Critical Casimir Forces at Work

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Similar to electromagnetic vacuum fluctuations which can induce long-range interactions amongst uncharged, metallic surfaces, an analog effect was predicted almost 30 years ago in confined binary mixtures close to their critical point. This so-called critical Casimir effect has attracted considerable attention because it can strongly modify the interaction potential of small objects immersed in fluid close to its critical point.

We present a direct measurement of critical Casimir forces between a colloidal particle and a flat surface in a water – 2,6-lutidine mixture. With total internal reflection microscopy (TIRM) which is capable to resolve forces down to 5fN, we obtain distance resolved particle-wall interaction profiles. Upon approaching the critical point we observe long-ranged interactions which are attractive or repulsive depending on the specific boundary conditions of the walls. This behavior is in good agreement with recent theoretical predictions. In addition, we demonstrate, how critical Casimir forces can be used for the assembly of ordered colloidal monolayers on chemically patterned substrates. Finally, we also discuss the possible use of critical Casimir forces to avoid stiction in nano-mechanical devices.