Project title: Ultrabright Sources of Attosecond Pulses

Supervisor(s):	**Mark Yeung**
Email contact:	**m.yeung@qub.ac.uk**
Helpful existing knowledge:	**Electromagnetism and optics, laser physics, plasma physics**
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Project Description:

The internal mechanics of atomic and molecular electronic systems operate on a timescale of attoseconds (10^{-18}s) which require sources of intense bursts of light on this same timescale both for the control and probing of such ultrafast dynamics [1]. This was the subject of a recent Nobel Prize in Physics [2]. One promising route to such a source is the intense interaction of a laser pulse with a solid density plasma surface which leads to relativistic electron motion and nonlinear modulation of the incident field corresponding to the presence of ultrahigh frequencies confined to attosecond scale bursts (see figure 1) [3].

This project will focus on the development of novel methods of optimising and characterising the generation of such attosecond pulses from intense femtosecond laser interactions with solid targets. This will consist of two main strands – maximising the generation efficiency of this mechanism and trialling state-of-the-art techniques for isolating individual attosecond pulses. This will comprise of both experimental work and the use of numerical simulation codes to model the interaction.

The successful applicant will work alongside experienced researchers in the Centre for Light Matter Interactions (CLMI) and will involve work at a variety of major facilities globally (eg. the Central Laser Facility in the UK and the JETI200 laser at the Helmholtz Institute Jena in Germany). As such, this project will provide the opportunity to travel and work alongside researchers from across the world and develop skills in optical alignment, X-ray spectroscopy and numerical modelling.

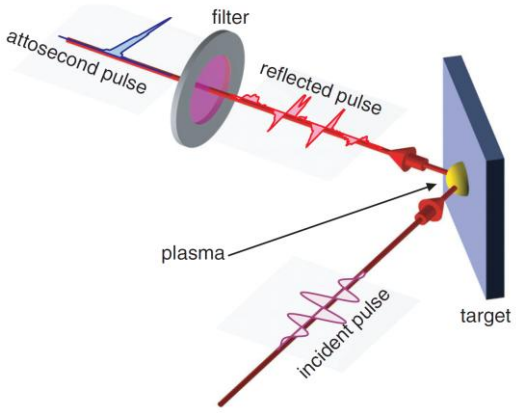

Figure 1 – Basic scheme of attosecond pulse production from a plasma surface. An intense laser pulse ionises the surface of a solid target and during the subsequent non-linear interaction yields high frequency radiation in the modulated reflected waveform. Filtering out low frequency components results in an ultrashort attosecond pulse. Figure taken from reference [4].

Useful references

[1] F. Krausz and M. Ivanov "Attosecond Physics", Rev. Mod. Phys., **81**, 163 (2009)
[2] https://www.nobelprize.org/prizes/physics/2023/summary/
[3] B. Dromey et al. "High harmonic generation in the relativistic limit", Nat. Phys., **2**, 456 (2006)
[4] G. Tsakiris et al. “Route to intense single attosecond pulses”, New J. Phys., **8**, 19 (2006)