Nonlinear Resonator Networks: From Complex Optics to Advanced Computing and Sensing

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Coupled systems with multiple interacting degrees of freedom provide a fertile ground for emergent dynamics, which is otherwise inaccessible in their solitary counterparts. Particularly, nonlinearity and non-equilibrium dynamics enable new opportunities in coupled photonic systems that are not present in their linear and equilibrium counterparts [1-7] that can have profound consequences in sensing and computing. In this talk, I will overview recent experimental progress on accessing such dynamics in time-multiplexed networks of nonlinear resonators towards computing and sensing applications. I will present demonstrations of topological dissipation [1], non-equilibrium spectral phase transitions [4, 5], topological mode-locked lasers [6], non-Hermitian topologically enhanced sensing [7], and photonic cellular automata [8, 9]. I will discuss the recent demonstration of neuromorphic computing in nanophotonic OPOs [10], as well as the demonstration of all-optical computing beyond 100 GHz [11]. Last, I will overview the progress on integrated optical parametric oscillators (OPOs) [12] and their networks in lithium niobate (LN) nanophotonics for sensing and classical and quantum information processing applications.

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