes of the confining surfaces are considered, some of which are relevant for recent experiments. A proposed novel approach, based on an integration scheme of free energy differences, is utilized to compute the universal scaling functions of the critical Casimir forces in the critical range of temperatures above and below the bulk critical temperature. The resulting predictions remarkably well agree with corresponding experimental data for wetting films of fluids and for colloidal systems in the presence of the critical solvent.