Controlling light to the extreme: new results and applications of the dispersion-scan technique

Helder M. Crespo(1)
(1) IFIMUP-IN and Department of Physics and Astronomy, Faculty of Sciences, University of Porto, Rua do Campo Alegre 687, 4169-007 Porto, Portugal, e-mail: hcrespo@fc.up.pt

Nowadays, intense light pulses comprising only a few oscillations of the electric field are key tools in many fields of science and technology. With such short pulses, which have typical durations in the few-femtosecond range, light-matter interactions can exhibit a strong dependence not only on the intensity profile of the pulses but also on their electric field. In this regime, knowing and controlling the carrier-envelope phase (CEP) of the pulses (which measures the position of the electric field within the pulse envelope) is therefore paramount for many important applications, such as attosecond science, which is providing direct access to the ultrafast dynamics of fundamental processes in matter, allowing for the ultimate control of physical systems and devices.

Few-cycle light pulses are among the shortest optical phenomena ever generated and measured, and their widespread use has been hampered due to limitations and difficulties in pulse measurement technology. The measurement and control of few-cycle light pulses is as challenging as their generation and is therefore a topic of intense research.

Invented in 2011, the dispersion-scan (or d-scan) technique [1] presents a new paradigm in ultrashort pulse measurement and control that effectively came to solve many of the problems associated with traditional pulse characterization methods when dealing with ultra-broadband few-cycle pulses. D-scan approaches ultrashort pulse measurement in a totally new way, whereby traditional pulse manipulation operations (such as beam splitting, temporal delay, and recombination) are totally left aside, and replaced by a single beam architecture that greatly simplifies its practical implementation. while enabling the measurement and compression of femtosecond pulses down to single-cycle durations [2,3] from single laser-based light sources. These sources are now enabling a variety of high-impact results and applications.

In this talk we will review some key aspects of the technique and present recent d-scan-enabled applications and results now being obtained by d-scan users around the world, such as ultrafast spectroscopy of magnetic dynamics with unprecedented temporal resolution [4], direct attosecond pulse generation, MeV electron acceleration at kHz repetition rates [5] or improved biomedical imaging.

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