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Time resolved optical and Raman spectroscopy under ultra-high vacuum conditions: a novel apparatus for pump-probe multi-messenger investigations

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In the last decades, advances in the generation and manipulation of ultrashort light pulses allowed photon and electron spectroscopies to access the time domain in the consolidated pump-probe scheme. Refined in several aspects, the technique has demonstrated its versatility in accessing the dynamics and transient states produced by impulsive photoexcitation on various physical systems, opening new perspectives for light-induced phase transformations. In this scenario, we propose a multi-messenger spectroscopic approach where the absorbed/scattered photons, photoemitted electrons, and electron-spins are measured as messengers of energy, momentum, and spin of the out-of-equilibrium states after coherent ultrafast photoexcitation of the system. At the SPRINT-NFFA facility, we developed a time-resolved optical and Raman spectrometer for pump-probe experiments with sub-ps time resolution on samples spanning the 8-350 K range under UHV conditions. The laser system, comprising multiple-OPA and a table-top HHG source, can deliver, in a two/three-pulse scheme, ultrashort (≈ 100 fs) IR-to-XUV pump pulses and visible sub-ps probe pulses for Raman and optical measurements. The reflected/scattered signal is collected at variable angles. The UHV chamber is coupled, via UHV-suitcase, with the angle- and spin-resolved photoelectron spectroscopy setups already operative at the facility*. We will present the experimental setup layout discussing the first experimental test results.

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