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A brisk walk through phase transitions in time: oscillating order and topologically protected hidden states

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New techniques in time-resolved optical spectroscopy allow us to investigate phase transitions under controlled, yet highly non-ergodic conditions. The measurement of the temporal evolution of not only single particle and collective excitations, but also topological excitations through the transition lead to a new insight into the emergence of functional properties under non-equilibrium conditions. The experiments on well-known rare earth tellurides and transition metal chalcogenides which I will discuss reveal some unexpected phenomena. Femtosecond coherent oscillations of the order parameter and the subsequent creation and annihilation of topological defects lead to the emission of dispersive Higgs-like amplitude waves [1,3]. Most remarkably, switching to a stable, topologically protected state can occur under specific conditions, opening a route to the creation of hidden states [2]. Such switching at unprecedented speed between macroscopic quantum states with different charge order indicates a potential for ultrafast non-volatile memory technology, in the form of either optically or electrically controlled RAM devices.

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