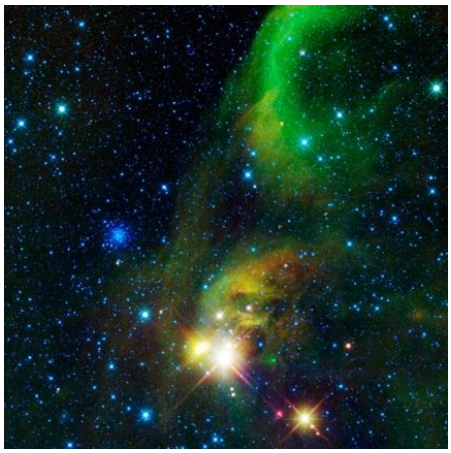
Laboratory Astrophysics: atomic physics and spectroscopy of astrophysically important elements and applications to astrophysics.



PhD project
Space, Plasma, and Climate Community
October 2025 start, full-time.

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Research areas: atomic physics, spectroscopy, astrophysics and atmospheric physics

Background: The spectra of planetary atmospheres and stars are usually extremely complex: all the elements of the periodic table may contribute, as molecules or atoms in more than one stage of ionisation, blends of several lines are the rule rather than the exception. New high-resolution spectrographs on ground- and space based telescopes give exciting spectra of stars and planetary atmospheres, but the laboratory atomic data (atomic energy levels, wavelengths etc), vital for the interpretation of the astrophysical spectra, are often too inaccurate and incomplete. Vast improvement is needed in many cases in knowledge of atomic spectra in the laboratory.

The Physics Department Space, Plasma & Climate Community's Spectroscopy Laboratory has world class instrumentation – two high resolution Fourier Transform spectrometers covering the IR, visible to the UV, with our UV spectrometer holding the short wavelength record for an instrument of its kind. These spectrometers, with their very high resolution and broad spectral range, are ideal for studies of astrophysically important atoms and ions. Once an atomic spectrum has been investigated in the laboratory, an analysis of the spectrum is carried out to yield new atomic parameters over a broad spectral range (infra red through to ultraviolet) at unprecedented accuracy. We collaborate internationally on applications of the new atomic data. Examples include our work on the Gaia ESO survey of 100,000s Galactic stars to understand Galactic evolution.

Research Objectives: An STFC funded Ph.D. project is available to investigate astrophysically important atomic spectra using high resolution spectroscopy. Spectra to be studied will be carefully selected to be most relevant and urgently needed for astrophysics applications. The initial stage of the project is experimental in nature with spectra being studied at Imperial College, and possibly also at the National Institute of Standards and Technology (USA), with whom we regularly collaborate. The student will then undertake a full analysis of the spectra, for example finding new energy levels. We anticipate collaboration with theoretical atomic physics groups during this analysis stage. The new atomic data will then be applied in particular astrophysical spectral analyses through collaboration with astronomers. Examples of our recent research include working with teams investigating topics as diverse as Galactic evolution, time variation of the Fundamental constants, and neutron star mergers where there is much interest currently because of Gravitational Wave observations.

You will gain: experimental expertise in a world-class laboratory, using unique instruments; experience undertaking experiments in laboratories abroad; learn about atomic physics; skills in theoretical analysis of spectra learning computational and analytical skills including machine learning and AI; experience working on applications of the new atomic data to analyses of particular astrophysical spectra.

The Student: The strongest candidates will have a first class degree in physics or astrophysics. This PhD suits a student who enjoys a combination of computational, analytical and experimental work.

Please contact me (j.pickering@imperial.ac.uk) if you have any questions.