
# GRADUATE SCHOOL COURSE CATALOGUE 2025/26

# SUPA Course Catalogue 2025/26

The Scottish Universities Physics Alliance, SUPA, is a collaboration of eight Physics departments across Scotland. The SUPA Graduate School shares teaching across these institutions. Upon enrolling for post-graduate studies in a SUPA university, you are automatically admitted to the SUPA Graduate School.

This catalogue contains information about how SUPA functions as well as current courses offered by SUPA.

General information about how to register, join courses and get credit for non-SUPA courses is on pages 4-7. A list of courses appears on pages 9-11, while longer course descriptions can be found on pages 12 - 33.

Each course description contains helpful information about the course. For example, the Status indicates if the course will be offered this year. Some courses are offered only in alternate years, and some courses may be suspended temporarily. Please check the status of a course to find out if it will be available this year.

At the bottom of each course description there is a link to the relevant my.supa course page. The link takes you to the registration page for the course.

Details for many semester 2 courses are not finalized until the end of Term 1. Please check back as we will post new information when it is available. The catalogue is updated multiple times during the year.

SUPA courses are shared in various ways. Some are held in the SUPA classrooms, which are listed on page 5. These rooms are linked by Zoom. Participants can join these classes in their local SUPA classroom or can join these zoom calls anywhere, using a personal device. Other courses are shared outside the SUPA classrooms. Information about how to join a course will be posted on the my.supa page for the course.

**Students are strongly encouraged to attend courses live, as they happen.** Interacting with the lecturer and other students during class time has been shown to have a positive impact on student learning. For any questions or concerns, please contact admin@supa.ac.uk

Welcome to SUPA!
The SUPA Team

## Table of Contents

# The SUPA Graduate School

SUPA courses fall into two categories, Specialist and Professional Development.
Students may fulfil their course requirements through courses offered outside SUPA. This is true for both Specialist and Professional Development courses. Students must discuss their course selections with their supervisors. Courses taken prior to enrolment in a PhD will not count toward PhD course requirements.
Student performance will be recorded by SUPA Central, and information may be provided to departments via the Graduate School Committee and the Executive Committee for student progression.

## Specialist Courses

Specialist courses are closely related to a student's research interests. Frequently, students take courses within their research theme. However, students are encouraged to take the courses most relevant to their work, regardless of theme. Specialist courses are listed by theme on pages 12 – 29.

Doctoral students are expected to take 40 hours of Specialist courses in the first two years of their studies. For example, a student might take a 24-credit course in their first year, and a 16-credit course in their second year. Your home university may have additional requirements.

All specialist courses are assessed. Students must pass the assessment to get credit for the course. Courses are assessed by various methods. The assessment for a specific course can be found in the course listing. Students are advised to check the type of assessment with the lecturer at the start of a course.

Students may audit Specialist courses. This may be appropriate if students are interested in the topic and want to attend lectures but do not have time to complete the course work. Students must enrol as non-assessed to audit courses. Students do not receive credit for audited classes.

## Professional Development Courses

Professional Development courses appeal to students in a variety of research areas. Professional development training can help students manage their research projects and improve their writing and coding skills. These courses may also broaden career options. Doctoral students are expected to take 20 hours of Professional Development courses in the first two years of their studies. Your own university may have additional requirements.

Professional Development courses will have an informal or ongoing assessment. These courses are listed on pages 30-33.

## My.SUPA

My.SUPA is an online space for managing your SUPA activities. Students must register with My.SUPA before they can enrol for courses:

- Go to http://my.supa.ac.uk
- Click 'Create a new account'
- Register using your university email address

An email will be sent to you with a verification link. If you do not yet have a university email address, use the best address for contacting you. Please change the email address on your account to your university email as soon as possible.

## Enrolling on Courses

Students must enrol for SUPA courses to attend or receive credit for them. To enrol, log on to My.SUPA and follow the instructions. When you enrol for the first time, you will be informed about SUPA's videoconference recording policy and asked for your consent. For more information about this policy, please email admin@supa.ac.uk.
Enrolment for Semester 1 opens in early September. Enrolment for Semester 2 opens in December.

Enrolment will typically stay open until the end of the first week of the course, for short courses and the end of the second week for full semester courses. After the open enrolment period, late enrolment may be possible with the lecturer's permission. Once you have permission from the lecturer to enrol late, contact the SUPA Administration team at admin@supa.ac.uk.

After you have enrolled on a course, you will be able to check the course page on My.SUPA for information such as lecture notes, recordings, and updates. During the enrolment period, students usually can access a limited portion of the course materials. The remaining course materials will become available to enrolled students once registration is closed. Some courses will close enrolment before the course start date. Details about enrolment closing will be in the course information page on My.SUPA.

During the enrolment period, students may change their enrolment status between being assessed and non-assessed, (auditing). To make these changes, first withdraw from the course on My.SUPA and then enrol again with the new status. If you have difficulty changing your enrolment status after enrolment has closed, contact admin@supa.ac.uk and notify the course coordinator.

To withdraw from a SUPA course, go to the course page and click the 'Unenrol me from SUPA [XYZ]' link. If you are not going to complete a course, it is important to unenrol.

We strongly encourage you to check My.SUPA course pages regularly as this is the main method for sharing course information. On the my.supa course page, you can share messages with everyone in the course by using the News Forum. Messages posted on the News Forum will be sent to you via the email address you provided to SUPA.

**My.SUPA Support**

If you experience difficulties while using My.SUPA, please email admin@supa.ac.uk. To report errors on the site or to request technical help, please contact webmaster@supa.ac.uk.

# Accessing Lectures

SUPA courses are delivered in a variety of ways, such as through videoconferencing, face to face, and distance learning. The course description will explain how the course is shared.

### Face to Face Courses

Courses that are taught Face to Face, listed as F2F, are taught with participants together in one room. Students and lecturers attend in person. Depending on the location of the course, students may have to travel and possibly stay overnight. Some lectures that are presented through VC may have tutorials, labs or discussions that students must attend in person. These will be listed as both VC and F2F. Please consider these aspects when registering for a course. A Face-to-Face course that spans a number of days in succession may be listed as Residential.
**Travel:** If you are required to travel to attend a SUPA course, SUPA will reimburse travel expenses. SUPA will cover the cost of accommodation only if there is not enough time to travel on the day of the event. Consult the lecturer if you are uncertain about start and end times. There is a simple, online form to request travel funds. You must apply for travel funds and receive confirmation from SUPA before you travel.
The accommodation allowance is up to £80 per night. Any expenses over £80 must be justified in your claim form. When claiming reimbursement, follow the procedures for claiming expenses at your university. Ensure you complete the departmental travel claim form clearly stating SUPA and the course name.

### Distance Learning Courses

Enrolling in Distance Learning courses will give you online access to recordings, notes, problem sheets and discussion forums. Students are expected to work independently and participate in activities set by the course lecturer. Students will submit exercises and receive feedback. There are no live broadcasts of lectures.

### Videoconferencing

Many SUPA courses are taught via videoconferencing. Lectures may be shared through zoom or Teams. In some cases, students go to the local SUPA classroom to attend the course. Instructions for individual courses and links to lectures will be shared through the my.supa course pages. Students may also join lectures from a personal computer or other device.

# The SUPA Classrooms

## Joining from the SUPA Classroom

**Starting up:**

- Turn on the projectors, (using the remote control), or screens, (using the power switch), at the front of the room.
- The SUPA Classrooms are set up as zoom rooms, so the controls are the same as in a zoom call. The touch screen monitor on the front desk has the controls for joining a call. Tap the touchscreen monitor on the front desk to wake it. If it has been turned off, turn it on using the power switch on the lower right side.
- A list of upcoming lectures will appear on the monitor. Touch the item on the monitor to join the call.
- If you are only presenting to people locally who are in the room with you, you still need to join a zoom call to use the projectors. If one has not been booked, join an instant zoom call.
- If you are joining a zoom call through a link that someone else has created, enter the call information to the touch screen and the classroom will join the call.
- The controls on the monitor are the same as for a zoom call. However, the control bar disappears if the monitor has not been touched recently. If you do not see the zoom controls, try tapping the screen to make them visible.
- For most people joining the call, Speaker view is recommended. The lecturer may prefer Gallery view. These options can be selected from the touchscreen monitor as in a zoom call.
- You can mute attendees, for example if there is a noise that is disrupting the call.
- Details on joining and Assistance available during calls

**Shutting down:**

- The zoom call will automatically end on the hour.
- To end a call before the hour, press Leave Meeting from the touchscreen monitor.
- Please switch off the projectors or screens at the front of the room. Please do not turn off the touchscreen monitor. When you leave, please turn off the room lights.

## Booking the SUPA VC Classrooms, the SUPA timetable

The SUPA classrooms are primarily used to deliver SUPA courses. However, they are also used for local meetings. If you would like to reserve a SUPA classroom, please consult the timetable, and contact SUPA by filling in this form.
The access codes for all SUPA VC rooms can be found here.

## SUPA Classroom Locations

**University of Aberdeen**
Aberdeen: OA MT 302 - This is not a dedicated SUPA classroom, but SUPA calls are often shared here. Alternately, students can join calls from a personal device.

**University of Dundee**
Classroom VC system currently offline, students should join calls from a personal device and are welcome to meet in the classroom
Ewing Building Basement
+44 (0)138 238 4695

**University of Edinburgh**
James Clerk Maxwell Building, Room 1301
Contact: SOPA Helpdesk
+44 (0)131 650 5900
Email: sopa-helpdesk@ed.ac.uk

**University of Glasgow**
Kelvin Building, Room 255a
Contact: SUPA
Email: admin@supa.ac.uk

**Heriot-Watt University**
Earl Mountbatten Building, EM1.27
Contact: Sean Farrell
+44 (0)131 451 3048
Email: s.j.farrell@hw.ac.uk

**University of St Andrews**
Physics and Astronomy Building, Room 307
Contact: Ian Taylor
+44 (0)133 446 3141
Email: iat@st-andrews.ac.uk

**University of Strathclyde**
John Anderson Building, Room 813
Contact: Timothy Briggs, Leanore Ferrans and Jamie McLaugh
+44 (0)141 548 3376
Email: physics-itsupport@strath.ac.uk

**University of the West of Scotland**
Henry Building, room F.318
Contact: Tom Caddell
+44 (0)141 848 3550
Email: tom.caddell@uws.ac.uk
The classroom VC system is currently offline. Students should join calls from a personal device and are welcome to meet in the classroom.

## Non-SUPA Credits

Students may complete their course requirements through courses offered outside SUPA. This applies to both Specialist and Professional Development courses. Examples of appropriate Specialist courses include Master's (MSci/MPhys/ MSc) and bachelor's courses. Attendance at national and international summer schools designed for research students (e.g. those organised by doctoral training centers or SUSSP) is also encouraged. Professional Development courses may be provided by a University, Research Council, VITAE or other organisations. Students are encouraged to take these opportunities with their supervisor's agreement.

**Getting Credit for Non-SUPA Courses**

A student will need to submit information about the course for it to be added to their SUPA record. For both professional development and specialist courses, students should complete the non-SUPA course form. The information needed is slightly different for the professional development and specialist courses and this is indicated on the form.

For **Professional Development** courses, the student's full name, the course name, date of completion, course description, course provider and number of credits are needed on the form. The course description should contain 3 –5 sentences about the content and should be emailed to your supervisor and admin@supa.ac.uk.

For **Specialist** courses, students must submit their full name, the course name, date of completion, course provider and number of credits on the form. Additional information is required, and this depends on whether the course was marked or unmarked.

Marked courses: These include master's and bachelor's level modules. The ideal arrangement is that the course coordinator arrange an assessment for the student. Even if postgraduate students are not typically assessed, the course coordinator may have a method for assessing them and students should consult the course coordinator about this. Students are not expected to register on the course through the host university. Instead, the course coordinator should email the student's marks to admin@supa.ac.uk, making it clear whether the student passed. All non-SUPA courses and marks will be reviewed by the GSC. The GSC cannot organise assessment for non-SUPA courses.

Unmarked courses: SUPA recognises that National and International Summer schools are valuable learning experiences even though they typically do not include an assessment. In these cases, and in any non-SUPA specialist course that cannot arrange an assessment, students must write a reflection on the course. The reflection may be up to 4000 words and should be submitted through the non-SUPA course form linked above. The reflection should include a brief (under 200 word) overview of the course content. Please then explore how the course content related to your own research. If that is not possible, please discuss the content you found most valuable.

The number of hours awarded for a course is based on the contact hours or the total length of the lectures, in hours. In all cases, for a single non-SUPA Specialist course, students can earn at most 20 hours of credit. Please note that this limit of 20 hours was put in place for students beginning in 2020/21. In previous years, the credit limit for a single non-SUPA course was 30 hours. Students who began their studies prior to 2020/21 will be allowed to claim up to 30 hours of credit for a single non-SUPA course.

## Frequently Asked Questions

**Is there a timetable for the SUPA courses?**
The SUPA timetable can be found here.

**How do I obtain a My.SUPA password and username?**
Go to the My.SUPA portal (http://my.supa.ac.uk) and click on the 'Create a new account' link.

**How do I reset my My.SUPA password or username?** Either use the 'Lost Password?' link in the login box on the My.SUPA portal or by email admin@supa.ac.uk.

**Who do I contact if I am having difficulty using My.SUPA to enrol (or unenrol) for courses?** admin@supa.ac.uk.

**How can I contact my lecturer?**
On the My.SUPA course page, in the 'Course Description' area, the lecturer's name will appear as a link that allows you to send them an email.

**What if I am unable to attend a SUPA lecture?**
If you are ill or find you have a conflicting obligation, please inform your lecturer.

**How can I obtain a copy of my SUPA transcript?**
An electronic copy of your transcript is available on My.SUPA on the 'Grades' tab of your student profile. To obtain an official copy of your transcript certified by the SUPA Graduate School Co-Ordinator, please write to the SUPA Office at admin@supa.ac.uk.

**Who is my local SUPA representative?**
On the contacts page of this handbook, page 11, you can find the names of all SUPA Graduate School Committee representatives. They can answer many questions about SUPA.

**I am organising an event, can SUPA help me promote it?**
Yes. If you are a SUPA member and your event is relevant to those working in Physics in Scotland, SUPA is happy to help with promotion. Please email admin@supa.ac.uk with a description of your event and electronic copies of any promotional materials (such as fliers or posters), and SUPA will work with you to promote your event.

**Can SUPA help me fund my participation in an event or course not organised by SUPA?** Unfortunately, SUPA only provides funding for SUPA-sponsored and SUPA-organised events. There is no funding available to attend other Summer Schools or conferences.

**Can I claim travel expenses from SUPA?**
Yes, if the events or courses were organised by SUPA and students must travel to attend. SUPA will cover reasonable costs, defined as: public transport or mileage on shared rides equivalent to public transport costs, meals or accommodation.
SUPA pays for transportation to the Annual Gathering from within Scotland. Attendees do not need to apply for this funding in advance. However, please check if group travel arrangements have been made for your university. For example, if a bus has been hired for people at your university to travel to the Annual Gathering, you should not plan to travel separately and be reimbursed. Extenuating circumstances will be considered.

**How do I claim back my expenses from a SUPA event?**
To claim back expenses for a SUPA event, please submit a claim form to your local department's finance office, clearly stating the name of the SUPA event or course. Do not send claims to the SUPA administration team unless specifically instructed to do so.

**Access**
If you have any difficulty accessing course materials, including lectures, or if lectures do not appear to be running as scheduled, please contact admin@supa.ac.uk as quickly as possible.

**Course Availability**
If a course is cancelled, students will be contacted to discuss alternatives. If a course is oversubscribed, students will be admitted in the order that they registered. When a course is full students will be added to a wait list.

**Course Credit**
The credit for each course is included in the course description.

**Transcripts**
You can track the number of course hours you have completed by viewing your online transcript in My.SUPA. To do so, log in to My.SUPA and click on your name in the upper right-hand corner of the screen. (The link should say: You are logged in as [NAME]). This will take you to your user profile. Click on the 'Grades' tab to view your transcript. To obtain an official copy of your transcript certified by the Graduate School Coordinator, please email admin@supa.ac.uk.

**Individual and Extenuating Circumstances**
Students may have unique, individual circumstances that affect their studies. For example, students with dyslexia may need additional time to complete exams. If you require any additional support in completing assessments, please contact the course lecturer who will follow guidelines established by the host university.

If unforeseen circumstances, such as an illness, adversely affect a student, course instructors and SUPA management may have some flexibility in assigning credit. The student should inform their local Graduate School Committee member and provide evidence of these unforeseen events as soon as possible. The Graduate School Committee will review cases individually.

## SUPA Contacts

**SUPA Team**

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**SUPA Graduate School Committee**

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Gregory Morozov
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## List of current SUPA courses 2025/26

Please note, some courses may appear twice, as they are relevant to more than one SUPA theme.

## Energy



## Nuclear Physics



## Particle Physics



## Photonics

| Course Title | Semester | Hours | Page |
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| **Professional Development Training** | | | |
| Maths Primer (SUPAPRI) | 1 | 6 | 42 |
| FPGA Programming for Physicists (SUPAFPP) | 1 | 12 | 42 |
| Software Carpentry (SUPASWC) | 1 | 16 | 42 |
| C++/Object Oriented Programming (SUPACOO) | 1 | 12 | 43 |
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| Introductory Data Analysis (SUPAIDA) | 2 | 6 | 44 |
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| Presenting Your Research (SUPAPYR) | 2 | 12 | 45 |
| Introduction to Machine Learning (SUPAIML) | TBC | TBC | 47 |
| Introduction to Python (SUPAPYT) | 2 | 8 | 47 |

*To register for the Outreach Training in Glasgow, please contact Linda Hadfield via email to register at linda.hadfield@supa.ac.uk specifying which city you would like to take the training in.

# Astronomy and Space Sciences

**Theme Leader: Aurora Sicilia Aguilar, University of Dundee**

The Astronomy and Space Sciences courses cover a broad range of topics aimed at widening students' knowledge of the field. They range from advanced extensions of subjects covered at undergraduate level to the introduction of new interdisciplinary sciences. We recommend that students take a mixture of core material, advanced courses (usually 16-20 hours equivalent credit) and more general topics, including computing and data reduction modules, to gain a broad grounding in astronomical methods and modern research areas.
Each course is self-contained, although background reading or another SUPA course may be recommended to bring students from various backgrounds up to speed. Students from other theme areas are very welcome to take Astronomy and Space Sciences courses, with modules likely to be of interest for Life Sciences and Plasma Physics students, but they should remember that a basic understanding of astronomy and astronomical terms will be assumed by course lecturers.

**A typical programme building to the core requirement of 40 hours of specialist courses might include:**

· A SUPA specialist Astronomy course (these generally constitute 16-20 hours)
· A technical SUPA course in another field or a second Astronomy course
· Non-SUPA courses as appropriate (e.g. for students changing specialities).
· Summer Schools in Astronomy and Space Physics
Students should note that certain Astronomy courses are only run biennially. Each student must consult their PhD supervisor to contract a suitable programme before registering, and students are encouraged not to over-register. The 40-hour course requirement is taken over the first and second years, although students from all years can take extra subjects for interest.

*TNG (Telescopio Nazionale Galileo) Dome, La Palma, Canary Islands*

## Semester 1

### Advanced Data Analysis Astronomy (SUPAAAA)

**Status:** Offered in 2025/26
**Lecturer:** Juan Hernandez Santisteban, Juan Varela and Paolo Annibale
**Institution:** St. Andrews
**Delivery:** Video Conference
**Hours Equivalent Credit:** 27
**Assessment:** any 2 of 3 Homework Sets and 2 Data Analysis Projects.

This module develops an understanding of basic concepts and offers practical experience with the techniques of quantitative data analysis. Beginning with fundamental concepts of probability theory and random variables, practical techniques are developed for using quantitative observational data to answer questions and test hypothesis about models of the physical world. Students develop their computer programming skills, build a data analysis toolkit, and gain practical experience by analysing real data sets. The two projects involve periodogram analysis of quasi-periodic oscillations in the HST light curve of an eclipsing dwarf nova, and a cross-correlation radial velocity analysis and mass estimation for a black hole binary, based on spectra from the Keck 10m telescope.

### Gravitational Wave Detection (SUPAGWD)

**Status:** Offered in 2025/26
**Lecturer:** Peter Murray
**Institution:** Glasgow
**Delivery:** VC - Tues 11:00 and Fri 13:00
**Hours Equivalent Credit:** 16
**Assessment:** Two sets of problem exercises plus Oral Examination

This course is for students interested in the physics of gravitational wave detection. Starting from the fundamentals of Einstein's General Theory of Relativity, the wave nature of weak field spacetime curvature perturbations will be derived in the transverse traceless gauge. Interactions of gravitational radiation with matter will be explored, leading to the basic principles of gravitational wave detectors. A full description of currently operating detectors will include instrumental noise sources, such as thermal, seismic, optical, and the standard quantum limit. Current topics discussed will include squeezing, and other non-classical light techniques for reducing optical noise in interferometric systems.

Astrophysical sources of gravitational waves will be discussed including expectations for source strengths from coalescing compact binary systems, pulsars, etc. together with a discussion of the data analysis techniques that are required for signal extraction and parameter estimation. An update will be given on the new astrophysics that has been deduced from the gravitational wave signals so far observed, and the promise of future "multi-messenger astronomy" will be explored. Plans for future detectors on the ground and in space will also be presented. Students are expected to spend 100 hours on this course.

## Semester 2

### Astrobiology and the Search for Life (SUPAASL)

**Status:** Offered in 2025/26
**Delivery:** zoom, not in the SUPA classroom
**Institution:** Various
**Hours Equivalent Credit:** 20
**Lecturer:** Charles Cockell
**Assessment:** Report

This course investigates the origin, evolution and distribution of life in the Universe, broadly considered as 'astrobiology'. The objective of the course is to provide a perspective on geology, biology and chemistry at an introductory level. The course will include lectures on the limits and conditions for life on Earth through time and how these may apply elsewhere in the universe. The course looks at the current scientific approaches used to address the hypothesis of life elsewhere in the Universe. The subjects discussed include: the formation of planetary systems and the conditions required for habitability, detection methods for extrasolar planets, the diversity of known exoplanet systems, the origin of life, evidence for earliest life on Earth, the geological and biological history of the Earth, conditions past and present on Mars and the icy moons of the giant planets, and finally the Search for Extra-Terrestrial Intelligence (SETI).

### SUPA Observing Course (SUPAOBS)

**Status:** Offered 2025/26
**Lecturer:** Aleks Scholz
**Institution:** St Andrews
**Delivery:** Recorded lectures with interactive sessions
**Hours Equivalent Credit:** 15
**Assessment:** Mock observing proposal as homework
**Coursework:** Students should expect to spend 20 hours on this course.

The course includes 5 lectures on the basics of professional observations, given by observatory director Dr. Aleks Scholz. This will be complemented by 5 lectures on specialised observing techniques.
Students will be offered an exclusive tour of the James Gregory Telescope in St Andrews, on a voluntary basis. We will also have observing sessions using telescopes in St Andrews that students can join remotely.

# Condensed Matter and Material Science

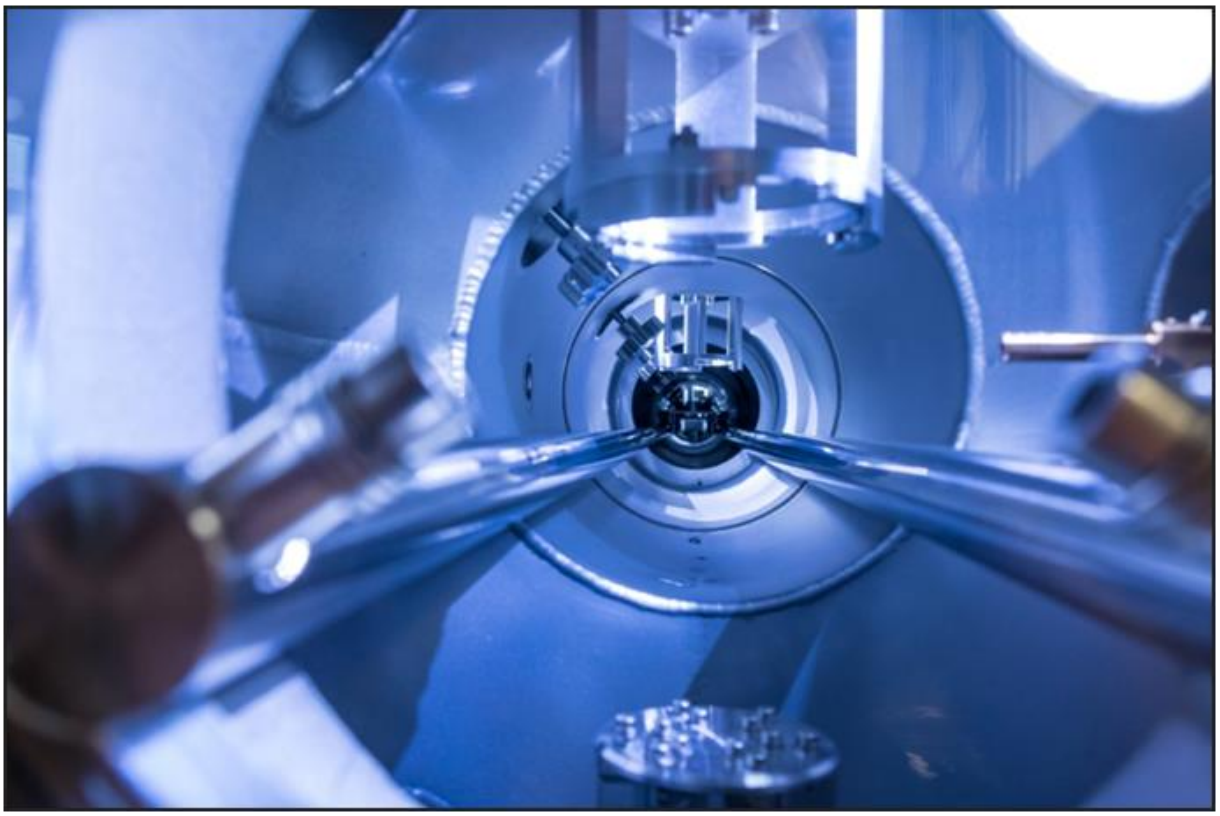
**Theme Leader: TBC**

Condensed Matter and Materials Sciences (CMMS) is a diverse subject covering many different specialities and attracts PhD students arriving from a wide range of backgrounds with different balances of theoretical and practical training. The program of study is therefore tailored individually for each student, in consultation with his or her PhD supervisor. The overall range and level of courses offered aim to introduce students to subject areas outside the immediate confine of their thesis research, as well as providing more specialist knowledge directly relevant to each dissertation. It is envisaged that during the first two years of study every student will complete a minimum of two physics-content courses, at least one summer school, plus at least one module covering transferable skills. A typical programme will comprise the following elements:

**CMMS courses organised by SUPA:** These are either graduate specific or advanced master's courses made available to all centres over the SUPA videoconferencing network. Courses offered are listed below and form the backbone of the CMMS graduate school programme.

**Core courses organised by SUPA:** Those of particular interest to CMMS students include Advanced Data Analysis and courses in different programming languages such as C++ and Python.

**Non-SUPA courses as appropriate** (e.g. for students changing specialities)
Summer Schools: Examples of appropriate summer schools include 'Physics by the Lake' for those with an interest in theory and HERCULES (Grenoble, France) for those doing research involving neutron and X-ray scattering at central facilities.



*Center for Designer Quantum Materials © Tricia Malley Ross Gillespie* [www.broaddaylightltd.co.uk](http://www.broaddaylightltd.co.uk)

## Semester 1

### Geometry and Physics of Soft Condensed Matter (SUPAGPSM)

**Status:** This course is biennial. It is not offered in 2025/26 but is expected to return in 2026/27.
**Lecturer:** Davide Marenduzzo
**Institution:** Edinburgh
**Delivery:** VC
**Hours Equivalent Credit:** 20
**Assessment:** Problem sheets.

In this course, we explore how to build theories for complex fluids; we will often be taking examples from the world of biology. The focus of the course will be to emphasise generic features to build up a repertoire of theoretical tools that are widely applicable to analyse a diversity of soft materials. Topics covered may vary from year to year depending on the specialisms of the staff involved but will include:
Physics and nonequilibrium thermodynamics of binary mixtures
Symmetries and phases of liquid crystals
Topological defects in liquid crystals
Hydrodynamic theories of complex fluids
Topological properties of DNA: knots and supercoiling

### Introduction to Computational Chemistry (SUPACCH)

**Status:** Offered in 2025/26
**Lecturer:** Herbert Fruchtl
**Institution:** St. Andrews
**Delivery:** VC
**Hours Equivalent Credit:** 9
**Assessment:** Continuous assessment through assignments

The course will introduce practical computational chemistry techniques. The focus is on an introduction to the current state-of-the-art computational chemistry codes together with the theory behind the methods. Ab initio, DFT and classical methods for molecular systems, solids and surfaces, as well as cheminformatics, will be introduced along with how they are used in practice by researchers in Scotland.

### Quantum Field Theory (SUPAQFT)

**Status:** Offered in 2025/26
**Lecturer:** Jonathan Keeling and Bernd Braunecker
**Institution:** St Andrews
**Delivery:** Video Conference
**Hours Equivalent Credit:** 30
**Assessment:** Continuous assessment

Quantum field theory combines classical field theory with quantum mechanics and provides analytical tools to understand many-particle and relativistic quantum systems. This course aims to introduce the ideas and techniques of quantum field theory. I will use examples drawn mainly from condensed matter physics to illustrate the ideas and application of quantum field theory.

## Modern Topics in Condensed Matter Physics (SUPATOP)

**Status:** Offered in 2025/26
**Lecturer:** Bernd Braunecker, Carolina de Almeida Marques, Andreas Rost
**Institution:** St Andrews
**Delivery:** By video, with lecture recordings made available
**Hours Equivalent Credit:** 32
**Assessment:** Problem Sheets, Presentations, Computational Exercises
**Course work:** Students are expected to spend 150 hours on this course, including both time in lectures and independent working.

The aim of this module is to introduce a variety of contemporary topics of condensed matter physics research. Topics covered in this module include topology, Fermi liquid theory, electronic properties of surfaces and low-dimensional solids, and many body problems in condensed matter physics. This course will cover the underlying principles and introductory theory of these states of matter, will introduce the probes necessary to investigate them and their application in the study of other quantum materials, and will provide a survey of the current state of experimental results in this evolving field. The module consists of a series of 21 lectures covering these topics and includes practical computational examples to develop a numerical approach to solving physics problems and a journal club session where students present a research paper.

## Advanced Statistical Physics (SUPAASP)

**Status:** Offered in 2025/26
**Lecturer:** Davide Michieletto and Tyler Shendruk
**Institution:** Edinburgh
**Delivery:** VC - Zoom
**Hours Equivalent Credit:** 22
**Assessment:** Report

In this course we will discuss equilibrium phase transitions, of first and second order, by using the Ising and the Gaussian models as examples. We will first review some basic concepts in statistical physics, then study critical phenomena. Phase transitions will be analysed first via mean field theory, then via the renormalisation group (RG), in real space. Momentum space approaches will be briefly discussed. We will conclude with a study of stochastic dynamics and the approach to equilibrium, and we will discuss nonequilibrium dynamics and nonequilibrium phase transitions.

## Quantum Mechanics for Scientists and Engineers, Discussion (SUPAQMSE)

**Status:** Offered in 2025/26
**Lecturer:** Niclas Westerberg
**Institution:** Glasgow
**Delivery:** VC
**Hours Equivalent Credit:** 18
**Assessment:** Weekly tutorials, where 1 question each week is selected as a marked hand-in exercise (marked at a pass/fail level).

In this course, we will study quantum mechanics at a level suitable as an introduction to the subject or as a refresher. The aim is to end the course with a working understanding of typical problems and techniques. The course will consist of two weekly sessions, supplemented by online lectures and material by David Miller and relevant books, where we go through important concepts and solve some exercises, respectively.

## Semester 2

### Soft Condensed Matter Physics (SUPASCM)

**Status:** Offered in 2025/26
**Lecturer:** Patrick Pietzonka
**Institution:** Edinburgh
**Delivery:** Lecture recordings
**Hours Equivalent Credit:** 16
**Assessment:** Coursework

Soft Condensed Matter Physics studies complex fluids in which intermediate level structures with length scale between small molecules and the macroscopic world exist colloidal particles, polymers, and aggregates spontaneously formed by soap-like (surfactant) molecules. This course emphasises the generic features of these systems (most importantly, Brownian motion) and develops simple models to account for their behaviour. It will also look at how the principle of soft matter physics can give insight into biological problems.

### Quantum Magnetism and Quantum Phase Transitions (SUPAQMPT)

**Status:** Offered in 2025/26
**Lecturer:** Bernd Braunecker, Jonathan Keeling
**Institution:** St. Andrews
**Delivery:** zoom, in the SUPA classroom
**Hours Equivalent Credit:** 18
**Assessment:** Continuous Assessment

These lecturers cover two closely related themes: models of magnetism and quantum phase transitions. The two parts are strongly linked in that many of the models we will introduce to describe magnetism turn out to be paradigmatic models of quantum phase transitions. The course is intended to be relevant not just for those working on traditional solid-state systems, but also those working on cold atom physics, where many of the same models and questions are also relevant.

### Electronic Structure Theory (SUPAEST)

**Status:** This is a biennial course. It is not offered in 2025/26 but is expected in 2026/27.
**Lecturer:** Elton Santos
**Institution:** Edinburgh
**Delivery:** Video Conference and Face to Face
**Hours Equivalent Credit:** 20
**Assessment:** Problem Sheets, Project

This course will introduce the methods and approaches used in parameter-free descriptions of the electronic structure of materials, which aim to solve the quantum mechanical many-electron problem. We will discuss underlying ground state theories, such as wave-function based correlation methods and density functional theory, and their implementations in high-performance computing environments. We will study how to use the linear response ansatz and many-body perturbation theory to extract excited state information from those calculations, and thus accurately simulate spectroscopic and inelastic scattering experiments. Assignments will involve calculations on realistic materials on the UK's national supercomputer.

## Response Functions MBQ2 (SUPARFN)

**Status:** TBD
**Lecturer:** Brendon Lovett
**Institution:** St. Andrews
**Delivery:** VC
**Hours Equivalent Credit:** 13
**Assessment:** Two assessed problem sheets

Response functions and Green's functions provide a powerful mathematical language in which to describe the physics of many-body quantum systems. This course is a short introduction to them. Quantum Field Theory is a pre-requisite for this course

## Non-Equilibrium Statistical Mechanics (SUPANSM)

**Status:** This is a biennial course. It is not offered in 2025/26 but is expected in 2026/27.
**Lecturer:** Tyler Shendruk
**Institution:** Edinburgh
**Delivery:** Video Conference
**Hours Equivalent Credit:** 12
**Assessment:** Peer-to-Peer Teaching
**Coursework:** Over the term, students are expected to spend a total of 25 hours on this course.

The course explores the theory of systems out of equilibrium, be they relaxing to equilibrium or held out of equilibrium by external agencies. The lectures fall into two parts. The first half of the lectures cover core techniques and ideas in non-equilibrium statistical mechanics. The remaining lectures cover specialist and current topics of research. This course is assessed by means of peer-to-peer teaching, with each student presenting lectures on course content.

## Chaikin and Lubensky's Principles of Condensed Matter (SUPACLP)

**Status:** Offered in 2025/26
**Lecturer:** Tyler Shendruk
**Institution:** Edinburgh
**Delivery:** Video Conference
**Hours Equivalent Credit:** 25
**Assessment:** Continuous Assessment

This course will primarily involve a combination of directed reading and discussions by the participants on topics chosen from Chapters 1-6 of the graduate text 'Principles of Condensed Matter Physics' by P. Chaikin and T. Lubensky (Cambridge University Press). Assessment will be based on performance in both the student discussions and selected problems.

# Energy

**Theme Leader: Lethy Jagadamma, University of St Andrews**

Our courses relate to two major aspects of the theme's activities:  solar and nuclear power. They are designed to be accessible to all Energy Theme students – so that nuclear students could take the solar power course and vice versa. In addition to these courses, students are encouraged to select courses relevant to their interests and projects from other themes (particularly Condensed Matter and Materials Sciences, Photonics and Nuclear and Plasma Physics).

## Semester 2

### Solar Power (SUPASPR)

**Status:** Offered in 2025/26.
**Lecturer:** Ifor Samuel and invited lecturers from across SUPA
**Institution:** St. Andrews
**Delivery:** In Person
**Hours Equivalent Credit:** 14
**Assessment:** Problem Sheets and reports on laboratory experiments

This course is an introduction to solar photovoltaics (PV). Lectures will discuss the problem of energy supply, and the amount of solar power potentially available. The general principles of PV will be covered, followed by lectures on a range of current and future PV technologies: crystalline, polycrystalline and amorphous silicon, thin film inorganic semiconductors, and organic semiconductor PV. Three lab sessions will enable students to explore key ideas in the lectures.

This is an intensive two-day course, taking place in St Andrews on the 14th and 15th of January 2026. Participants are welcome to attend the Energy Theme Meeting on the afternoon of 14th January. Please also register for the theme meeting if you plan to attend.

### Laser Driven Plasma Acceleration (SUPALDP)

**Status:** Offered in 2025/26
**Lecturer:** Dino Jaroszynski, Paul McKenna, Zheng-Ming Sheng and Bernhard Ersfeld
**Institution:** Strathclyde
**Delivery:** zoom, in the SUPA Classroom
**Hours Equivalent Credit:**16
**Assessment:** Continuous Assessment

This course will address the topical research in laser plasma interactions, laser-plasma acceleration and plasma-based radiation sources. It will be divided into four connected parts starting with a thorough but brief introduction to the main theoretical concepts of laser-plasma interactions. The second and third parts will address the interaction of intense laser pulses with under-dense and over-dense plasma respectively, with particular emphasis on laser-plasma acceleration, absorption, propagation, electron transport, plasma waves, shock waves, radiation mechanisms, non-linear optics of plasma etc. The fourth part will introduce students to the main concepts of free-electron lasers, which are important tools for scientists investigating the structure of matter. Students will proceed quickly from basic concepts to advanced and current applications such as compact radiation and particle sources, inertial fusion energy, fast ignition etc. They will gain a good introduction to laser-plasma interactions, which will provide a good basis for postgraduate research in this area.

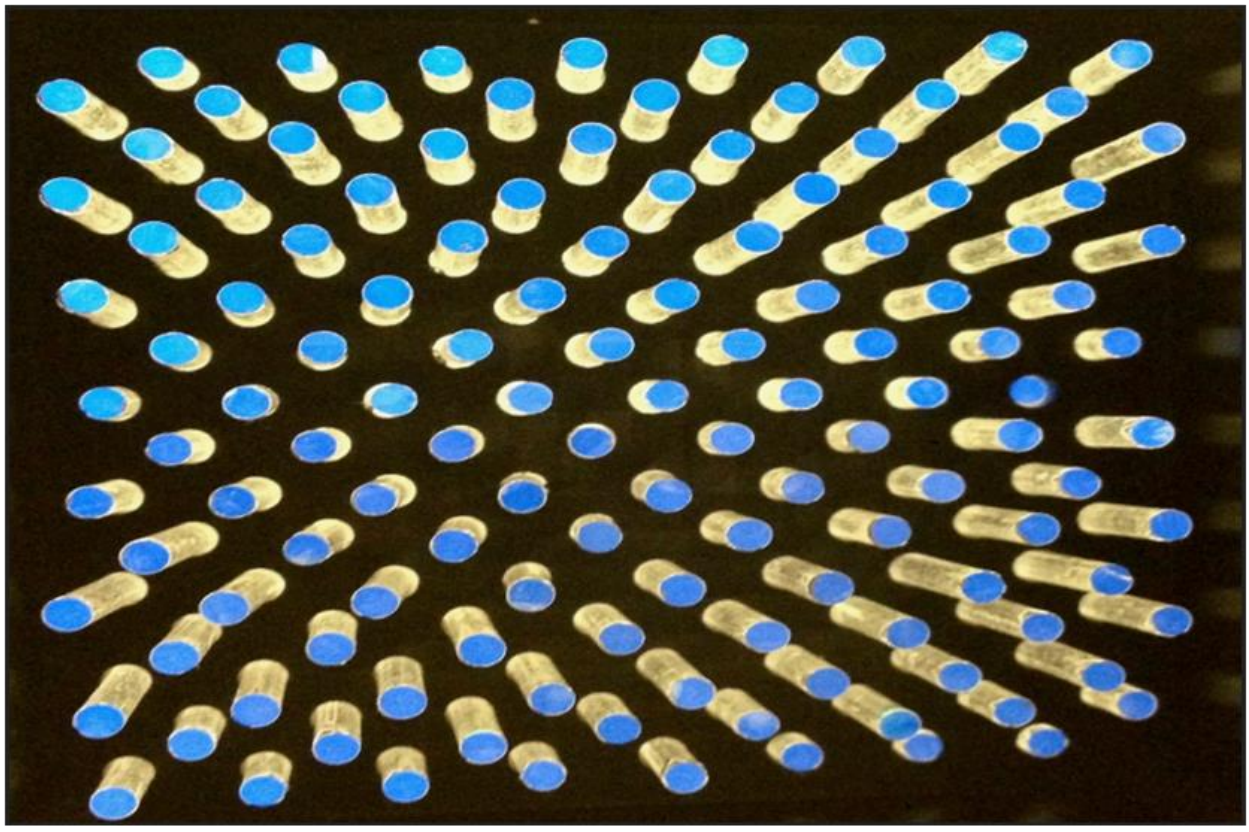
# Nuclear Physics

**Theme Leader: David O'Donnell, University of West of Scotland**

The Nuclear and Plasma Physics (NPP) theme covers a wide range of subject areas, including several different specialities. Depending on their individual backgrounds and areas of research, PhD students will be required to attend a different set of SUPA courses. The decision on which courses to include should be made in consultation with the student's PhD supervisor. Typically, a two-year course program will include:

- Specific NPP lectures taken from the course list
- Core skills classes, such as C++ Programming and Data Analysis, where appropriate
- Transferable skills courses such as an Entrepreneurship course

Where the number of courses taken exceeds the minimum requirement, students and their supervisors should agree on which courses should contribute towards the overall assessment. There are several Doctoral Training Centres that are part of NPP. PhDs in these Centres are usually four years in duration, where the whole of the first year is dedicated to formal courses and mini projects. Students will normally decide on their PhD topic at the end of the first year.



*POM Matrix, Muon Imaging System, University of Glasgow/Lynkeos Technology*

## Semester 2

### Nuclear Instrumentation (SUPANIN)

**Status:** Offered in 2025/26
**Lecturer:** Tom Davinson
**Institution:** Edinburgh
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 6
**Assessment:** continuous assessment

The objective of this short course of lectures is to provide students with an insight into the state-of-the-art of nuclear instrumentation technology and techniques - particular emphasis will be given to topics either not found, or not well-covered, in the standard textbooks. Topics will include noise, interference, grounding and other black arts, the origins of detector energy and time resolution, ASICS, data acquisition and analysis, and digital signal processing.

### Quarks and Hadron Spectroscopy (SUPAQHS)

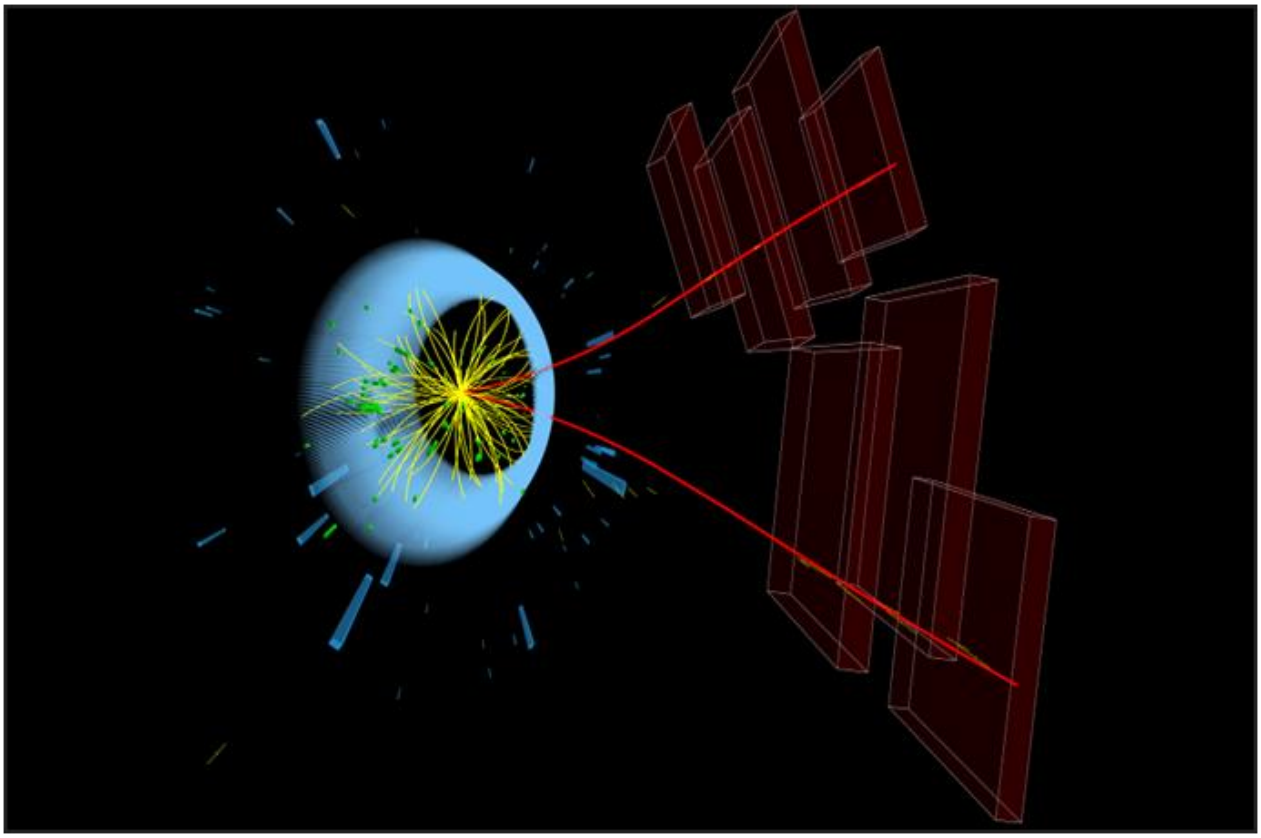
**Status:** Offered in 2025/26
**Lecturer:** Oliver Jevons
**Institution:** Glasgow
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 8
**Assessment:** End of term exam, lasting approximately 2 hours

The course will provide an introductory look at topics which fall under the remit of modern experimental hadron physics, generally considered under one of two broad categories: hadron structure and hadron spectroscopy. Lectures will introduce concepts which are studied in experiments today, from the probability distributions which can be used to 'image' protons and neutrons, to the searches for exotic states lying at the extremes of QCD.

# Particle Physics

**Theme Leader: Victoria Martin, University of Edinburgh**

The SUPA Graduate School runs an extensive programme of Particle Physics courses to provide new graduate students with the necessary skills required to carry out research. The Particle Physics courses are divided into categories corresponding to whether the student is undertaking theoretical or experimental research areas. Students should discuss with their supervisor which optional courses they should attend. All experimental particle physics students should take all the following courses: Detector Physics, Collider Physics, Flavour Physics & Discussion Classes, unless there is a good academic reason to make a different choice. and in consultation with their supervisor.



*A candidate Bs meson decays into two muons, © CERN 2019*

## Semester 1

### Advanced Statistical Physics (SUPAASP)

**Status:** Offered in 2025/26
**Lecturer:** Davide Michieletto and Tyler Shendruk
**Institution:** Edinburgh
**Delivery:** VC
**Hours Equivalent Credit:** 22
**Assessment:** Report

In this course we will discuss equilibrium phase transitions, of first and second order, by using the Ising and the Gaussian models as examples. We will first review some basic concepts in statistical physics, then study critical phenomena. Phase transitions will be analysed first via mean field theory, then via the renormalisation group (RG), in real space. Momentum space approaches will be briefly discussed. We will conclude with a study of stochastic dynamics and the approach to equilibrium, and we will discuss nonequilibrium dynamics and nonequilibrium phase transitions.

### Detectors (SUPADET)

**Status:** Offered in 2025/26
**Lecturer:** Kenneth Wraight, Dima Maneuski, Stephen Eisenhardt, Richard Bates, Andrew Blue
**Institution:** Glasgow/Edinburgh
**Delivery:** VC
**Hours Equivalent Credit:** 16
**Assessment:** Assignment Sheets

The course will give a comprehensive overview on the many techniques and technologies utilised in the building of particle physics detectors. The series of 11 hours of video lectures is complemented by 5 hours of residential laboratory sessions. The course is self-contained and requires no prior knowledge of the field. Students will be assessed using problem sheets.

## Semester 2

### Collider Physics (SUPACOP)

**Status:** Offered in 2025/26
**Lecturer:** Giuseppe Callea, Liza Mijovic
**Institution:** Edinburgh and Glasgow
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 18
**Assessment:** Peer Review (40%), Literature Review (60%)

The SUPACOP lectures provide the common core for all particle physics students in semester 2. The course covers three main subject areas:
· Electroweak and Higgs Physics
· QCD
· Beyond the Standard Model (BSM) Physics (including Supersymmetry)
The objective of the course is to provide a general overview of theoretical, phenomenological and experimental aspects of electroweak theory, QCD and BSM physics, concentrating on the most influential and/or recent measurements from colliders.

### Quarks and Hadron Spectroscopy (SUPAQHS)

**Status:** Offered in 2025/26
**Lecturer:** Oliver Jevons
**Institution:** Glasgow
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 8
**Assessment:** End of term exam, lasting approximately 2 hours

The course will provide an introductory look at topics which fall under the remit of modern experimental hadron physics, generally considered under one of two broad categories: hadron structure and hadron spectroscopy. Lectures will introduce concepts which are studied in experiments today, from the probability distributions which can be used to 'image' protons and neutrons, to the searches for exotic states lying at the extremes of QCD.

### Flavour Physics (SUPAFLA)

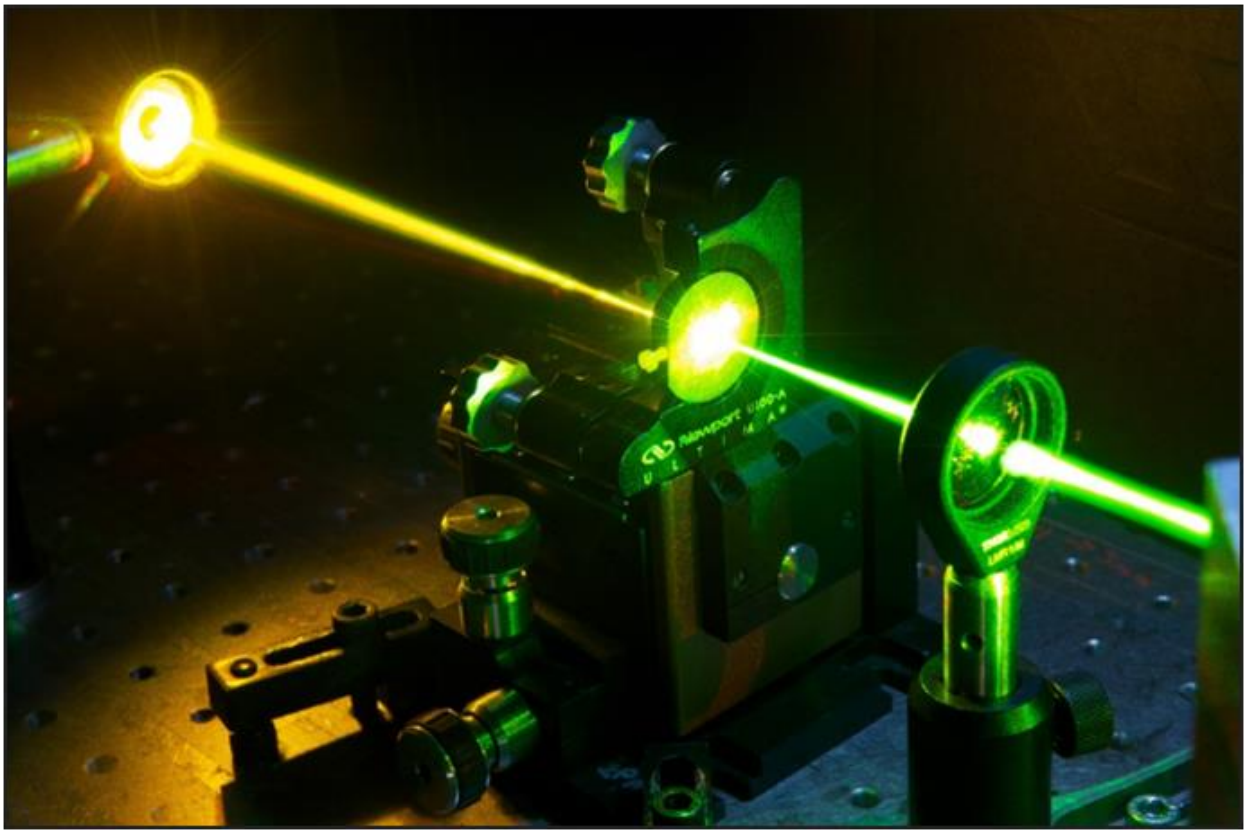
**Status:** Offered in 2025/26
**Lecturer:** Mark Whitehead and Phillip Litchfield
**Institution:** Glasgow
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 16
**Assessment:** continuous assessment

Flavour Physics attempts to answer some of the most profound open questions in modern physics such as how we understand particle mass in the Standard Model (and beyond), and the violation of spacetime symmetries such as CP symmetry. This introduction to Flavour Physics consists of two parts, dealing separately with Flavour Physics of the quark and lepton sectors.

# Photonics

**Theme Leader: Robert Thomson, Heriot-Watt University**

The programme offered within the Photonics Theme involves a selection of lecture courses which we hope will be of interest to you. Additionally, there are opportunities to take part in some distance learning courses. It may also be useful for you to look at courses offered through other themes, especially Condensed Matter and Material Physics and the Core courses. Students are also encouraged to attend Photonics related seminars hosted across Scotland.



*A diamond microlens Raman laser being pumped by a green laser. Image courtesy of Prof Alan Kemp, University of Strathclyde.*

## Semester 1

### Introduction to Practical Experimental Optics and Microscopy (SUPAEOM)

**Status:** Offered in 2025/26
**Lecturer:** Jonathan Taylor
**Institution:** University of Glasgow
**Delivery:** In-person practical labs, asynchronous lectures, and tutorials
**Hours Equivalent Credit:** 15
**Assessment:** Continuous assessment via submitted lab notebooks

This course is very popular and unfortunately has limited space. Enrolling through the my.supa system is the first step in registering for the course but does not guarantee a place. The lecturer will review all the interested students and will contact those who will be admitted. Please do not assume you will be admitted to the course but have a back-up option for another course to take.

This course is aimed at students with a grounding in optical theory but seeking to expand their lab skills in optics and imaging. It covers:
- basic design, construction and precision alignment of experiments from kit optical components (e.g. Thorlabs components)
- understanding of microscope objective lenses and their properties for optical experiments
- hands-on use of a variety of microscope and camera systems
- understanding of camera properties such as read noise, and selection of optimal camera technology
- designing and constructing with laser safety in mind
- computational techniques for image deconvolution

### Nanophotonics (SUPANAN)

Status: Offered in 2025/26
Lecturer: Andrea Di Falco, Graham Bruce
Institution: St. Andrews
Delivery: Video Conference
Hours Equivalent Credit: 27
Assessment: Tutorials

Nanophotonics deals with structured materials on the nanoscale for the manipulation of light. Photonic crystals and plasmonic metamaterials are hot topics in contemporary photonics. The properties of these materials can be designed to a significant extent via their structure. Many of the properties of these nanostructured materials can be understood from their dispersion diagram or optical band structure, which is a core tool that will be explored in the module. Familiar concepts such as optical waveguides and cavities, multilayer mirrors and interference effects will be used to explain more complex features such as slow light propagation and high Q cavities in photonic crystal waveguides. Propagating and localised plasmons will be explained and will include the novel effects of super-lensing and advanced phase control in metamaterials.

## Semester 2

### Ultrafast Photonics (SUPAUPH)

**Status:** Offered in 2025/26
**Lecturer:** Derryck Reid
**Institution:** Heriot-Watt
**Delivery:** Distance Learning
**Semester:** 2
**Hours Equivalent Credit:** 10
**Assessment:** Online Assessment

This is a short, distance learning course operated by Heriot-Watt University via their Canvas virtual learning environment. To complete the course students must carry out an online assessment using the Canvas system, which means they must first apply for an account. Details for doing this appear on the UPH my.SUPA page. SUPA students must first register on my.SUPA by Monday 12 January 2026, after which they will receive Canvas log-in details. Registration will be closed after this deadline.

**Courses coming in 2026/27. Please note the courses below will begin in Semester 2, 2026/27. Enrolment for which will open in December 2026:**

### Photonic Sensors (SUPAPHS)

**Status:** Opens to SUPA in 2026/27
**Lecturer: TBC**
**Institution:** Heriot-Watt
**Delivery:** Video Conferencing
**Semester:** 2
**Hours Equivalent Credit: TBC**
**Assessment:** TBC

This course aims to give an understanding and awareness of modern photonic sensing devices and systems and include contextualisation through topical case studies.

Topics included: Fundamentals of UV-to-IR light detection; Fibre sensors; Interferometric sensing; Field sensing; Spectroscopic and fluorescence sensors; Nanophotonic sensors; Single-photon detection' Quantum sensors; Topical case studies, such as LIDAR; FBG structural health monitoring; integrated photonic sensing systems; bio-chemical sensing; gravitational wave detection.

### Optical Metrology (SUPAOMY)

**Status:** Opens to SUPA in 2026/27
**Lecturer: TBC**
**Institution:** Heriot-Watt
**Delivery:** Self–led Distance Learning
**Semester:** 2
**Hours Equivalent Credit: TBC**
**Assessment:** TBC

This course aims to provide fundamental knowledge and understanding of optical metrology.

Topics include: An introduction to optical metrology; Principles of laser interferometry; non-ideal interferometers; Fringe counting interferometry; Laser stabilisation and comparison techniques; Diode lasers in metrology.

# Physics and Life Sciences

**Theme Leader: Stuart Reid, University of Strathclyde**

The theme of Physics and Life Sciences (PaLS) covers a large breadth of both physical and life sciences. As students come from a wide range of backgrounds and experiences, and are pursuing diverse PhD projects, the exact courses to be taken should be discussed with the student's individual supervisor. Students are also invited to select relevant courses from any of the themes or to take appropriate and relevant non-SUPA courses within their home institution, but it is essential that the appropriate assessment (in the form of examination, written assignment or oral assignment) be discussed and agreed with the PaLS Theme Leader in advance.

## Semester 1

### Biophotonics (SUPABPH)

**Status:** Offered in 2025/26
**Lecturers:** Carlos Penedo-Esteiro, Juan Varela and Paolo Annibale
**Institution:** St. Andrews
**Delivery:** Video Conference, lectures and tutorials
**Hours Equivalent Credit:** 27
**Assessment:** Attendance, news and views article, presentation
**Coursework:** Students are expected to spend 27 hours on lectures and 115 hours on independent work.

The module will expose students to the exciting opportunities offered by applying photonics methods and technology to biomedical imaging, sensing and detection. A rudimentary biological background will be provided where needed. Topics include fluorescence microscopy and assays including time resolved applications, super-resolution imaging, optical tweezers for cell sorting and DNA manipulation, single molecule studies, optogenetics and methods to measure forces in biology.

### Introduction to Practical Experimental Optics and Microscopy (SUPAEOM)

**Status:** Offered in 2025/26
**Lecturer:** Jonathan Taylor
**Institution:** University of Glasgow
**Delivery:** In-person practical labs, asynchronous lectures, and tutorials
**Hours Equivalent Credit:** 15
**Assessment:** Continuous assessment via submitted lab notebooks

This course is very popular and unfortunately has limited space. Enrolling through the my.supa system is the first step in registering for the course but does not guarantee a place. The lecturer will review all the interested students and will contact those who will be admitted. Please do not assume you will be admitted to the course but have a back-up option for courses to take.

This course is aimed at students with a grounding in optical theory but seeking to expand their lab skills in optics and imaging. It covers:
- basic design, construction and precision alignment of experiments from kit optical components (e.g. Thorlabs components)
- understanding of microscope objective lenses and their properties for optical experiments
- hands-on use of a variety of microscope and camera systems
- understanding of camera properties such as read noise, and selection of optimal camera technology
- designing and constructing with laser safety in mind
- computational techniques for image deconvolution

## Semester 2

### Astrobiology and the Search for Life (SUPAASL)

**Status:** Offered in 2025/26
**Lecturer:** Charles Cockell
**Institution:** Edinburgh
**Delivery:** zoom, not in the SUPA Classroom
**Hours Equivalent Credit:** 20
**Assessment:** Report

This course investigates the origin, evolution and distribution of life in the Universe, broadly considered as 'astrobiology'. The objective of the course is to provide a perspective in geology, biology and chemistry at an introductory level. The course will include lectures on the limits and conditions for life on Earth through time and how these may apply elsewhere in the universe. The course looks at the current scientific approaches used to address the hypothesis of life elsewhere in the Universe. The subjects discussed include: the formation of planetary systems and the conditions required for habitability, detection methods for extrasolar planets, the diversity of known exoplanet systems, the origin of life, evidence for earliest life on Earth, the geological and biological history of the Earth, conditions past and present on Mars and the icy moons of the giant planets, and finally the Search for Extra-Terrestrial Intelligence (SETI).

### Biological Physics (SUPABPS)

**Status:** Offered in 2025/26
**Lecturer:** Chris Brackley and Gavin Melaugh
**Institution:** Edinburgh
**Delivery:** Distance Learning, with recorded lectures
**Hours Equivalent Credit:** 12
**Assessment:** Written assessment

This is a level 11 undergraduate course organised by the University of Edinburgh. It provides a physics-based introduction to Biological Physics for students who have not taken such a course as undergraduates. This course covers a variety of different topics and models within this interdisciplinary space.

Physics can provide a valuable insight into the behaviour of complex biological systems, and a physical approach to biological problems can provide a new way of looking at the world. This course will introduce you to the basics of biological systems and then provide examples of how familiar physical principles underlie complex biological phenomena. It will introduce you to the wonders of biology: the organisms, cells and molecules that make up the living world. We will demonstrate the power of physical concepts to understand and make predictions about biological systems, from the folding of a protein into a unique three-dimensional structure within a reasonable timeframe, through the motions of proteins to drive biological processes, to the locomotion of bacterial cells. The physical concepts will be substantially familiar, but their applications will be novel. Where possible, examples will be drawn from the recent scientific literature.
To get the most out of the course, students should be familiar with basic concepts from statistical physics (partition functions, free energies, entropy, canonical and grand canonical ensembles, random walks and diffusion). The course comprises 12 lectures and is assessed through a written assignment based around a seminal biophysics paper and topic of the student's choosing.

Many students in the Physics and Life Sciences theme appreciate the Professional Development course on Mathematical Modelling offered in Semester 2.

# Physics Education Research

**Theme Leaders: Nic Labrosse, University of Glasgow**
**and Anna Wood, University of Edinburgh**

## Semester 2

### Physics Education Research Foundations (SUPAPERF)

**Status:** This is a biennial course and is offered in 2025/26
**Lecturer:** Ross Galloway and Linda Hadfield
**Institution:** Glasgow
**Delivery:** Zoom, live discussions
**Hours Equivalent Credit:** 10
**Assessment:** Written weekly summaries, Annotated Bibliography at the end of term

This course is for SUPA students who are interested in physics education research. Students in all themes are welcome and no previous knowledge of physics education is required. We will read approximately one paper every week, depending on the length. Students will write a short summary or reflection on the paper each week for assessment. Class time will be spent discussing the content of the paper. Reading will include research papers and texts.

### Physics Education Research Current Topics (SUPAPERT)

**Status:** This is a biennial course. It is not offered in 2025/26 but is expected in 2026/27.
**Lecturer:** Ross Galloway and Linda Hadfield
**Institution:** Glasgow
**Delivery:** Zoom, live discussions
**Hours Equivalent Credit:** 10
**Assessment:** Written weekly summaries, Annotated Bibliography at the end of term

This course is for SUPA students who are interested in physics education research. Students in all themes are welcome. While it would be helpful to take the Foundations course first, interested students will benefit from this course even if they have no previous experience. We will read approximately one paper every week, depending on the length. Students will write a short summary or reflection of the paper each week for assessment. Class time will be spent discussing the content of the paper. We will respond to students' interest in the selection of papers, and students will be encouraged to lead the discussion. Students will submit an annotated bibliography of the papers covered as their final project.

# Plasma Physics

**Theme Leader: Declan Diver, University of Glasgow**

## Semester 1

### Plasma Physics (SUPAPPH)

**Status:** Offered in 2025/26
**Lecturer:** Kevin Ronald, Bengt Eliasson, Declan Diver
**Institution:** Strathclyde
**Delivery:** Video Conference
**Hours Equivalent Credit:** 12
**Assessment:** Multiple Choice Exam and Continuous Assessment

This course will address fundamental concepts in plasmas, from plasma creation from a neutral gas through to full ionization. Basic plasma timescales and length scales will be derived, such as the plasma, cyclotron and collision frequencies, skin depth, sheath extent and Larmor radius. Waves and instabilities in fully ionized (and magnetized) fluid and kinetic plasmas will also be addressed. The many natural and man-made types of plasma and their applications will be outlined, and in particular magnetically confined plasmas will be discussed with examples, including tokamaks.

## Semester 2

### Laser Driven Plasma Acceleration (SUPALDP)

**Status:** Offered in 2025/26
**Lecturer:** Dino Jaroszynski, Paul McKenna, Zheng-Ming Sheng and Bernhard Ersfeld
**Institution:** Strathclyde
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 16
**Assessment:** Continuous Assessment

This course will address the topical research in laser plasma interactions, laser-plasma acceleration and plasma-based radiation sources. It will be divided into four connected parts starting with a thorough but brief introduction to the main theoretical concepts of laser-plasma interactions. The second and third parts will address the interaction of intense laser pulses with under-dense and over-dense plasma respectively, with particular emphasis on laser-plasma acceleration, absorption, propagation, electron transport, plasma waves, shock waves, radiation mechanisms, non-linear optics of plasma etc. The fourth part will introduce students to the main concepts of free-electron lasers, which are important tools for scientists investigating the structure of matter. Students will proceed quickly from basic concepts to advanced and current applications such as compact radiation and particle sources, inertial fusion energy, fast ignition etc. They will gain a good introduction to laser-plasma interactions, which will provide a good basis for postgraduate research in this area.

### Plasma Physics II

**Status:** Offered in 2025/26
**Lecturer:** Declan Diver
**Institution:** Glasgow
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 12
**Assessment:** Multiple Choice Exam and Continuous Assessment

# Quantum Technologies

**Theme Leaders: Sonja Franke-Arnold, University of Glasgow and John Jeffers, University of Strathclyde**

## Semester 1

### Theoretical Foundations of Quantum Technologies (SUPATFQ)

**Status:** Offered in 2025/26
**Lecturer:** Sarah Croke (Glasgow), Jonathan Prithcard (Strathclyde) and John Jeffers (Strathclyde)
**Institution:** Various
**Delivery:** Video Conference
**Hours Equivalent Credit:** 20
**Assessment:** Problem sets and Essay
**Course work:** Students will spend about 50 hours total on this course, including lectures and assignments

This course will provide the background theory relevant to Quantum Technologies.
Part I (3 lectures) – Basic Atomic Physics: Historical introduction to atomic physics, Angular momentum; Atomic structure; Atom-light interactions.
Part II (3 lectures) – Basic Photonic Quantum Optics: Field quantisation, single-mode fields and quantum states; beam splitters and interferometers; non-classical light and its generation.
Part III (3 lectures) – Applications of Quantum Information: Quantum key distribution, Quantum sensing; Qubits, classical and quantum gates; introduction to quantum algorithms.

### Quantum Mechanics for Scientists and Engineers, Discussion (SUPAQMSE)

**Status:** Offered in 2025/26
**Lecturer:** Niclas Westerberg
**Institution:** Glasgow
**Delivery:** VC
**Hours Equivalent Credit:** 18
**Assessment:** Weekly tutorials, where 1 question each week is selected as a marked hand-in exercise (marked at a pass/fail level).

In this course, we will study quantum mechanics at a level suitable as an introduction to the subject or as a refresher. The aim is to end the course with a working understanding of typical problems and techniques. The course will consist of two weekly sessions, supplemented by online lectures and material by David Miller and relevant books, where we go through important concepts and solve some exercises, respectively.

## Semester 2

### Quantum Devices (SUPAQMD)

**Status:** Offered in 2025/26
**Lecturer:** Margherita Mazzera and Cristian Bonato
**Institution:** Heriot-Watt
**Delivery:** Teams call, not in the SUPA Classroom
**Hours Equivalent Credit:** 30
**Assessment:** two 3-hour take-home exams (one per module, 50% each). An oral viva with one-to-one discussion of research papers might be required if the 50% threshold for passing is not reached in either one of the take-home exams.
Course Work: Approximately 7 hours per week outside of class

(1) Introduction to nanophysics, qubits and the density matrix formalism.
(2) Nanofabrication: Overview of the most common nanofabrication techniques and Nanostructure characterisation.
(3) Quantisation by confinement, effect of confinement on transport properties of solids, Effect of confinement on excitons, screening and energy renormalization.
(4) Spins in quantum mechanics, spin polarisation and readout, Nuclear spin baths, Applications to quantum sensing and quantum computing.
(5) Intro to superconductivity, macroscopic quantum model, London equation, Meissner effect, Josephson junctions, kinetic inductance.
Devices: kinetic inductance detectors, SQUIDs, SSPDs, superconducting qubits

### Physical Systems for Quantum Technologies, SUPAPSQ

**Status:** Offered in 2025/26
**Lecturer:** Paul Griffin, Sam Bayliss, Alessandro Fedrizzi, Martin Weides
**Institution:** CDT in Applied Quantum Technologies
**Delivery:** zoom, in the SUPA Classroom
**Hours equivalent credit:** 20
**Assessment:** Problem sets and essay
**Course work:** Students will spend about 50 hours total on this course, including lectures and assignments

This course will introduce physical systems and experimental techniques relevant to Quantum Technologies. Part I (3 lectures, Paul Griffin) – Atoms: Laser cooling and atomic clocks; Atoms in optical lattices; Rydberg atoms in tweezers for quantum computation; Part II (2 lectures, Sam Bayliss) Spin Qubits: Spin-light interfaces; Physical systems; Initialisation, readout and control of spin qubits; Applications to quantum sensing and quantum networks; Part III (2 lectures, Alessandro Fedrizzi) – Photonics; Part IV (2 lectures, Martin Weides) – Superconducting Qubits: Quantum circuits, materials and interfacing concepts.

### Quantum Magnetism and Quantum Phase Transitions (SUPAQMPT)

**Status:** Offered in 2025/26
**Lecturer:** Bernd Braunecker, Jonathan Keeling
**Institution:** St. Andrews
**Delivery:** zoom in the SUPA Classroom
**Hours Equivalent Credit:** 18
**Assessment:** Continuous Assessment

These lecturers cover two closely related themes: models of magnetism and quantum phase transitions. The two parts are strongly linked in that many of the models we will introduce to describe magnetism turn out to be paradigmatic models of quantum phase transitions. The course is intended to be relevant not just for those working on traditional solid-state systems, but also those working on cold atom physics, where many of the same models and questions are also relevant.

# Professional Development Training

All SUPA students are required to complete 20 hours of Professional Development Training during the first two years of their PhD studies. SUPA Professional Development Training Courses are listed in this section. In addition, students may also participate in Professional Development Training run by their local departments and universities or run by Vitae (a UK-wide organisation sponsoring Skills Training) or their Research Councils.
Please note that enrolment times for Professional Development Training are often different from Specialist Courses. Information about enrolment for each course will be posted on My.SUPA course areas and announced to all students via email. If you have any questions about enrolment, please email admin@supa.ac.uk.

Courses run by Vitae and individual universities can be found at the following websites:

Vitae

University of Aberdeen

University of Dundee

University of Edinburgh

University of Glasgow

Heriot-Watt University

University of St Andrews

University of Strathclyde

University of the West of Scotland

## Semester 1

### Maths Primer (SUPAPRI)

**Status:** Offered in 2025/26
**Lecturer:** Patrik Öhberg
**Institution:** Heriot Watt
**Delivery:** Teams call, Lectures are pre-recorded, and class time is used for questions and discussion.
**Hours Equivalent Credit:** 6
**Assessment:** Continuous Assessment

The course will be in the form of a maths primer intended for beginning PhD students in condensed matter, solid state and photonics. The topics which will be covered include Matrix diagonalisation, functional derivatives, complex integration and residues, Fourier transforms, and a discussion on different notations which the students will encounter during their studies.

### FPGA Programming for Physicists (SUPAFPP)

**Status:** Offered in 2025/26
**Lecturer:** Johannes Hernsdorf
**Institution:** Strathclyde
**Delivery:** zoom call, not in the SUPA Classroom
**Hours Equivalent Credit:** 12
**Assessment:** Continuous Assessment
**Course work:** Students are expected to spend about 2.5 hours each week on independent work for this course, in addition to lectures.

Field programmable gate arrays (FPGAs) are configurable digital electronic devices capable of providing high-speed, low-latency and controlled latency digital interfaces to experiments. For example, FPGAs have been used in fluorescence lifetime measurements, various imaging methods, detection of photon correlations, gravitational wave detectors, and gravimeters. This course will equip students with the basic knowledge of how to interface physics experiments to digital electronics, and how to program FPGAs. An introduction to hardware description languages (HDLs) is given on the example of Verilog. HDLs are fundamentally different from computer programming languages and understanding them is crucial for the use of FPGAs. After completion, participants will be able to integrate FPGAs into their own experiments, create simple FPGA configurations, understand common problems and strategies to overcome them, and be aware of resources to help extend these skills.

### Software Carpentry (SUPASWC)

**Status:** Offered in 2025/26
**Lecturer:** Daniel Williams and Norman Gray
**Institution:** Glasgow
**Delivery:** To be determined
**Hours Equivalent Credit:** 16
**Assessment:** Continuous Assessment

Many researchers need to write (computer) code of some type or other, though typically as an auxiliary activity – researchers should not turn into 'programmers'. It is useful for researchers to do that part of their work effectively, now and in the (transferrable) future. The Software Carpentry course (SWC) aims to instil pragmatic good practice in scientists. The course is practical, in the sense of describing how to work with specific tools, but we also make a point of discussing these in a wider context of good (reproducible!) scientific practice.

## C++/Object Oriented Programming (SUPACOO)

**Status:** Offered in 2025/26
**Lecturer:** Gary Robertson
**Institution:** Glasgow
**Delivery: L**ectures are shared through zoom in the SUPA Classroom. Labs are in person.
**Hours Equivalent Credit:** 12
**Assessment:** Continuous assessment; This course has priority booking for Particle Physics students. Please refer to the timetable and visit the My.SUPA course area for more information.

The course introduces the core concepts of C++ via four lectures and four laboratory tutorial sessions. This course assumes no prior knowledge of C++, but recommends some experience with the Linux file system and use of a text editor or integrated development environment (IDE). The course will be run in-person but both lectures and labs will have a remote connection available for those unable to travel to Glasgow. For the lab portion a personal computer or laptop is required but an online development environment is provided so a working c++ compiler on your local machine is not needed.

The aim of the course is to introduce the main C++ concepts and highlight those used commonly in research applications. The topics covered include:

- C++ syntax
- Data types and operators
- Input/output streams
- Conditional logic and loops
- External library functions (string, vector, stringstream, etc)
- Strings and arrays
- User defined functions
- User-defined classes
- Templated functions and classes
- Inheritance and polymorphism
- Pointers and memory management
- Random numbers and statistical distributions
- Code compilation and make
- Running code via command line
- Code style best practices

## Outreach Training (Glasgow)

**Status:** Offered in 2025/26
**Lecturer:** Glasgow Science Centre Staff
**Institution:** Glasgow Science Centre
**Delivery:** In person
**Hours Equivalent Credit:** 10
**Assessment:** Presentation

This course takes place over 2 days, September 4th and October 16th. On the first day students will be introduced to ideas about science communication and education and will observe experienced science communicators. Students are encouraged to develop an activity about their research for general audiences. On the second day, some weeks later, students will have the opportunity to present their activity to general audiences in the museum. If students feel they cannot develop their own activity, some prepared activities will be available. Students must participate in both days to receive credit.
No previous experience or specialist knowledge is required.

SUPA will reimburse for travel to this course, but please complete the travel application form in advance. See Face to Face courses on Page 5.

To register, please contact Linda.Hadfield@supa.ac.uk

## Semester 2

### ROOT (SUPAROO)

**Status:** Offered in 2025/26
**Lecturer:** Marcos Miralles Lopez
**Institution:** Glasgow
**Delivery:** Face to Face
**Hours Equivalent Credit:** 9
**Assessment:** Continuous Assessment

ROOT is a primary data analysis framework tool developed by CERN and used in experimental particle physics and, increasingly, many other fields. This course is based on hands-on sessions in which you will learn the basic features of ROOT, through to producing a publication-quality plot from raw data.

### Introductory Data Analysis (SUPAIDA)

**Status:** Offered in 2025/26
**Lecturer:** David O'Donnell
**Institution:** UWS
**Delivery:** zoom call, not in the SUPA Classroom
**Hours Equivalent Credit:** 6
**Assessment:** Continuous Assessment
This course provides an introduction to uncertainty in measurement. Topics will include random error and relation to statistics; probability distributions and their properties; calculation and estimation of uncertainty; least squares model; applications of data analysis.

### Advanced Data Analysis for the Physical Sciences (SUPAADA)

**Status:** Offered in 2025/26
**Lecturer:** Ik Siong Heng
**Institution:** Glasgow
**Delivery:** Recorded lectures with interactive sessions through zoom, not in the SUPA Classroom
**Hours Equivalent Credit:** 14
**Assessment:** Moodle quiz at the end of lectures and tutorials
**Course work:** Students are expected to spend 100 hours on this course

This course will provide a comprehensive introduction to the principles and practice of advanced data analysis, with particular focus on their application within the physical sciences and on the (rapidly growing) use of Bayesian Inference methods.

Over the past few decades Bayesian inference methods, as a powerful tool for analysing data, have been growing ever more common across a diverse range of fields of physics. Bayesian inference provides a natural framework in which to address key quantitative questions, constrain the parameters of physical models and measure how well competing models can describe the available data. They also provide an objective and straightforward framework in which to incorporate prior information about those models, obtained e.g. from previous analyses or from theory. Moreover, recent advances in computational methods also offer simple algorithms in which to implement Bayesian methods – even with very large and complex data sets – on a standard desktop computer.

These lectures will give a comprehensive introduction to Bayesian inference methods. The lectures will include some practical exercises designed to introduce some useful codes and algorithms – as well as to showcase the vast array of online resources available to support the newcomers to Bayesian inference who seeks to apply these methods to their data.

## Industry Skills (SUPAISC)

**Status:** Offered 2025/26
**Lecturer:** Various external speakers, organised by SUPA
**Institution:** SUPA
**Delivery:** Distance Learning
**Hours Equivalent Credit:** 5
**Assessment:** Written reflections

In recorded interviews, individuals who have built their career on a PhD in physics describe their career path and their current work. Students choose 5 interviews from those available, listen to the interview and answer reflective questions. This flexible format can be completed at any time during the term.

Students may choose from interviews that are publicly available at The Way We Work, on the supa webpage, and from recorded sessions of Careers Online at Lunchtime. Students may want to investigate the interviews before registering on the course.

## Mathematical Modelling (SUPAMMD)

**Status:** Offered in 2025/26
**Lecturer:** Marco Thiel
**Institution:** Aberdeen
**Delivery:** zoom call, not in the SUPA Classroom
**Hours Equivalent Credit:** 33
**Assessment:** Students must engage with assignments.
**Coursework:** In addition to the lectures and tutorial, students should expect to spend about 100 hours on coursework during the term.

This course shows you how to develop mathematical descriptions of phenomena. We use mathematical techniques to describe a large variety of "real-world" systems: spreading of infectious diseases, onset of war, opinion formation, social systems, reliability of a space craft, patterns on the fur of animals (morphogenesis), formation of galaxies, traffic jams and others. This course boosts your employability and teaches tools that are highly relevant for almost every researcher.

## Presenting your research (PYR)

**Status:** Offered in 2025/26
**Lecturer:** Cheryl Patrick
**Institution:** Glasgow and Edinburgh
**Delivery:** zoom call in the SUPA Classroom with in-person sessions
**Hours Equivalent Credit:** 12
**Assessment:** Presentation

This highly interactive course explores how to present your research effectively to achieve the results you want. We will investigate some communication techniques and discuss how to tailor your presentations to suit your audience. We will try some design tools and discuss how visual materials can aid or hinder your ability to communicate. Finally, all students will get an opportunity to present about their own research, or another topic of their choice. Participants will receive staff and peer feedback in a supportive, non-judgemental environment.

## Introduction to Machine Learning (SUPAIML)

**Status:** Offered in 2025/26
**Lecturer:** Rastko Sknepnek
**Institution:** Dundee
**Delivery:** Teams call, not in the SUPA Classroom
**Hours Equivalent Credit:** 30
**Assessment:** Continuous Assessment
**Coursework:**

In this module, you will learn basics of the theories behind modern machine learning techniques. During ten three-hour labs, you be asked to implement several key machine learning techniques and apply them to real-world problem, such as predicting house prices, recognition of handwriting, etc. This module can serve as a basis for preparing for a career in modern machine learning – a rapidly growing field of academic and industrial applications.
The module will cover:

- Basics of probability theory and statistics used in machine learning.
- Linear regression
- Logistic regression
- Naïve Bayes models
- Support vector machines
- Deep neural networks
- Hopfield model

## Introduction to Python (SUPAPYT)

**Status:** Offered in 2025/26
**Lecturer:** Albert Borbely
**Institution:** Glasgow
**Delivery:** Lectures in a zoom call, not in the SUPA Classroom, and in-person lab
**Hours Equivalent Credit:** 8
**Assessment:** Assignment Problem

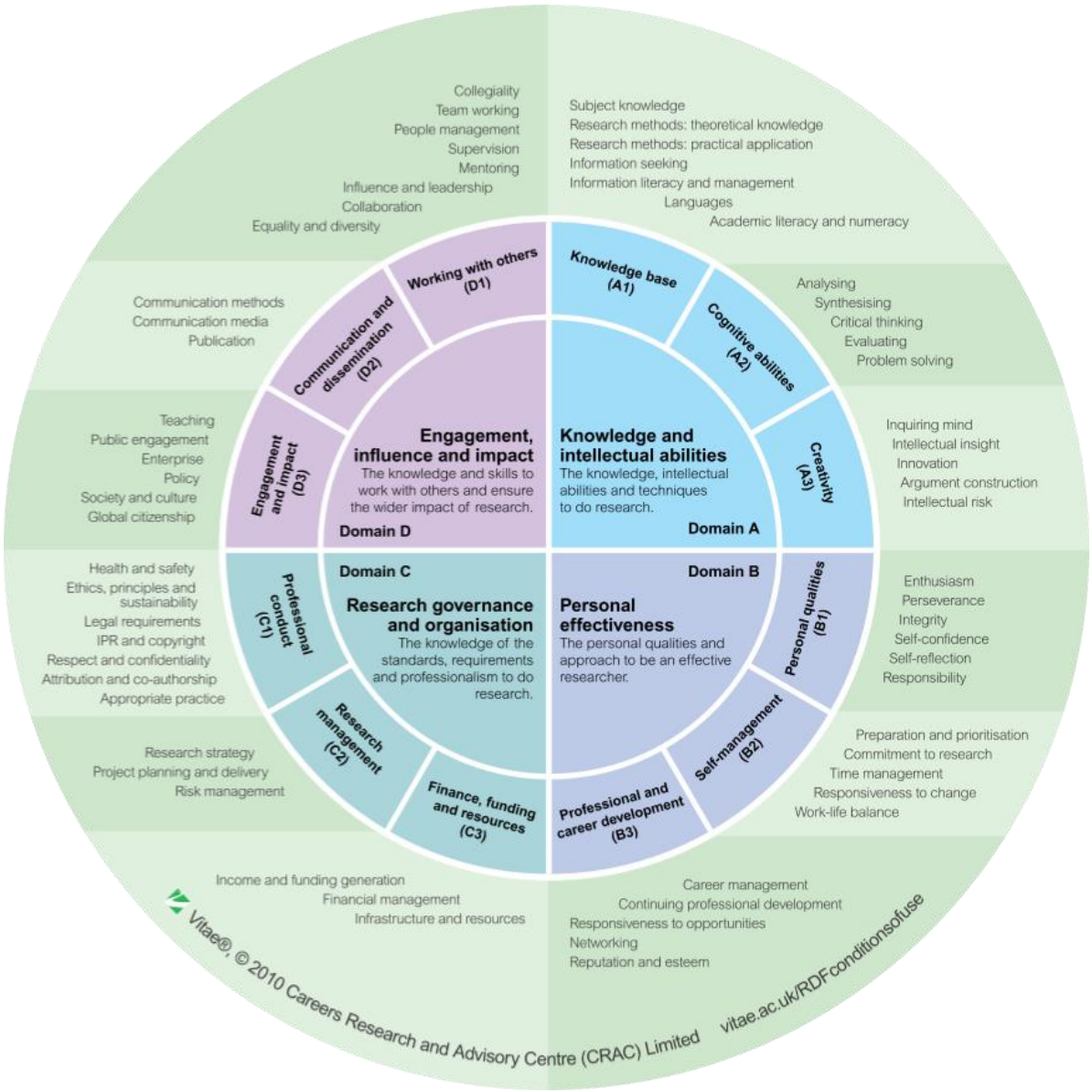
This is an introductory Python programming course where students are shown how to solve a wide range of problems. After completion students will be able to solve problems, both using strictly native Python modules as well as make use of the extensive library of external Python modules. This course is taught through practical lab sessions, primarily in person but also through zoom. Recorded lectures and slides are made available.

## Researcher Development Framework

The Researcher Development Framework describes the knowledge, behaviours and attributes of successful researchers and encourages you to aspire to excellence through achieving higher levels of development. It is invaluable for planning, promoting and supporting your personal, professional and career development. Further information can be found online at: www.vitae.ac.uk/rdf.

You can use the RDF to identify strengths and prioritise your professional development, considering the skills and experiences that will enhance your career prospects. It will also support you to articulate your knowledge, behaviors and attributes to employers.

As you start your doctorate, consider looking at the 'Getting Started' lens of the RDF, which will help you consider the right questions to identify the training you should consider for the best possible start. The lens can be found at https://www.supa.ac.uk/courses



## Plagiarism

While undertaking SUPA courses with assessment, you will be required to abide by your university's rules on plagiarism. Students will be subject to the disciplinary procedures of their university.