Dynamics of Ribbon Colloid Suspensions

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This project is concerned with a study of colloidal suspensions confined to narrow channels. The influence of dimensionality on the properties of dense fluids has been of interest lately. Many phenomena in physics, chemistry and biology can be modeled with a colloidal suspension. Examples of such phenomena include molecular motion in zeolites, particles in microfluidic devices, ion transport in cell membranes. Studying such systems at molecular level presents many challenges due to their size. However, many of these systems can be modeled with colloids large enough to be imaged with a visible light microscope.

Our basic experimental system consists of an aqueous suspension of micron-sized (1-3 um) colloidal silica spheres confined to a long narrow channel. The sample channel cell is printed on a polydimethylsiloxane substrate. After a suspension is prepared and placed in the channels, it is recored by means of digital video microscopy. Two-dimensional position data is then extracted from movie frames and analyzed on a computer. The data is then used to calculate various functions which can be compared to theoretical predictions and from which certain properties of the suspension can be inferred.

The purpose of this research is to gain insight into effects of confinement on hydrodynamic interaction of colloidal systems. The majority of previous theoretical and experimental studies focused on either quasi-one-dimensional (q1D) or quasi-two-dimensional (q2D) systems. This research is concerned with "intermediate" systems and transition from q1D to q2D. Our experiments explore the effects on the pair diffusion coefficients of the system by varying confining channel width and suspension density. Pair diffusion coefficients within whole channels and within individual strata are investigated. Ultimately, we aim to determine how dynamic parameters of the system change during q1D-q2D transition and evaluate how well theoretical knowledge of q1D or q2D systems can be applied to the transitional state.