

PhD Project: Atomic physics and plasma spectroscopy of astrophysically important elements

Full-time studentship (starting October 2025) within the Space, Plasma & Climate Community, Physics Department, Imperial College London, South Kensington Campus

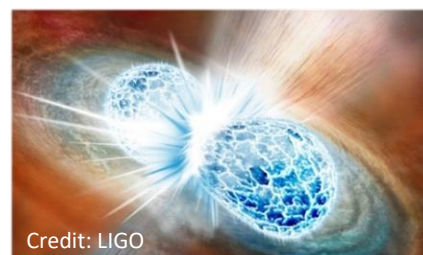
Research Areas: Atomic & plasma physics, spectroscopy, and astrophysics

Background: New, high-resolution spectrographs on ground- and space-based telescopes are providing incredible spectra of stars and planetary atmospheres, enabling us to answer some of the most exciting questions about the Universe and our place within it. However, the fundamental laboratory atomic data vital for the interpretation of these astrophysical spectra are often too inaccurate and incomplete. Vast improvements in the quality and quantity of experimental atomic data are urgently needed. The spectra of stellar and planetary atmospheres are usually extremely complex: all the elements of the periodic table may contribute, and atoms in more than one stage of ionisation and blends of many lines are the rule rather than the exception.



The Imperial College London Space & Atmospheric Physics Spectroscopy Laboratory has world class instrumentation – two high-resolution Fourier transform spectrometers covering the infrared (IR) to vacuum ultraviolet (VUV) spectral range, with our VUV spectrometer holding the short wavelength record for an instrument of its kind. These spectrometers, with 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 determine previously unknown atomic parameters such as energy levels and transition probabilities at unprecedented accuracy. We collaborate internationally on applications of the new atomic data and recent examples include our work on the Gaia ESO survey of 100,000s Galactic stars to understand Galactic evolution.

Research Objectives: An interdisciplinary 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 at collaborating laboratories in the USA, Sweden or Spain. The student will then undertake a full analysis of the spectra to determine urgently needed atomic data, which involves applications of a range of traditional computational algorithms, as well as exploring AI and machine learning models to develop novel spectrum analysis methods. We also anticipate new quantum mechanical atomic structure calculations to be made, through collaborations 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 instrumentation; experience undertaking experiments in laboratories abroad; deeper knowledge of atomic physics; skills in theoretical analysis of atomic spectra; a variety of computational and analytical skills including machine learning and AI; experience working on applications of new atomic data to analyses of astrophysical spectra.

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

Applications: information on how to apply can be found at:
<https://www.imperial.ac.uk/study/apply/postgraduate-doctoral/>

Please inform Prof. Juliet Pickering j.pickering@imperial.ac.uk when you have submitted your online form.

Eligibility information for STFC Research Council studentship funding and other funding routes can be found at: <https://www.imperial.ac.uk/study/fees-and-funding/>

Application deadline 31st January 2025.