The recent advent of attosecond pulses enables pump-probe experiments at the time scale of electron dynamics, which allows investigations of processes on the electronic time scale. At this point, a scalable theoretical method to model electron dynamics, reliable beyond the perturbative regime, becomes crucial. Time Dependent Density Functional Theory (TDDFT) is a good candidate which can, in principle, reproduce the density response to all orders. In practice however, approximations need to be used for the exchange-correlation (XC) functional.

We define a non-equilibrium response function and reference a fundamental property of quantum systems driven by external fields: Once the external field has been turned off, assuming clamped ions, the resonances are constant.

This property results in an exact condition for the XC functional, which is: Any spurious time-dependence of the Kohn Sham response needs to be cancelled out. As we demonstrate with several examples, XC approximations currently in use typically violate this condition, resulting in spurious time-dependent spectra.