Project Title: Synthesizing 3D Light Fields for Manipulating Chiral Matter

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Type of Project: EXPERIMENTAL

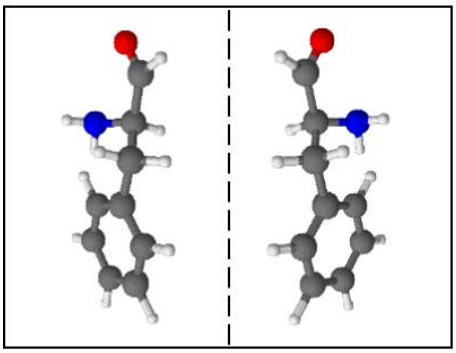
Helpful existing knowledge: Electromagnetism and optics, Python or Matlab skills

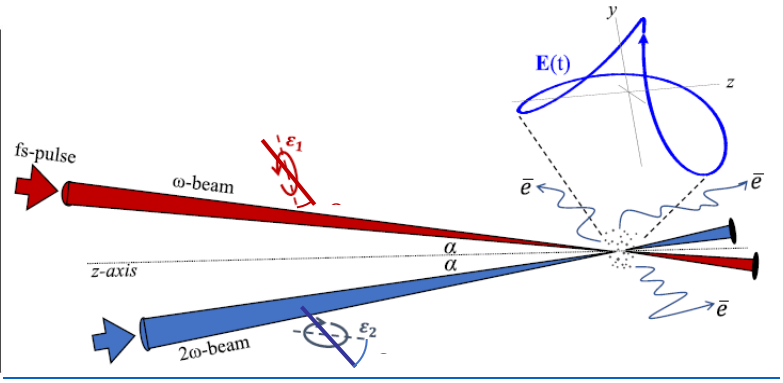
Funding status: Royal Society International Exchange – funds a collaboration with University of Bordeaux, QUB Agility Plus funding

Project Description

A chiral object has no internal plane of symmetry and its mirror image cannot be superimposed on itself. In biology, the building blocks of life such as sugars, amino acids, and DNA are chiral and exist only in one-handed form. The origin of this homochirality in Nature is one of the great unanswered questions in Science. As a result, chirality is very important to the pharmaceutical industry as the interaction drugs have with the body critically depends on the handedness of the molecule.

Being able to preferentially manipulate or distinguish a chiral molecule from its mirror image is difficult. Circularly polarised light can induce the chiral interaction but it is very weak. In this project, by overlapping multiple laser pulses, exotic polarization states of light will be created so that the electric field maps out twisted 3D shapes in space. The aim is to demonstrate that these can selectively ionise and/or destroy one handedness of a chiral pair of molecules. This symmetry breaking is of fundamental interest but could also unlock the potential for lasers to synthesize chirally pure chemical samples.





Skills gained by student

- Simulation skills using Matlab or Python
- Data Analysis
- Short pulse lasers and optics
- Vacuum Technology
- Mass Spectrometry

Useful references

Determining Molecular Chirality with Femtosecond Lasers, Caoimhe Bond, PhD Thesis (2021)
pureadmin.qub.ac.uk/ws/portalfiles/portal/238774588/CaoimheBond_Thesis.pdf

Synthetic chiral light for efficient control of chiral light–matter interaction, D. Ayuso et al., Nat. Phot., 13, 866–871 (2019)
doi.org/10.1038/s41566-019-0531-2