# Reshaping Ultrashort Electromagnetic Pulses Using Nonlinear Optical Effects

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Attosecond physics looks to understand the nonlinear response of materials, measuring the evolution of quantum wavepackets under the influence of strong electromagnetic radiation. Nonlinear optics looks at how these specific materials affect the properties of electromagnetic waves, such as frequency, polarization, and phase. Electrons inside of a material change on attosecond (1 as = $10^{-18}$ s) scales, and these processes can be incited and measured using highly intense, ultrashort pulses of light on the order of femtoseconds ($10^{-15}$ s). Nonlinear optical processes can be used to improve physics experiments, telecommunications, and potentially for surgical procedures.

The focus of the model presented in this project is to study the nonlinear effects of two different kinds of materials, namely argon, and glass (fused silica). This is accomplished by passing a 70 fs laser pulse with a wavelength of 1.8 µm through 1 m of argon and subsequently through 3 mm of glass. These materials can reshape laser pulses to desired widths of 10 fs and can create new useful frequency components, which are very useful for attosecond science applications.

This project demonstrates how nonlinear optics can be used to understand how materials produce new frequency components and altered waveforms that can be useful in many applications. Nonlinear optical processes have found usage in important physical experiments such as the detection of gravitational waves. Nonlinear processes can also be used to improve signal transfer rates, such as satellite communication and telecommunications speeds, such as fibre optic internet.