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Synchronous Droplet Microfluidics: One "Clock" to rule them all

GEORGIOS KATSIKIS, MANU PRAKASH, Stanford University — Controlling fluid droplets efficiently in the microscale is of great interest both from a basic science and a technology perspective. Here we demonstrate a general-purpose, highly scalable microfluidic control strategy through a single global clock signal that enables synchronous control of arbitrary number of droplets in a planar geometry. A rotating precessive magnetic field provides the clock signal, enabling simultaneous control of droplet position, velocity and trajectories. Using high-speed video capture and computational droplet tracking, we characterize a number of propagation circuits. Successful propagation depends on driving frequency and the size of the droplets, which is characterized as a regime diagram and rationalized in terms of Stokes and Capillary numbers. Novel interaction regimes for hydrodynamic interaction between droplets are also identified, paving the way for building complex synchronous fluidic circuits in the future.

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