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Collective oscillations and coupled modes in confined microfluidic droplet arrays[1] ULF D. SCHILLER, Department of Materials Science and Engineering, Clemson University, JEAN-BAPTISTE FLEURY, RALF SEEMANN, Experimental Physics, Saarland University, GERHARD GOMPPER, Institute of Complex Systems, Forschungszentrum Jülich — Microfluidic droplets have a wide range of applications ranging from analytic assays in cellular biology to controlled mixing in chemical engineering. Ensembles of microfluidic droplets are interesting model systems for non-equilibrium many-body phenomena. When flowing in a microchannel, trains of droplets can form microfluidic crystals whose dynamics are governed by long-range hydrodynamic interactions and boundary effects. In this contribution, excitation mechanisms for collective waves in dense and confined microfluidic droplet arrays are investigated by experiments and computer simulations. We demonstrate that distinct modes can be excited by creating specific 'defect' patterns in flowing droplet trains. While longitudinal modes exhibit a short-lived cascade of pairs of laterally displacing droplets, transversely excited modes form propagating waves that behave like microfluidic phonons. We show that the confinement induces a coupling between longitudinal and transverse modes. We also investigate the life time of the collective oscillations and discuss possible mechanisms for the onset of instabilities. Our results demonstrate that microfluidic phonons can exhibit effects beyond the linear theory, which can be studied particularly well in dense and confined systems.

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