Abstract Submitted
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Droplet flows through periodic loop networks RAPHAEL JEANNERET, MICHAEL SCHINDLER, DENIS BARTOLO, ESPCI — Numerous microfluidic experiments have revealed non-trivial traffic dynamics when droplets flow through a channel including a single loop. A complex encoding of the time intervals between the droplets is achieved by the binary choices they make as they enter the loop. Very surprisingly, another set of experiments has demonstrated that the addition of a second loop does not increase the complexity of the droplet pattern. Conversely, the second loop decodes the temporal signal encrypted by the first loop [1]. In this talk we show that no first principle argument based on symmetry or conservation laws can account for this unexpected decoding process. Then, to better understand how a loop maps time intervals between droplets, we consider a simplified model which has proven to describe accurately microfluidic droplet flows. Combining numerical simulations and analytical calculations for the dynamic of three droplets travelling through N loops: (i) We show that three different traffic regimes exist, yet none of them yields exact decoding. (ii) We uncover that for a wide class of loop geometry, the coding process is analogous to a Hamiltonian mapping: regular orbits are destabilized in island chains and separatrix. (iii) Eventually, we propose a simple explanation to solve the apparent paradox with the coding/decoding dynamics observed in experiments. [1] M.J. Fuerstman, P. Garstecki, and G.M. Whitesides, *Science*, 315:828, 2007.

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