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Critical Casimir Interactions: New fluctuation forces in colloidal science PETER SCHALL, Institute of Physics, University of Amsterdam — Casimir forces arise from the confinement of fluctuations between two walls. Critical Casimir forces provide thermodynamic analogues of quantum-mechanical Casimir forces and arise from the confinement of concentration fluctuations of a critical solvent. These forces act also between colloidal particles that are suspended in this solvent, giving rise to temperature-dependent attractive interactions between the particles. We use these temperature-dependent forces to control colloidal phase transitions. In this talk, I will present a new index and density-matched model system that allows direct observation of these phase transitions with confocal microscopy. In three dimensions and real time, we follow how a colloidal gas freezes into a colloidal liquid, and the colloidal liquid freezes into a solid, all driven by critical Casimir forces. We measure the critical Casimir particle pair potential directly from the pair correlation function, and use Monte Carlo simulations to map the complete gas-liquid-solid phase diagram. Excellent agreement with the experimental observations is obtained. Our measurements include microgravity experiments on board the International Space Station (ISS) to elucidate non-equilibrium assembly of the particles achieved by controlled temperature quench.

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