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Coherent transport and manipulation of excitations in semiconductors using acoustic fields

Coherent acoustic phonons in the form of surface acoustic waves (SAWs) propagating on a semiconductor surface create a moving elastic and piezoelectric modulation of the underlying material. In this talk, I show that this dynamic modulation gives rise to new elasto- and electro-optic interaction mechanisms in GaAs-based nanostructures, which can be used for the coherent transport and manipulation of elementary excitations. Examples will be given for tunable photonic devices based on the manipulation of photons by acoustic fields as well as for the coherent control and transport of electrons, excitons, and electron spins by SAWs. In particular, SAWs are able to transport carriers with a well-defined velocity while maintaining the electron spin coherence over long distances ($\sim 100 \mu\text{m}$). The electron spin vector can be coherently controlled during transport by applying an external magnetic field along the transport path, thus opening the way for applications of the acoustic transport in quantum information processing.



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