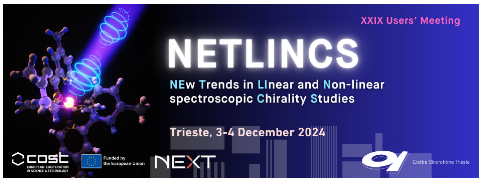

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Nanoscale Sensing of Non-Centrosymmetric Systems by Quantum Control Methods

Quantum control methods exploit quantum mechanical effects in order to manipulate quantum systems towards a desired final state - in particular when several final states are energetically allowed - in most cases by applying external electromagnetic fields. In this way, quantum control methods can be used as the underlying mechanism of novel sensing methods at the nanoscale when frequency-based-only spectroscopic techniques fail to distinguish between two systems that are energetically degenerate. Non-centrosymmetric systems, like chiral systems, with states for which parity is not well-defined, are systems
resulting into two or more energetically degenerate equilibrium configurations. In such systems quantum control methods exploit the frequencies and phases of the external electromagnetic fields in order to distinguish between energetically degenerate systems, by steering the system to a different final state since the process dynamics is phase-sensitive.

In this work we investigate some of the quantum control methods for sensing non-centrosymmetric molecular systems at the nanoscale. In particular, we use cyclic population transfer (CPT) methods that steer the initial state to the desired final state almost adiabatically, which are in general robust but require long duration thus being prone to detrimental effects due to the environment. We also use methods that try to mimick the adiabatic methods but with much shorter duration, usually called shortcuts to adiabaticity (STA) methods; these methods avoid the detrimental effects of the environment that typically downgrade the adiabatic methods, and CPT as one of them, by reaching the desired final state in much shorter time. Lastly, we also use methods that bring the system in the desired final state at particular time moments with well-defined repetition rate, thus creating a discrete time crystal of the final state, by periodically driving externally the system by Floquet engineering.

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