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Particle trapping in merging flow junctions by fluid-solute-colloid-boundary interactions[1] SANGWOO SHIN, University of Hawaii at Manoa, JESSE AULT, Oak Ridge National Laboratory, AMY SHEN, Okinawa Institute of Science and Technology — Merging of different streams in channel junctions represents a common mixing process that occurs in systems ranging from soda fountains and bathtub faucets to chemical plants and microfluidic devices. Here, we report a sudden trapping of colloidal particles in a merging flow junction when the merging streams have a salinity contrast. We show experimentally and numerically that the particle trapping is a consequence of complex interactions between diffusioosmosis, diffusiophoresis, and the freestream flow. A delicate balance of these transport processes results in a stable vortex near the junction that traps the particles in various modes depending on the flow conditions. We use 3-D particle visualization and numerical simulations to provide a rigorous understanding of the observed particle trapping phenomenon. The trapping mechanism we identify is unique from the well-known inertial trapping that is enabled by the vortex breakdown as the current particle trapping can occur even at Reynolds number below unity. Our study demonstrates a good example of how nonlinear, coupled fluid-solute-colloid-boundary dynamics can result in peculiar particle behavior in simple flow systems.

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