The flow of particle-laden flows occurs widely, including bulk flows at low or high Reynolds numbers. We give a few examples of our current work in this area.

First we consider flow in a T-junction, which is perhaps the most common element in many piping systems. The flows are laminar but have high Reynolds numbers, typically Re=100-1000. It seems obvious that any particles in the fluid that enter the T-junction will leave following the one of the two main flow channels. Nevertheless, we report experiments that document that bubbles and other low density objects can be trapped at the bifurcation. The trapping leads to the steady accumulation of bubbles that can form stable chain-like aggregates in the presence, for example, of surfactants, or give rise to a growth due to coalescence. Our three-dimensional numerical simulations rationalize the mechanism behind this surprising phenomenon. Second, we consider low-Reynolds-number flows of colloidal solutions in channels and porous systems involving chemical gradients. We document how salt gradients, via a mechanism referred to as diffusiophoresis, can remove particles from dead-end pores or deliver particles into such pores. The transport can be size dependent and we explore the phenomenon using experiments and modeling. Also, we show a final example to show how the effect can produce membraneless filtration.

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