Inertial microfluidics for high speed, high-throughput particle and fluid manipulations

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Although microfluidic flows are treated as Stokes-flow for most operation conditions, fast flow speed can lead to fairly high Reynolds number (~100). In this regime, non-negligible inertial effects appear, which include inertial focusing, ordering, and inertially-driven secondary flows. Inertial microfluidic systems allow manipulation of fluid flows and particles within microchannel flows at extremely high speed and throughput, which leads to applications in high-throughput cell separations and flow cytometry. In this talk, the inertial effects in microfluidic systems and their applications will be introduced. Recent results of investigating inertial focusing beyond simple parabolic flows in rectangular channels will also be discussed. Inertial focusing behavior is observed and new methods of focusing position manipulation are suggested by velocity profile engineering in non-rectangular cross-section channels and co-flow system of two fluids having different viscosity. In addition, real-time tuning of inertial focusing positions and fluid mixing will be discussed.