

A physicist's view of *hydrophobicity*: drying is critical

Prof. Robert Evans

*HH Wills Physics Laboratory,
University of Bristol,
U.K.*



All physical scientists would agree that for water (or another liquid) at a flat substrate a contact angle $\theta > 90^\circ$ defines the substrate as hydrophobic (solvophobic): it prefers gas to liquid. Is there an effective indicator of local ordering of the liquid, manifest at *microscopic* distances from the substrate, that correlates with the *macroscopic* (thermodynamic) contact angle?

We show such an indicator is the local compressibility $\chi(z)$ which measures fluctuations in the local density of the adsorbed liquid. For distances z within one or two molecular diameters of a weakly adsorbing substrate, where θ approaches 180° (drying), classical Density Functional Theory and Grand Canonical Monte Carlo simulations for a LJ liquid and for the realistic SPC/E model of water, show that $\chi(z)$ takes values that are orders of magnitude larger than in the bulk liquid. Such behaviour is characteristic of a *critical* drying transition. For substrate-fluid potentials that exhibit dispersion forces (power-law decay), critical drying occurs in the limit of vanishing attraction. By contrast, the wetting transition is always first order.

(Work with M.C. Stewart and N. B. Wilding.)

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**MPIDS, Prandtl lecture hall, building AI,
Am Faßberg 11, Göttingen**

**Max Planck Institute for Dynamics and Self-Organization
Dynamics of complex fluids - Nonequilibrium soft matter group**

Dr. Marco Mazza

Email: marco.mazza@ds.mpg.de, Phone: +49-(0)551/5176-233

Am Faßberg 17, 37077 Göttingen, Germany