**Band topologies and spin-phonon dynamics of spin-orbit coupled insulators: a study with the real-time TDDFT**

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**Topological phases of solid-state bands have been widely examined in these days condensed matter field, and global properties immune to local perturbations have been explored as topologically non-trivial observables. The computations of topological quantities of real materials are affordable only through the theories of linear responses over the static ground electronic structure. Here, we propose a conceptually novel and general method: we perform the time evolution of the solid state, , through the time-dependent Schrödinger equation, and calculate physical observables such as charge current or spin current as an expectation evaluated from the time-evolving states functions. We present exemplary cases of trivial insulator, a spin-frozen valley-Hall system, a spin-frozen Haldane-Chern insulator, and quantum spin-Hall insulators. The same real-time dynamics is also used for the phonon-coupled spin dynamics of semiconductors with strong spin-orbit coupling. We present that the spin precession dynamics of MoS2 in which the spin is strongly coupled to a specific optical phonon. This dynamical spin state can be resolved into discrete Floquet-phononic spectra, and once the phonon is pumped so as to break time-reversal symmetry, the resulting spin-Floquet structures induce net out-of-plane magnetizations in the otherwise non-magnetic 2D material.**