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Reversible and Irreversible Flow in Microfluidics

We present a deterministic microfluidic ratchet where the trajectory of a particle in a certain size range are not reversed when the sign of the driving force is reversed at low Reynolds number. This non-thermal and deterministic ratcheting effect is produced by employing triangular rather than the conventionally circular posts in a laterally displaced post array. The effect of the ratchet is to transport particles of a certain size range in a direction orthogonal to the average flow, with no net displacement of the fluid itself. The underlying mechanism of this method is shown to be connected to the asymmetric fluid velocity distribution through the gap between the right-triangular posts. This motion is not based on diffusion like other ratcheting schemes, it is deterministic, and it has a very well defined range of size action. It remains somewhat of a puzzle how to reconcile this motion with the time-reversible nature of the low Reynolds number version of the Navier-Stokes Equation, perhaps more surprises await us as we explore the range of unusual structures that can be made using the techniques of microfabrication.

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