# Metamaterials of Fluids of Light and Sound

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Lattices of exciton-polariton condensates represent an attractive platform for the study and implementation of non-Hermitian bosonic quantum systems with strong non linear interactions. The possibility to actuate on them with a time dependent drive could provide for example the means to induce resonant inter-level transitions, or to perform Floquet engineering or Landau-Zener-Stückelberg state preparation. In this context, we introduce polaromechanical metamaterials [1], two-dimensional arrays of $\mu$m-sized traps confining zero-dimensional light-matter polariton fluids and GHz phonons. A strong exciton-mediated polariton-phonon interaction induces a time-dependent inter-site polariton coupling $J(t)$ with remarkable consequences for the dynamics. When locally perturbed by continuous wave optical excitation, a mechanical self-oscillation sets-in [2] and polaritons respond by locking the energy detuning between neighbor sites at integer multiples of the phonon energy, evidencing asynchronous locking involving the polariton and phonon fields. These results open the path for the coherent control of dissipative quantum light fluids with hypersound in a scalable platform.

[1] D. L. Chafatinos, A. S. Kuznetsov, A. A. Reynoso, G. Usaj, P. Sesin, I. Papuccio, A. E. Bruchhausen, K. Biermann, P. V. Santos, and A. Fainstein, Asynchronous Locking in Metamaterials of Fluids of Light and Sound, arXiv:2112.00458 [physics.optics].

[2] D. L. Chafatinos, A. S. Kuznetsov, S. Anguiano, A. E. Bruchhausen, A. A. Reynoso, K. Biermann, P. V. Santos, and A. Fainstein, Polariton-driven phonon laser, Nature Communications **11**, 4552 (2020).