Nonlinear Optics in Gas-Filled Optical Fibres

Hollow-core fibres, both with and without microstructure, provide a versatile platform for ultrafast nonlinear optics in gases at high intensity over long interaction lengths. Gas-filled hollow fibres can be transparent in regions of the electromagnetic spectrum ranging from X-rays to terahertz, and many gases, particularly the light noble gases, have ionisation energies significantly higher than those of solid-state materials. Combined, these properties mean that high optical pulse power and pulse energy can be transmitted and manipulated in hollow-core fibres over a wide spectral range. The fact that gases are compressible means that the material dispersion and nonlinearity of a gas-filled hollow fibre can be easily controlled during an experiment, allowing live dispersion and nonlinearity tuning. Furthermore, the fundamental character of the nonlinear response can be altered through the type of gas used and the role of plasma or Raman effects. In this lecture I will explain how these properties can be exploited for sub-femtosecond pulse compression of near-infrared laser pulses using optical solitons, for frequency up-conversion to the far-ultraviolet through either soliton dynamics or four-wave mixing processes, and for a new regime of broadband supercontinuum generation.

Lecturer: John Travers is a Professor of Physics at Heriot-Watt University. He has made multiple significant contributions to ultrafast nonlinear optics and is recognised as a pioneer in using gas-filled hollow waveguides for ultrafast frequency conversion, pulse compression and supercontinuum generation. John received the M.Sci degree in Mathematics and Physics from Durham University, UK, in 2003 and the M.Sc and Ph.D degrees from Imperial College London in 2004 and 2008, working with Prof. J.R. Taylor. For his Ph.D thesis he was awarded the European Physical Society's Quantum Electronics Thesis Prize. After working for six years in Prof. Philip Russell's division at the Max Planck Institute for the Science of Light, Erlangen, Germany, he moved to the Institute of Photonics and Quantum Science at Heriot-Watt University in 2016, where he was promoted to full Professor of Physics in 2019. In 2015 he was awarded a European Research Council (ERC) Starting Grant. In 2020 he was awarded an ERC Consolidator grant and elected Fellow of Optica (OSA). In 2022 John was awarded the IET A F Harvey Engineering Research Prize for his work on vacuum ultraviolet generation and extreme pulse compression in gas-filled hollow-core fibres. For further details see https://lupo-lab.com.