

# “Quantum Criticality” in Soft Matter

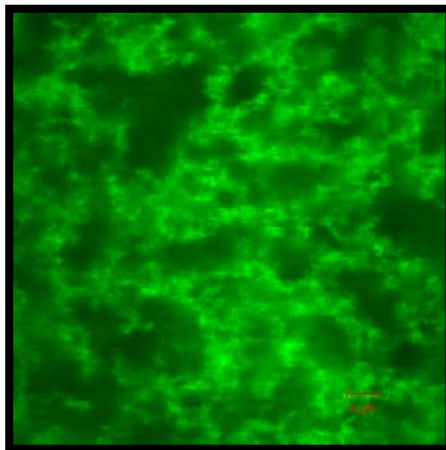
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Colloids are fascinating systems, because they display fundamental properties of condensed liquid and solid phases. Since the particles can be observed with a microscope, colloids allow direct insight into atomic processes in condensed matter.

We have recently developed a novel colloidal system, in which we can directly control particle interactions with temperature: The attractive forces between particles arise from the confinement of critical fluctuations of the solvent near its critical point, analogous to quantum vacuum fluctuations confined between plates (“Casimir force”). Thus, we can “freeze” particles from a dilute gas phase into a condensed liquid and solid phase, and we use a microscope to obtain direct three-dimensional images of these transitions. This microscope allows us to follow the trajectories of several ten thousand particles with time, providing a unique three-dimensional insight into atomic dynamics in condensed matter.

In this project, we explore using these attractive interactions to form colloidal crystals from a colloidal liquid. How does the crystal form from the liquid when we increase the attractive interactions between the particles? Can we measure the attractive particle potential at freezing/melting directly? What happens when we use anisotropic particles; can we mimic “atomic orbitals”? Three-dimensional imaging of the individual particles gives direct insight into the connection between atomic potential and the structure of condensed matter.



Aggregated phase of colloidal teflon particles in a mixture of water and 3-methylpyridyne  
The particles are frozen into a loose “gel” phase due to their very strong attraction.

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