Monte Carlo Study of Alignment of Microscopic Disks by Critical Casimir Forces

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Critical Casimir forces act between small objects immersed in a liquid that is close to the critical point. In this study [1], colloidal disks of micrometer size were suspended in a water–lutidine binary mixture near its lower critical demixing point. We observed that the critical Casimir attraction caused the disks to align over the circular patches on the substrate in two distinct configurations — parallel or perpendicular — depending on the size of the patch and the thermodynamic distance from the critical point. I will present a theoretical method based on an adapted Monte Carlo simulation to calculate the probabilities of these configurations. The interaction potential between the disk and substrate consists of critical Casimir, screened electrostatic and gravitational interactions, and it is modeled using the Derjaguin approximation. The theoretical predictions are in qualitative agreement with experimental results.

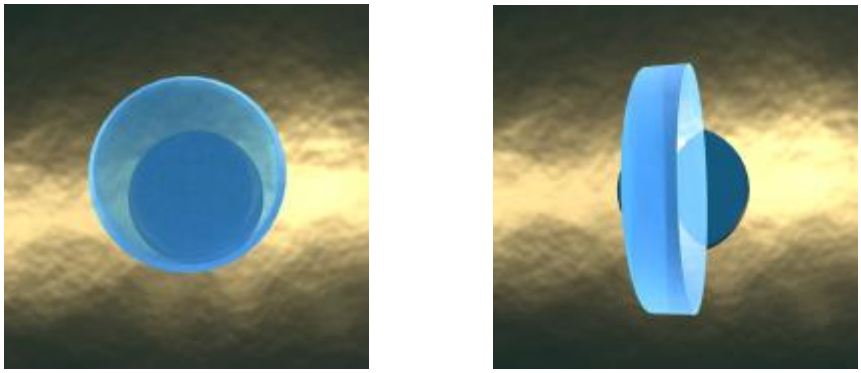

Figure 1. Schematic plot of the disk over the patch on the substrate in parallel (left panel) and perpendicular (right panel) configurations.

Reference:

[1] G. Wang, P. Nowakowski, N. Farahmand Bafi, B. Midtvedt, F. Schmidt, A. Callegari, R. Verre, M. Käll, S. Dietrich, S. Kondrat, G. Volpe, *Nat. Commun.* **15** (2024) 5086.