Local Analysis of Microstructures and Heterogeneous Dynamics in a Two-Dimensional Binary Colloidal Glass Former

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At the University of Konstanz I investigated a binary 2D glass former of super-paramagnetic colloids together with K. Zahn and G. Maret. In the experiments, the particles were confined to a horizontally adjusted water-air interface of hanging droplet geometry due to gravity. A homogeneous external magnetic field, *B*, applied perpendicular to the particle monolayer, allowed to tune the repulsive dipole-interaction between the induced magnetic moments of the particles from outside. The in-plane particle interaction is described by an interaction parameter, *G*, which is given by the magnetic interaction potential divided by the thermal energy. Because of this ratio, *G(B)* corresponds to an inverse system temperature. The centers of mass positions of the particles were time-dependently distinguished by video-microscopy. Thus, partial radial pair-distribution functions and mean-square particle displacements could directly be calculated for different *G*, which allowed identifying the system as a two-dimensional (2D) colloidal glass former.

Because particle coordinates are available, I could microscopically investigated the particle configurations in the monolayer as well as the heterogeneous dynamics for different *G*, both characterized by triangles of nearest neighboring particles (TNNP). Thus, the amorphous 2D short-range order could be described by (idealized) locally densely packed triangles, called elementary triangles (ET). However, the different ET posses a special shape for each possible 3-particle combination of big and small colloids. Regions with structural frustration occur between clusters of ET-like TNNP. For decreasing system temperature the number of densely packed triangles increased and those triangles began to conglomerate and to form clusters of local density-optimized structures. For low system temperatures cooperatively moving clusters of mainly ET-like TNNP were observed, which are also found in regions of relatively fast particles. This behavior seems to be responsible for heterogeneous dynamics in supercooled liquids.

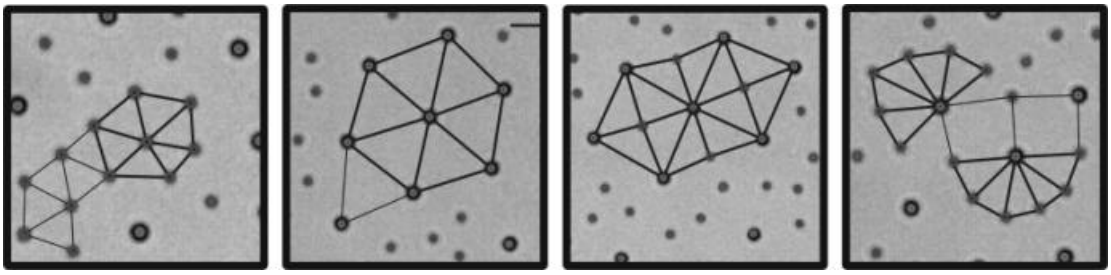

Figure 1: Several ET-like TNNP in a supercooled liquid of the investigated 2D binary colloidal suspension.

Finally, I qualitatively describe the glass transition of the investigated 2D colloidal suspension as a kind of conglomeration of local density-optimized ET-like TNNP of different shapes, which then lead to a stable frame through the whole glass. At last, I call this glass description the “concept of local density-optimized crystallite clusters”.