Traffic flows through periodic loop network

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Numerous microfluidic experiments have revealed non-trivial traffic dynamics when droplets flow through a T-junction or a loop. The binary choice made by a droplet as it reaches a T-junction results in a non-linear traffic dynamics and a complex encoding of the distances between the particles. Here, we aim at understanding how long-range hydrodynamic interactions build up in 1D networks with non-trivial topologies, such as periodic loop networks. To do so, we investigate how a fluidic loop maps the distances between droplets. We consider the simplest non-trivial setup made of 3 interacting droplets travelling through N loops. Combining numerical simulations, experimental measurements and analytical calculations on this system: (i) We show that the loop acts as a piecewise linear map. (ii) We demonstrate that for a wide class of loop geometries (including symmetric loops), the dynamic displays unexpected Hamiltonian features. (iii) We check that our theoretical model is in quantitative agreement with experiments with no adjustable parameter.