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PHOTONIK SEMINAR

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Light-matter condensates: from physics research to Bose-enhanced chemistry

Strong light-matter interaction inside optical cavities brings new eigenstates so-called cavity polaritons, which offer extraordinary control over the physical and chemical properties of matter [1]. One could alter chemical reactions [2], enable long-range energy transfer [3], modulate single/triplet dynamics [4], boost nonlinear optical response [5] etc. Obeying Bose statistics and despite their non-equilibrium nature, under certain conditions cavity polaritons undergo a transition to a macroscopically occupied state exhibiting off-diagonal long-range order – polariton Bose-Einstein condensate (BEC) [6,7].The macro-coherent and nonlinear nature of polariton condensates accessible at room T make them outstanding candidates for integrated on-chip photonics [8] including classical and quantum computing [9].Recently we showed molecular vibrations playing a central role in the thermalization and buildup of nonequilibrium light-matter BEC in strongly coupled organic systems [5,8]. The mechanism of condensation demonstrates an unprecedented high nonlinearity undergoing bosonic stimulation mediated by the optomechanical coupling with intense molecular vibrations [5]. In this talk, I will present an original approach based on light-matter BEC of both excitonic and vibrational states enabling unprecedented large spatial and temporal coherence at room temperature for molecular optoelectronics and offering bosonic stimulation as an elegant solution to the cornerstone problem of large dark-state density that deters the efficiency of cavity QED chemistry [10].

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