Ultrashort Pulse Characterization

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The response times of electronic detectors are still orders of magnitude behind the time scales achieved and dealt with in Ultrafast Optics and Photonics. In these fields, researchers routinely experiment on physical phenomena spanning picosecond femtosecond and attosecond ranges. As a result, special non-trivial characterization methods are needed for dealing with such extremely short durations. Most characterization methods stem from the idea of "autocorrelation", or using a short event to measure itself. This basic idea provides some clues about the pulse. Fortunately, however, the field of ultrashort pulse characterization has gone much further beyond the limited estimates from simple autocorrelations. Today, we can extract the complete temporal / spectral evolution of ultrashort pulses, including both the intensity and phase information. Even further, space-time couplings and complete spatio–temporal electric fields can also be extracted with high sensitivity and reliability.

In this course, we will first review fundamental principles of ultrashort pulse characterization. We will then go deeper into particular commonly used methods such as Frequency-Resolved Optical Gating (FROG) and Spectral Phase Interferometry for Direct Electric-field Reconstruction (SPIDER), as well as their derivative methods. We will also discuss additional considerations for particular pulse regimes including near-single-cycle durations, relatively long – narrowband lasers, and extremely complicated pulses.