Title:	Development of attosecond delay lines for ultrafast metrology and isolation of non-adiabatic attosecond dynamics in atoms
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Abstract:	Optical delay lines are key tools in ultrafast science and technology with several applications from femtosecond metrology to attosecond pump-probe spectroscopy of matter. In this thesis work, we have developed and designed an attosecond resolved dispersion-free optical delay line for easy Ultrafast metrology by using a pair of knife- edge prisms, we symmetrically split and later recombine the two wavefronts. We have demonstrated this optical delay line as an autocorrelator for femtosecond metrology. We have employed two measurement methods namely interferometric autocorrelation and SHG-FROG and validated them theoretically and established them as an auto- correlator and FROG device for many to few-cycle femtosecond pulses. Our setup is compact, and offers attosecond stability with flexibility for independent beam-shaping of the two arms. In addition, another in-house developed picometer resolved Ultrathin interferometer is calibrated for precise "Zero Path difference" position using White light interfer- ometry by performing simulations using Huygens-Fresnel-Kirchhoff diffraction theory. We have incorporated this Ultrathin interferometer with an attosecond beamline as it provides attosecond stability as well as resolution due to its compact geometry and common path configuration. The ultrathin-delay line allowed us to observe non-adiabatic phenomena in High Harmonic Generation (HHG) in gases via a temporally structured IR pulse. The tem- poral structuring is done via temporally delaying two moderately long IR-IR pulses which provide a different resultant pulse in the time domain at different delay posi- tions. The change in the resultant pulse or double pulse is investigated at different time delay positions and spectral changes are observed due to the interference effect induced via time delay between both identical pulses. We have observed spectral vari- ations such as splitting (double peak structure) and spectral shifting in some delay regimes at the sub-cycle scale near time zero. The method of using delayed IR-IR pulses with attosecond resolution is easy to perform and efficiently used for control- ling electron trajectories and isolating complex Quantum path interference (QPI) in HHG. Our experimental results show good qualitative agreement with theories based on classical electron trajectories and quantum dynamics within the TDSE framework. The method is ideal to use with few-cycle pulses for controlling and tuning attosec- ond pulse train (APT) as well as Isolated attosecond pulses (IAP) with precise delay control.
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