Topic: **Temporal Effect on the Higher Harmonic Generation**

Type of work: B.Sc. Thesis, Research Project, MSc. Thesis

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Topic Description:

High Harmonic Generation (HHG) is a fascinating nonlinear optical process where intense laser light interacts with a gas medium, producing extreme ultraviolet (XUV) or even soft X-ray radiation. This phenomenon is not only of fundamental interest but also central to cutting-edge research in ultrafast science. The importance of this field was globally recognized with the 2023 Nobel Prize in Physics, awarded to scientists who pioneered experimental methods for generating attosecond pulses using HHG. These breakthroughs have opened new windows into observing electron dynamics on their natural time scale.

This student project focuses on investigating the temporal effects that influence the HHG process. You will explore how properties of the laser pulse—such as its duration, chirp, and phase—affect the generation efficiency, spectral structure, and angular distribution of harmonics. Special attention will be given to the interplay of short and long electron trajectories and how their contributions can be controlled or enhanced through temporal shaping of the laser field.

Goals and Objectives:

- Understand the basic physics of HHG and the three-step model.
- Explore the role of the driving laser pulse's temporal properties (e.g., chirp, pulse duration).
- Analyze how temporal effects influence the efficiency and spectral features of HHG.
- Optionally, assist in experimental measurements if available.

Skills Gained:

- Fundamentals of ultrafast optics and nonlinear processes.
- Introduction to time-frequency analysis and trajectory modeling.
- Experience in data analysis, simulations (e.g., Python/MATLAB), or laboratory work.