Attosecond Chronoscopy: From Atoms to Condensed Matter

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Observing and clocking non-equilibrium electronic dynamics in real time has developed into one of the key areas of attosecond physics . Attosecond chronoscopy holds the promise to provide novel information on many-electron systems complementary to conventional spectroscopy. The timing of the photoelectric effect represents one of the first breakthroughs of attosecond chronoscopy . Its extension to condensed matter opens up new opportunities to explore electronic band structures and topology, electron transport, and decoherence. We will illustrate the timing of electronic processes with the help of a few recent prototypical examples. They include the Eisenbud-Wigner-Smith (EWS) time delays in atoms and molecules and transport time delay in layered materials , the influence of the collective screening response on electron timing, the quest for identifying the speed limit of optoelectronics, and timing of valleytronics in graphene.