



University of St Andrews  
*Scotland's first university – 1413*



Physics & Astronomy  
Undergraduate 2024 Entry

# Physics & Astronomy at St Andrews

Physics and Astronomy are key subjects for understanding the universe around us. There is a fascination and a challenge here. Why is the sky blue? What is the difference between metals and semiconductors? How are matter and energy related? What happens near a black hole? How did the universe begin? Answers to these and similar questions can then lead to investigation and understanding of related phenomena, and to the development of new technologies.

We can use physics to understand aspects of systems ranging from the smallest parts of our bodies to the vast collections of galaxies. Physics is relevant in almost every human endeavour. Our teaching emphasises an understanding of these ideas. Our courses are interesting, current, relevant, and thought-provoking.

- Students at the University of St Andrews are more positive about their education than students at any other mainstream university in the UK (*National Student Survey 2023*). This is the 15th time in the past 17 years that St Andrews has been ranked at the top of universities across the UK in this survey.
- Students enjoy a wide range of activities in a student-focused community within a historic coastal town.
- Students are guaranteed University accommodation in the first year.
- Our School is large enough to have major research strengths, but small enough that there is good student-staff interaction, and some small class sizes.
- Programmes are flexible, with a choice of entry and exit points and degree intention as a student proceeds.
- Well-qualified entrants may complete an Honours BSc degree in three years, or an MPhys degree in four.
- The University Observatory contains the largest operational optical telescope in the UK.
- The 2018 formal review of our teaching programme commended the School for "its strong sense of community. Students perceive staff as welcoming, approachable and supportive."
- Internationally recognised research in astrophysics, biophotonics, lasers and optoelectronics, mm-waves, magnetism, semiconductors, solid-state and theoretical physics informs our teaching.
- Ranked number one in the UK for student academic experience (*NSS 2023*), the University is also first in Scotland and fifth in the UK for Physics (*Guardian Good University Guide 2024*).
- Awarded Scottish University of the Year, the School of Physics and Astronomy is ranked second in the UK (*The Times and Sunday Times Good University Guide 2024*).



Research in quantum materials



## Degree Options for Physics or Astronomy

### Single Honours

Astrophysics (BSc)	F511
Astrophysics (MPhys)	F510
Physics (BSc)	F301
Physics (MPhys)	F300
Theoretical Physics (MPhys)	F340

### Joint Honours (BSc)

<b>Physics and:</b>	
Mathematics	FG31
Philosophy	FV30

### Joint Honours (MPhys)

Theoretical Physics and Mathematics	FGH1
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### Joint Honours (MSci)

Physics and Chemistry	FF13
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Also note the alternative entry route:  
Gateway to Physics and Astronomy BSc (FH31)  
and MPhys (FH3C)

(See page 8 for Entry Requirements)

Traditional student pier walk



Second year lecture



Group investigation in first year



Second year problem-solving workshop



Photograph of Orion nebula taken by students at the Observatory



*“The students and staff within the School of Physics and Astronomy at St Andrews form such a welcoming and supportive community. The dedication from lecturers to provide support and world-class teaching has been my lifeline to this demanding degree and I feel incredibly privileged to be learning in an environment where everybody is on each other’s team”*

Pavani

## The School

Along with several other science Schools, Physics & Astronomy lies on a pleasant modern site close to the town centre, as pictured on the back cover of this leaflet. Teaching, research, library and computing facilities are in our building, and the well-equipped University Observatory nearby has the largest operational optical telescope in the UK.

Having about 40 members of teaching staff and around 150 research staff and students, the School is large enough to provide a wide coverage of physics and astronomy at undergraduate level and lively enough to produce significant research. However, the School is small enough for staff and students to get to know each other in a way that is not possible at much larger universities. Some 80-130 students per year graduate from the School. The comparatively small size of the University as a whole facilitates the ready mixing of those studying different subjects. There is a cosmopolitan feel to St Andrews, with students from all over the UK, and indeed from around the world.

## BSc and Integrated Masters programme details

A five-level structure is used in order to provide suitable entry and exit points tailored for students with different backgrounds and desires. These levels, which usually last an academic year each, are shown in the table on pages 8 and 9. There can be a choice of entry level depending on school qualifications and how broad you wish your entry year to be.

First-year entry has been designed for those entering straight from Scottish Highers, those wishing to experience the traditional broad-based first year at university, and students on some joint programmes.

If you have good Advanced Highers or A-Levels, and you are sure that you wish to study for a degree in physics and/or astronomy, you

are invited to enter directly into second year. Currently around one third of our entrant students take this accelerated entry route.

There is an alternative first-year entry route called the Gateway to Physics and Astronomy designed for students with high academic potential who have experienced disadvantage. Slightly lower qualifications (e.g. ABBB at Higher) are needed for entry. About half the entry year is with the traditional entry students, about half is on strongly tutored modules in academic skills relevant to physics and mathematics. Successful completion of this year allows progression to our second year physics, astrophysics, and mathematics modules.

### Gateway to Physics and Astronomy

There is a choice of exit levels with the BSc Honours degree taking three or four years and the more advanced MPhys and MSci Honours degree taking four or five years, depending on the point of entry. The Integrated Masters degree is particularly appropriate if you wish to go on to pursue a research or development career in physics or astronomy. Your final decision on the BSc or Integrated Masters degree need not be made until third year.

In third and fourth year you take some or all of the mainstream modules in quantum mechanics, nuclear and particle physics, thermal and statistical physics, electromagnetism, computational physics, and condensed matter physics, as well as choosing additional modules in specialist areas. Depending on the degree programme these might include extragalactic astronomy, computational astrophysics, special relativity and fields, fluids, laboratory modules and many others. All final year students undertake a major research project, which is often carried out within one of the School’s research groups.

The MPhys additional year contains a choice of advanced lecture modules in areas such as biophotonics, Monte Carlo radiation transport techniques, applications of quantum physics, magnetofluids and space plasmas, and contemporary astrophysics, as well as a major research project. All of our BSc, MPhys and MSci degrees are accredited by the UK and Ireland Institute of Physics.

Lectures are supplemented by tutorials. These provide the opportunity for in-depth discussions of issues arising from lectures, as well as broader topics in physics and astronomy.

Appropriate laboratory periods introduce you to a wide range of equipment and techniques. Third and fourth year physics lab modules, for example, currently contain work with surface probes, X-ray crystallography, cryogenics, and optical tweezers. Astronomy students have the use of telescopes at the Observatory.

In your final year you can participate in the extensive research activity of the School by undertaking a project which extends over a large part of the academic year. This is a great way to learn and experience the development of physics first hand. Many projects take place in our state-of-the-art research labs, some may include travel to international facilities, and some projects result in scientific publications. Recent projects have included the investigation of cloud formation in planetary atmospheres, generating and exploring the use of specially shaped laser beams for use in health monitoring, and exploring the theory of quantum networks for enhancing solar cell efficiency.

For Single Honours students in the School, advanced communication and other skills are developed in the 3000-level Transferable Skills for Physicists module, which normally includes an informal weekend spent away from St Andrews, giving a talk on a chosen topic in physics or astrophysics.

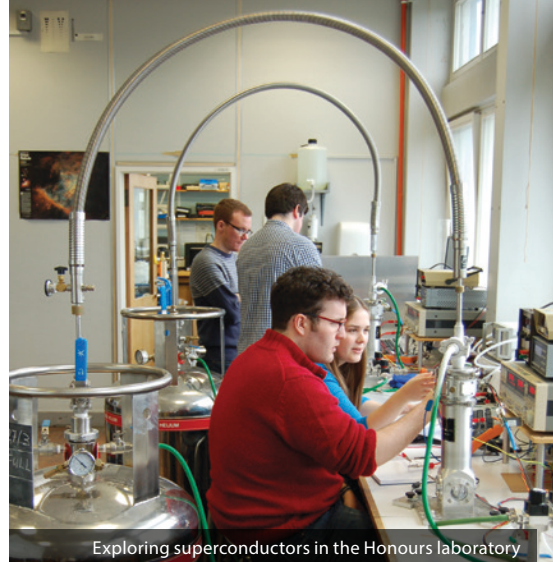
Depending on the modules you have chosen to take, it is possible to postpone the final choice of degree title at least until you reach 3000-level. Many students make use of this flexibility.

### Teaching and research quality

In the latest Research Excellence Framework (REF 2021), the quality of our research in physics and astrophysics was ranked top in Scotland and eighth in the UK.

The most recent formal review of our teaching programme in 2018 commented on the “attractive, balanced and modern presentation of Physics and Astronomy” and “a well-functioning School with a healthy student-staff relationship”.

Students across the university hold our teaching and their experience in high regard, with St Andrews recording the highest positivity score in Scotland (*National Student Survey 2023*).



Exploring superconductors in the Honours laboratory



Staff-student discussion



Exploring magnetic effects in the Honours laboratory



The University Observatory



*“Studying Physics at St Andrews is a great balance between being given enough independence to allow me to grow, and getting enough attention from staff to feel supported to do my best. There are opportunities to take leadership roles or to take part in research projects. I worked with my quantum mechanics lecturer on a summer project designing and coding an interactive simulation on indistinguishable particles. These amazing aspects of studying Physics, plus getting to live in such a beautiful and lively student town, has made me so glad I chose to apply to St Andrews!”*

Charlie

# Outline of degree programmes

## Traditional first year entry

For those who wish to take a broader first year, and for all on some joint degree programmes.

Standard entry requirements for Highers are AAAA, for A-Levels are AAA, and for International Baccalaureate 38 points (HL6,6,6) in all cases including Physics and Mathematics.

## Gateway entry

**Physics and Astronomy (Gateway) entry point.**

Students who have academic potential but due to disadvantage are unlikely to quite reach our normal entry requirements, may be eligible for an alternative first year programme that leads on to the existing second year. Please see page 5 and the School web pages for more details.

## First year

Six 20-credit modules are normally taken in this first year of study. These include Physics 1A and 1B, which cover topics such as Newtonian Mechanics, Quantum Phenomena, Waves and Optics, Properties of Matter, and Lasers.

Intending astronomers must take AS1001; this is an option for others. The Astronomy module contains topics on The Solar System, Stars & Elementary Astrophysics, The Galaxy, and Galaxies & Cosmology.

All these modules contain suitably graded practical work and tutorials.

Intending Physics or Astronomy students must include at least one or two Mathematics modules, depending on school qualifications. A wide choice of other first year modules from across the University is available, subject to timetable constraints.

## Direct entry to second year

**Possible entry point for those with good Advanced Highers or A-Levels and planning a Single Honours degree in the School.\***

University entry as for first year entry, but to be eligible to start at second year, Highers-qualified students would also need A grades at Advanced Higher in Physics and Mathematics along with AAAA at Highers.

## Second year

All Physics and Astronomy students take Physics 2A, Physics 2B, Mathematics modules MT2501 and MT2503 which build on first year, Advanced Higher, or A-Level work. Topics include Classical Mechanics, Relativity, Oscillations in Physics, Quantum Physics, Classical Waves, Electricity and Magnetism, Thermal Physics, Linear Algebra, and Multivariate Calculus. Astrophysicists take AS2001 or AS2101. This or another module is taken by physicists. Practical work and small-group tutorials also aid learning.

This information is for guidance only. For Joint Honours degrees the subject with the higher entry requirements determines the likely minimum grades. Admissions Officers consider all aspects of every application, particularly the Personal Statement. Remember that you must also meet the general entry requirements: [Studying Physics and Astronomy](#)

St Andrews uses contextual data to assess UK applications. Our indicator will tell you whether you are likely to need to achieve the 'standard', 'entry', or 'Gateway' entry requirements.

[Undergraduate academic entry qualification indicator](#)

\*Direct entry to second year of the joint degrees with Mathematics is also possible.

## Third and fourth years

These two years of study can lead to the BSc Single Honours degree in:

### Physics or Astrophysics

Lectures are supplemented by tutorial work. Third and fourth year Physics students take two laboratory modules, and Astrophysics students can take observational and computational Astrophysics modules. Theoretical Physics students usually take theory modules instead of labs. Fourth year BSc students undertake a major project.

For students who have taken the appropriate modules in the second subject, the following joint BSc degrees are also available:

- **Physics and Philosophy**
- **Physics and Mathematics**

## BSc Honours degree

This is taken in three or four years, depending on the point of entry.

## Integrated Masters additional year

This year contains advanced lecture courses and a substantial project.

The MPhys degree titles are:

- **Astrophysics**
- **Physics**
- **Theoretical Physics**
- **Theoretical Physics and Mathematics**

The MSci degree:  
**Physics and Chemistry**

## Honours MPhys or MSci degree

Integrated Masters degree is taken in four or five years, depending on the point of entry.

### Scholarships

The School offers a number of scholarships of £1,000 or more to selected students entering the School, including some reserved for Gateway entrants. The University has a variety of other scholarships on offer.

#### Undergraduate scholarships

### Meet us

The University organises visiting days for prospective students to visit the University and see for themselves the Schools in which they are interested. These take place on a number of Wednesdays and Saturdays through the year.

For the 2023-24 session some of these days will be virtual, and some in person. On request, visits may be organised at other times as well.

#### Meet us

### International links

We are pleased to welcome a number of overseas students to our School for a semester, a year, or the full degree programme. Our University has exchange links with a number of overseas universities. Students may apply to be considered to spend their third or fourth year at one of these institutions.

The School's Student-Staff Council organises summer placements for selected students at international facilities such as the High Magnetic Field Facility in Grenoble.

Research links are maintained with scientists in many countries.

### Career Opportunities

Degrees in physics and related subjects are welcomed by employers, and St Andrews graduates do well at finding employment in areas of their choice. A significant number of graduates go into some form of research or development in industry or in Government agencies, either immediately after graduation or following a higher degree. Examples of high technology industries in which physicists work include optoelectronics, computing, telecommunications, aerospace, and semiconductors. In our degree programmes we work with students to develop relevant skills such as problem solving, mathematical modelling, and the ability to communicate complicated ideas. These skills also make for

graduates who are well-suited for more general careers in management, banking, and related areas. A good physics training opens the door to many different careers. We have a number of graduate profiles on our School website. These include graduates who have entered careers in research (various universities and companies), software (Aptus, California), medical physics (NHS, Manchester), accountancy (PwC), and business analysis (Sky).

#### Physics and Astronomy graduate comments

#### Graduate destinations



*“Studying Physics at St Andrews is an enjoyable experience. Lecturers are very approachable and keen to answer questions I might have about course material. My classmates have been supportive and friendly, and I think this is in part a result of the healthy environment which the School fosters. I like the flexibility to supplement my physics courses with others – Computer Science and Dolphin Acoustics were interesting to explore.”*

Joel



# Student experience

St Andrews offers you a student experience like no other, currently voted the best in the UK in the *National Student Survey* (2023). There are societies, sports clubs, traditions and events throughout the year, so whether you have existing activities you want to continue or want to explore other areas, you will always find something to get involved in.

The School's students run AstroSoc and PhySoc with social and academic events associated with astronomy and physics respectively. The School's Student-Staff Council also plays an active role in academic and other events, including a dinner-dance for students and staff.



*"The Physics community in St Andrews is one of the best things about studying Astrophysics in St Andrews. Being able to study in such a tight-knit and welcoming environment has only made my love of stars stronger. The quality of teaching has always been fantastic, and all the lecturers and tutors are always ready to help with understanding. Each student is valued and guided through our studies, and we also have a strong student representation scheme that gives us a voice to effect change in our own learning. I've made many life-long friends here, through classes, social life and society activity alike. You get to meet so many people from many different backgrounds, and many experiences and perspectives come together. And since everyone is in the same boat, it's always so wonderful to talk to someone who understands the worries and joys of being a student. The student life is vibrant, and there's always something for you to find your place. Within Physics, there are the traditional PhySoc Wine and Cheese nights or the staple Astrosoc Observing nights with hot chocolate that are always a great time! There's also plenty of sports societies and social events always on to find the best way to unwind. From societies and sports to all the varied traditions of the Uni, studying in St Andrews is a unique experience I'm so glad to have had in my life."*

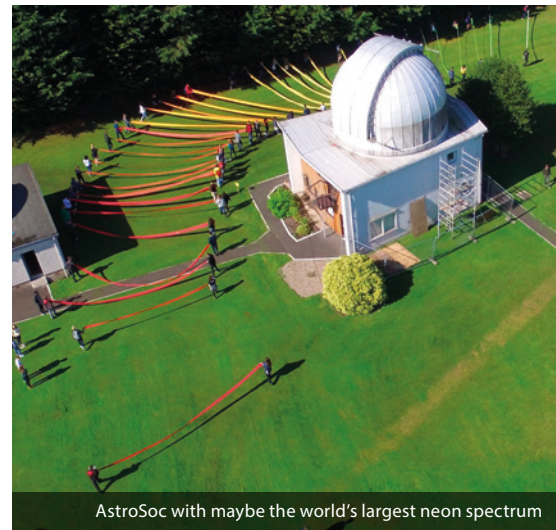
Laura



Music in the Rector's Café



McIntosh Hall



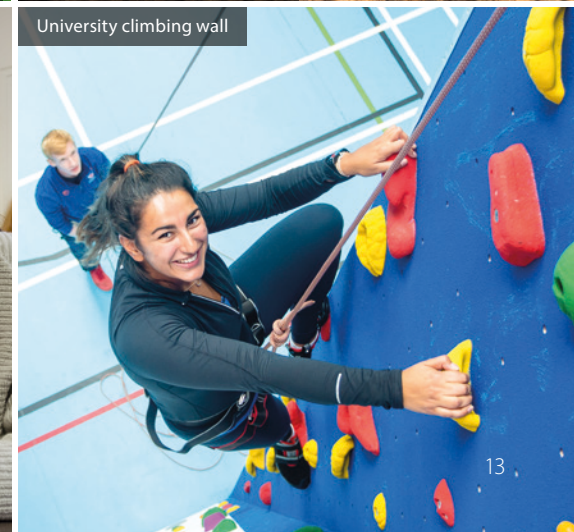
AstroSoc with maybe the world's largest neon spectrum



May Dip (an optional tradition)



Group study area in the School



University climbing wall

# Research

The School has a successful research programme exploring a range of fundamental and applied areas of physics and astronomy. In the latest Research Excellence Framework (REF 2021) our research in physics and astrophysics was ranked eighth in the UK and top in Scotland for quality.

With most teaching staff directly involved in research you can expect to find classes that are informed by the latest research in astronomy and physics, and taught in many instances by internationally-recognised experts in their fields. Through their research many staff also have useful links with companies and organisations. The links between teaching and research are probably strongest for students in their final-year project, which they often undertake within one of the research groups and with access where appropriate to specialised equipment, some of which is unique within the UK. Our Centre for Designer Quantum Materials, for example, includes apparatus for growing new materials one layer of atoms at a time, and for exploring these designer materials using techniques that can image its electrons and measure their properties with atomic resolution.

The main research activities of the School are in the areas of: Astronomy and Astrophysics, Laser Physics and Optoelectronics, Biophotonics, Quantum Optics, Magnetism and Superconductivity, Quantum Materials, Millimetre-wave Techniques, and Theoretical Physics. The School is a member of the Scottish Universities Physics Alliance, which is a major collaborative project enhancing physics research in Scotland. [SUPA](#)

Recent research contributions to science from our School include:

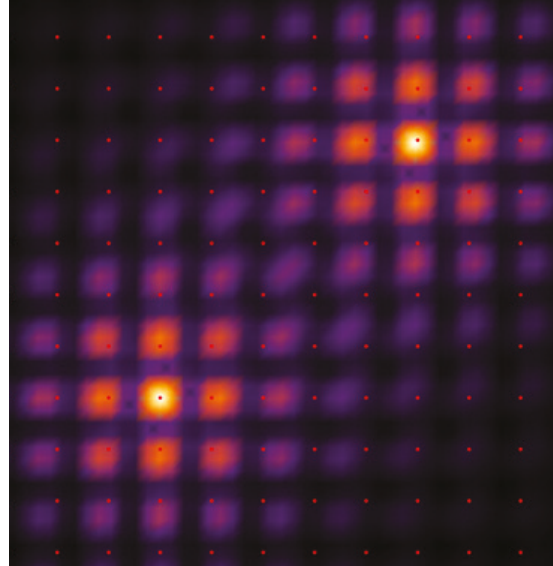
- The discovery of the nearest yet seen rocky planet outside our own solar system.

- The discovery of planets around another star looking like an analogue of our solar system.
- Exploring black hole physics in a special optical fibre.
- The development of light emitting polymers to sniff for landmines.
- Using optical forces to create the fastest man-made rotating object.
- Wide-field high-resolution imaging for neuroscience and developmental biology.
- Tracking biological cells through feeding them microlasers.
- Imaging of magnetism at the atomic scale in quantum materials.
- Controlling novel electronic states in atomically-thin materials.
- Theory of how to build quantum materials that absorb light at a super-fast rate.
- Reproducible and quantitative detection of cancer markers using nanoplasmonic sensors.

## Research and Students

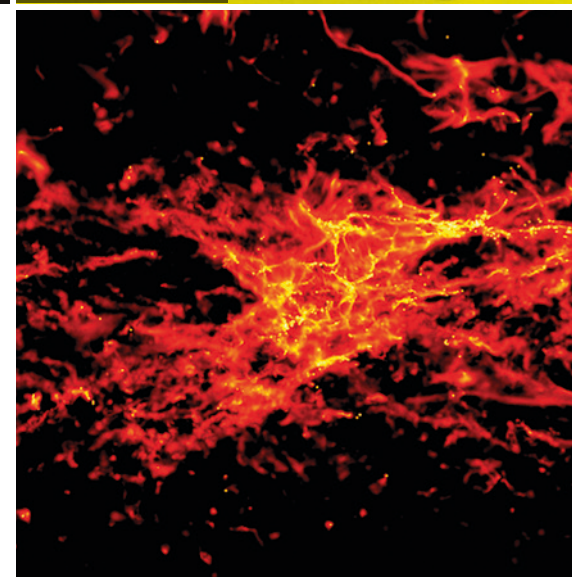
Our undergraduate students have various opportunities to interact with the research work of the School. The most obvious is the final-year project, which sees most students working with one of the research teams.

The School's research informs our teaching generally. In some of our first-year laboratories, students carry out a research-style investigation, normally followed by a visit to a relevant research laboratory. Third-year students can explore topics of local research and present this to the class in the Transferable Skills for Physicists module. Final-year lectures can take students to the current research frontiers. There are opportunities for funded summer internships with our research groups, and astronomers can, after suitable training, have access to some of the Observatory's telescopes to carry out their own investigations.



Cleanroom laboratory

Our research spans a wide size range. The image above shows the theoretical predictions of electron density around two phosphorus donor atoms in silicon (about 0.4 nm apart), which may be useful for quantum computing gates. The image on the right shows research on star formation in a spiral galaxy (about  $6 \times 10^{20}$  m across). We use nested numerical simulations of how gas flows in a galaxy. Top right shows work in our research cleanroom building and investigating polymer optoelectronic devices.



*“Since graduation, physics has taken me from a conference in California, via work trips to China, to robots in Cambridge. I spent my PhD making liquid crystal lasers, and then moved to working on technology for smartphone cameras. I’m now a Senior Systems Engineer at CMR Surgical, a global medical devices company dedicated to transforming surgery with a next-generation surgical robot. It’s all been fascinating, and I meet fellow St Andrews alumni wherever I go!”*

Jennifer



## The School of Physics & Astronomy

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# Physics and Astronomy at St Andrews

## **Curriculum Development**

As a research intensive institution, the University ensures that its teaching references the research interests of its staff, which may change from time to time. As a result, programmes are regularly reviewed with the aim of enhancing students' learning experience. Our approach to course revision is described here:

## **Curriculum at St Andrews**

Photographs (unless noted in captions) by: Peter Adamson, broad daylight, Christopher Davy, Guthrie Aerial Photography, A Robotham, Rhona Rutherford, Laurence Winram, and others.

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