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Recent developments in time-dependent density-functional theory within and beyond linear response

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Time-dependent density functional theory (TDDFT) is a popular and rather successful method in the description of photo-absorption spectra of atoms and molecules in the linear response regime. In extended solids, however, a satisfactory description of excitonic effects has become possible only recently with the advent of advanced approximations for the exchange-correlation kernel f_{xc}. One of these advanced approximations is the so-called bootstrap kernel [S. Sharma et al, PRL **107**, 186401 (2011)]. We shall explore the performance of this kernel in the long-wavelength limit and for finite values of q, looking at electron-loss as well as photo-absorption spectra. We find, in particular, that excitonic effects in LiF and Ar are enhanced for values of q away from the Γ-point [S. Sharma et al, New J Phys **14**, 053052 (2012)]. Then we present two recent developments in TDDFT beyond the linear-response regime: (i) By using a geometrical partitioning, we calculate the angle and energy resolved photo-electron spectra of finite systems including multi-photon effects [De Giovannini, et al, A. Rubio, PRA **86**, 062515 (2012)]. (ii) Finally we show how the dynamics of many-electron systems can be controlled with lasers by marrying TDDFT with optimal control theory [A. Castro et al, PRL **109**, 153603 (2012)].