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Dynamical Patterns of Phase Transformations from Self-Trapping of Quantum Excitons

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Abstract:

Phase transformations induced by short optical pulses is a mainstream in studies of cooperative electronic states. We present a semi-phenomenological modelling of spacio-temporal effects expected when optical excitons are coupled to an order parameter as it happens in organic compounds with neutral-ionic (NI) phase transitions. After the initial pulse of photons, a quasi-condensate of excitons appears as a macroscopic quantum state which then evolves interacting with other degrees of freedom prone to instability. The self-trapping of excitons enhances their density which can locally surpass a critical value to trigger the phase transformation. The system is stratified in domains which evolve through dynamical phase transitions and may persist even after the initiating excitons have recombined. A conceptual complication appears in NI systems where both the excitation and the ordering are built from the intermolecular electronic transfer. To describe both thermodynamic and dynamic effects on the same root we adopt for the phase transition a view of the Excitonic Insulator - a hypothetical phase of a semiconductor which appears if the total energy of an exciton becomes negative. We call for the possible dynamic realization of this once exotic conjecture in circumstances of fast optical pumping. This work has been performed in collaboration with N. Kirova and expired by experiments by H. Okamoto.

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