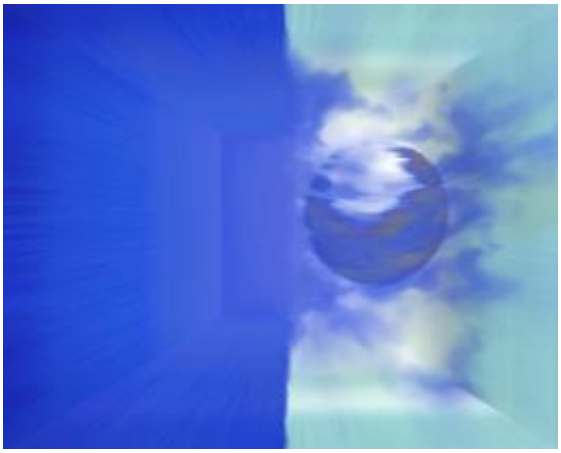
Objects moving in a stream create constructive wakes, study finds

July 18 2012, By Matthew Chin and Wileen Wong Kromhout



Artist rendering of particle-induced convection in a microchannel.

(Phys.org) -- From driftwood traveling down a river to a blood cell flowing through your artery, objects moving in a stream of fluid are mostly thought to passively go with the flow but not disturb it in controllable ways.

Researchers at the UCLA Henry Samueli School of Engineering and Applied Science have recently found that objects within a confined stream create controllable disturbances that can be used to move mass or heat at high rates, potentially providing simple solutions to performing chemical reactions on particles or cooling microelectronic chips.

Bioengineers at the UCLA's Microfluidic Biotechnology Laboratory have been studying the behavior of small objects flowing in microfluidic systems — small-scale pipes with dimensions similar to that of a human hair. They have previously demonstrated the existence of several non-intuitive behaviors, including the lateral movement and alignment of randomly distributed particles entering a channel and the spontaneous ordering of these suspended objects into trains with consistent spacing.

In addition to studying how the momentum of the fluid acted on the objects, the researchers investigated how objects themselves affect the flow. They found that suspended and self-aligned spheres in a microchannel about five to 10 times larger in diameter than the spheres within induced an additional lateral motion of fluid that helped move surrounding fluid towards the aligned stream.

The researchers identified that this effect depends on the combined effect of fluid inertia and the nearby walls around the particles. Conversely, if the objects were not initially aligned while flowing downstream, the effect becomes destructive, leading to less fluid motion.

The new discovery has implications for enhancing mass and heat transfer by the simple addition of small particles to a flow. The transport of fluid, and therefore heat, uniquely operates at an improved efficiency as flow rate increases, which is normally not expected.

The research, published online in the journal *Proceedings of the National Academy of Sciences*, was led by UCLA biomedical engineering doctoral candidate Hamed Amini and UCLA associate professor of bioengineering Dino Di Carlo. It was funded by the National Science Foundation.

"We first became aware of this effect by observing fluorescent streaks

of fluid move across the channel towards the suspended and aligned particles," said Di Carlo, who is also a member of the California NanoSystems Institute at UCLA. "It was quite exciting to see this unexpected and beautiful behavior for the first time!"

This discovery could enable applications such as the cooling of electronics to increase their performance, or enhanced catalytic reactions on the surfaces of suspended microparticles for speedier chemical synthesis.

More information: www.pnas.org/content/early/201 … /1207550109.abstract

More information is available on the Di Carlo Laboratory website at www.biomicrofluidics.com

Provided by University of California, Los Angeles

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