Droplet migration toward and away from wall in micro-flow

YENG-LONG CHEN, SHIH-HAO WANG, WEI-TING YEH, Academia Sinica — The hydrodynamically-induced particle migration phenomenon in microfluidic flow has been applied for cell isolation and particle separation. First-order analysis has been able to predict the migration velocity due to particle surface inertial stress and particle deformation, for small Reynolds $Re$ and Capillary ($Ca$) numbers [1]. However, at moderate flow rates, non-linear dependences of particle migration on flow rate are found [2]. We employed lattice Boltzmann-immersed boundary method to examine the dependence of droplet migration on $Re$, $Ca$, and the droplet inner/outer viscosity ratio $\lambda$. We found that whether a droplet migrates towards or away from the wall at steady state depends strongly on $\lambda$. At high flow rates, droplets with lower inner viscosity migrate towards the center. At low flow rates, there is an optimal $\lambda$ at which the droplet steady state position is closest to the channel center. This result agrees with prior experimental observations for oil in water droplets [3]. The consequences for particle separation will be discussed.