# On the Use of Lattice Boltzmann Method for Simulating Peristaltic Flow of Particle-Laden Bingham Fluids in a Closed Cavity

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**Abstract:** With the advent of microfluidic systems, the need to manipulate small amounts of physiological fluids within a small cavity (without causing any damage to the fluid or its constituents) has dramatically increased in recent years [1]. Ordinary micro-pumps and stirrers are often realized to be inappropriate in such applications both because of the small space involved and also because they damage the fluid under investigation (say, blood samples, cell cultures, etc.). Recent studies involving Newtonian fluids have shown that peristaltic wave(s) generated by transversely vibrating the flexible walls of a closed micro-cavity can be used as an efficient tool for pumping the fluid and/or mixing enhancement in such tiny devices [2]. The question then arises as to the efficiency of this simple mechanism when the fluid under investigation is viscoplastic and/or contains solid particles. In the present work, it is aimed to numerically investigate the effect of a fluid's yield stress on the mean flow and mixing efficiency within a closed-ended rectangular-shaped cavity. Lattice Boltzmann method (LBM) combined with the smoothed particle method (SPM) are used for this purpose. To represent the yield stress of the physiological fluid, use is made of the bi-viscosity model. Numerical results suggest that yield stress has a non-trivial effect on the velocity profile as dictated by the morphology of the un-yielded zones. It is also concluded that when dealing with small-amplitude peristaltic waves, the yield stress improves the mixing efficiency as compared with the Newtonian fluids. But, for large-amplitude waves, the fluid's yield stress is predicted to weaken the mixing efficiency. Our preliminary results also suggest that a large particle placed on the center of the channel remains on the center before reaching the end wall, but undergoes a reciprocating motion while moving along the axis. An initially off-center particle, however, is predicted to undergo a vortical motion within the channel right from the beginning.

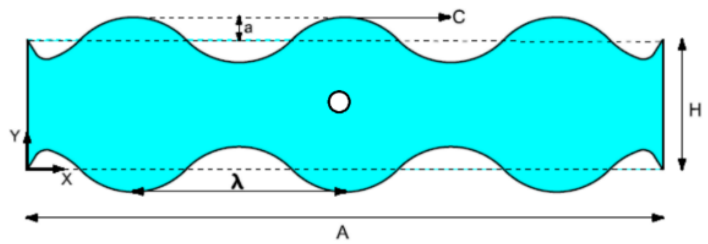


**Figure 1:** Schematic showing the flow geometry.

## References:

[1] Yi M., Bau H.H. (2002), "Peristaltically induced motion in a closed cavity with two vibrating walls", *Phys. Fluids*, **14**, 184-197.

[2] Kumar S., Kim H.J., Beskok A., (2007), "Numerical simulations of peristaltic mixing", *J. Fluids Eng.*, **129,** 1361-1371.

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