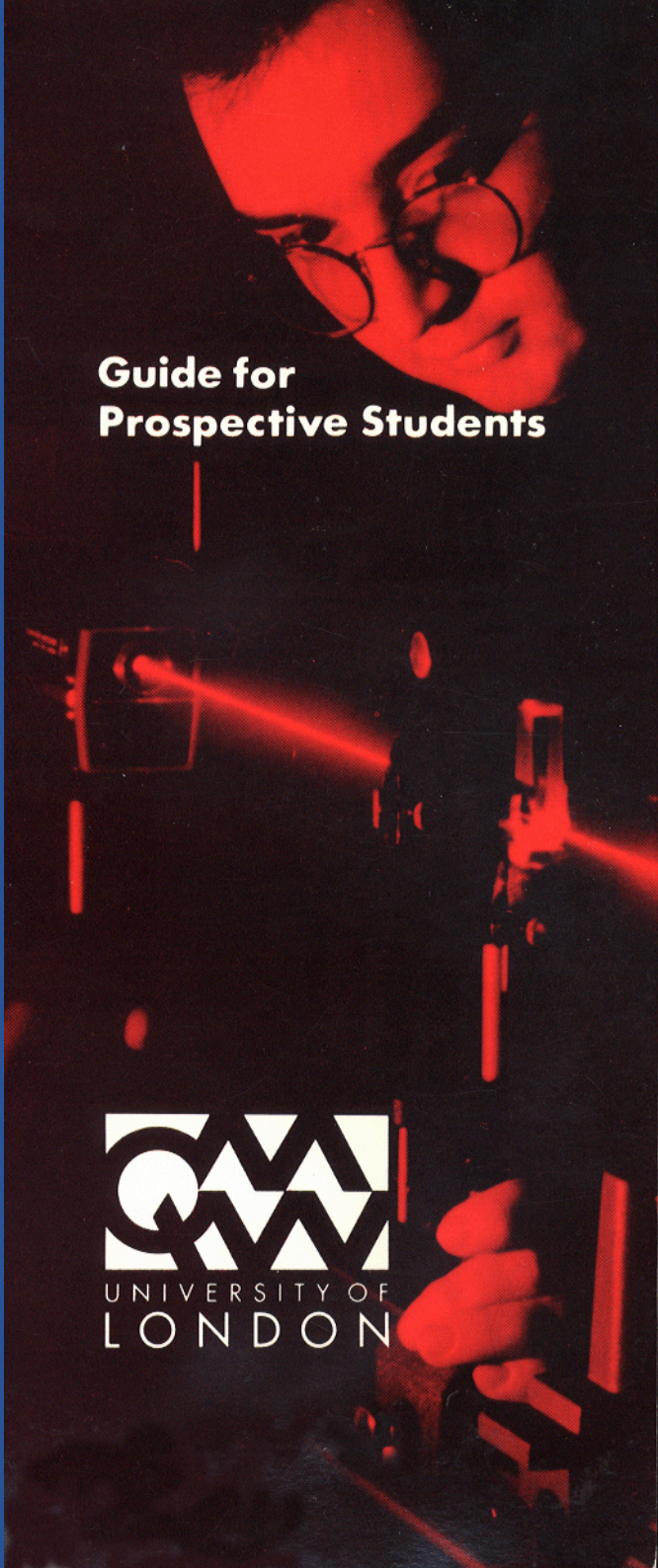
Department of Physics



Guide for Prospective Students

UNIVERSITY OF LONDON

Queen Mary and Westfield College

Above : The Physics Building showing dome of one of the rooftop telescopes.
Cover : Laser in use in an undergraduate laboratory.

Abstract designs appearing throughout this booklet are taken from murals representing themes in physics on the front of the Physics Building.

Physics at QMW

- Why a new physics degree?
- Constructing your degree programme
- Your degree - education or training?
  - Physics
  - Theoretical Physics
  - Astrophysics
  - Physics & Economics
  - Physics & Electronics
  - Physics & Materials Science
  - Astronomy
  - Physics with Business Studies
  - Physics with Computing
  - Physics & the Environment
- Teaching and learning
- Admission requirements
- QMW and its surroundings
- Research in the Department

Address all enquiries to:
Dr Reg Gibson,
Admissions Tutor,
Department of Physics,
Queen Mary and Westfield College,
Mile End Road, London, El 4NS

Telephone : 071 - 975 5077 (direct line)

A College video is available free to schools.

WHY A NEW PHYSICS DEGREE?

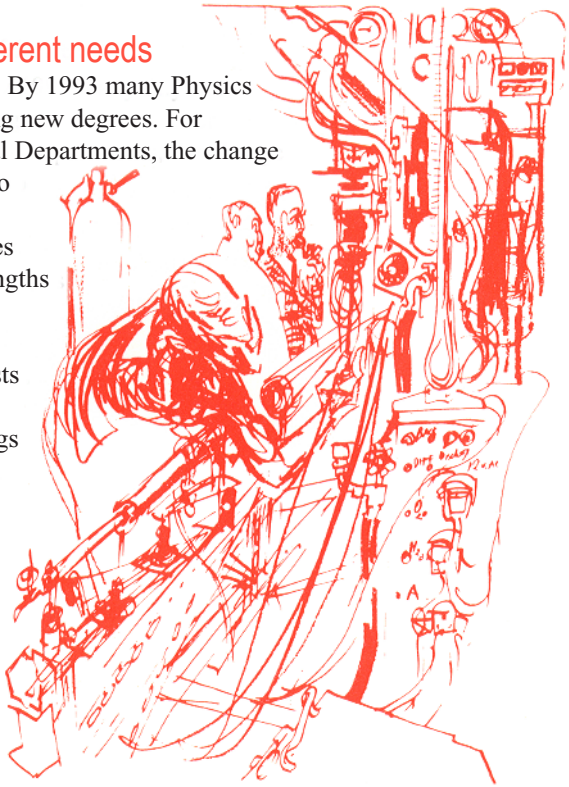
The problem with traditional courses

Most Physics degree courses ". . . teach a good deal more than the average student can be expected to absorb and understand . . . even reasonably good students absorb and understand rather little . . ." (from a recent Institute of Physics report, *The Future Pattern of Higher Education in Physics)*.

Who wants this? Certainly not employers, who seek ". . . ability to think logically, analyse problems and devise solutions . . ." And certainly not you, the student. You have a right to expect courses matched to your school curricula, courses that satisfy your curiosity about natural phenomena, demonstrate science in action and encourage you to experience it for yourself.

Each student has different needs

Change is coming. By 1993 many Physics Departments will be offering new degrees. For some of the more traditional Departments, the change may be difficult. It is easy to see why this is so. Each student has different abilities and expectations. Your strengths may be in computing, economics, mathematics, electronics . . . Your interests may lie in astronomy or medical physics, superstrings or microprocessors, with or without Russian, business studies, statistics . . . It is not easy to tailor a Physics degree course to these varied needs.
Except at QMW.



Research: Felix Topolski

Modular degrees hold the key

QMW has offered modular degrees for over twenty years with students selecting up to eight modules a year from the complete spectrum of science, engineering, arts, and social studies. A few years ago the demand was for 'single subject' degrees, perhaps with a certain amount of specialisation, and most of the courses we offered in the UCCA handbook were of this sort: Physics, for example, with Astrophysics and Theoretical Physics as variations. But many students, under the guidance of their personal tutor, selected individual programmes of study; in some years no two graduates have taken exactly the same set of modules! We have regularly introduced new modules and developed cross-faculty programmes. Thus QMW is in a unique position to adapt to new school curricula and the challenges of the 21st century.

Physics-based degrees at QMW

QMW offers a range of Physics-based degrees, linked by a common core of material which comprises about one-half of the degree. In the past most students have come with Mathematics and Physics A-levels; they have completed the core material within the first two years and rounded it off with a final year consisting entirely of optional courses. These options, and other modules outside the core, determine the precise degree subject —Astronomy, Physics & Electronics, and so on.

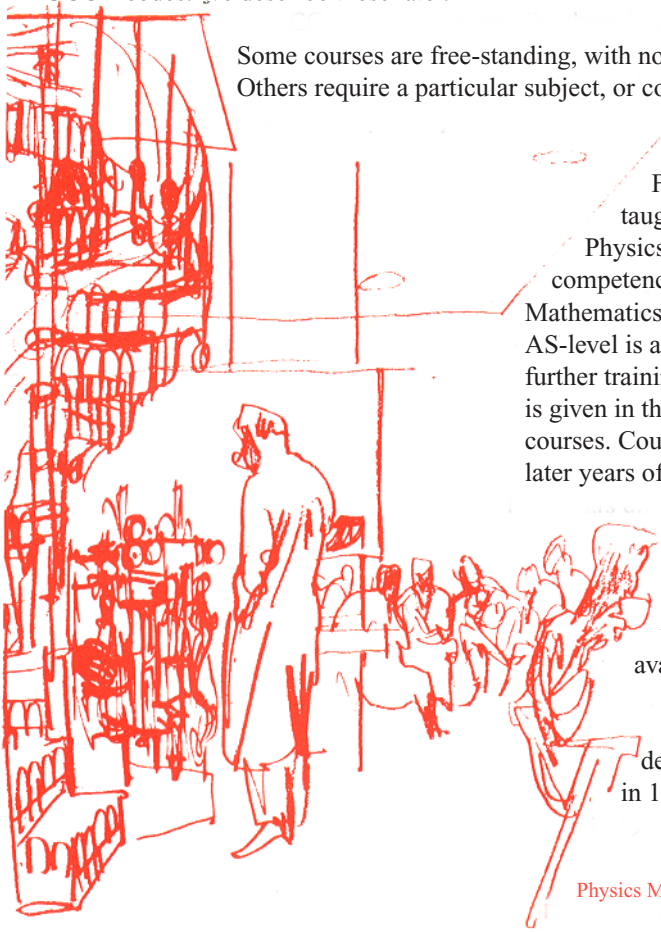
This pattern is a good one—employers like it and it will be retained—but it doesn't suit all undergraduates. Some may not have studied mathematics or physics to A-level. They will expect a different programme with the core material coming later, or they may want to take an unusual combination of subjects, or to study physics as just one component of a general science degree—or indeed to learn about physics in a social or historical context.

By adding modules where needed, modifying others, and devising new programmes, we are now able to offer the new physics degree—to be precise, a number of degrees with a common theme. On the next pages we explain more about physics at QMW, and describe our present UCCA codes. But don't forget that these are just samples of what is possible—if you are unsure of the options, or would like further advice, please contact our Admissions Tutor Dr Reg Gibson on 071 975 5077.

CONSTRUCTING YOUR DEGREE PROGRAMME AT QMW

The ingredients - some courses relevant to physics

The number of modules (called 'course units' in London University) grows year by year, as does the variety of degree programmes that can be constructed. Shown opposite are just a few of the course units in physics and related subjects. Some combinations of these courses are listed as UCCA codes. We describe these later.



Some courses are free-standing, with no prerequisites. Others require a particular subject, or combination of subjects, at A- or AS-level. For courses taught in the Physics Department competence in Mathematics up to at least AS-level is assumed and further training in Mathematics is given in the Physics core courses. Courses taught in later years often have an earlier course as a prerequisite. Most modules are taught each year; all will be available to students starting their degree programmes in 1991.

Physics Museum : Felix Topolski

Natural Phenomena

- The States of Matter
- Waves & Optics I
- Thermal Physics
- Quantum Physics
- Global Physical Environments
- Ecosystems: Patterns & Processes

Conceptual Frameworks

- From Newton to Einstein
- Electric & Magnetic Fields
- Quantum Mechanics I
- Space, Time & Gravity
- Statistical Physics
- Earth & Atmospheric Processes

Structures in Nature

- Elementary Particle Physics
- Solid State Physics
- Electronic Materials
- Nuclear Physics
- Theory of Plasmas
- The Elements & their Compounds

Astronomy & Astrophysics

- Physics & Astronomy of the Stars
- The Solar System
- Physics & Astronomy of Galaxies
- The Interstellar Medium
- Cosmology
- Astrophysical Fluid Dynamics

Theoretical Physics

- Quantum Mechanics II
- Physical Dynamics
- Electromagnetism
- Fluid Dynamics
- Linear & Nonlinear Dynamics
- Signals & Systems Theory

Applied Science

- Circuits & Digital Logic
- Microprocessor Applications
- Fundamentals of Telecommunications
- Instrumentation
- Optical Communications & Optoelectronics
- Magnetic Resonance Spectroscopy

Methods and Skills

- Mathematical Techniques I & II
- Partial Differential Equations
- Computing in Physical Science
- Numerical Analysis
- Algebraic Computing
- Electronic Design & Applications
- Knowledge Based Systems
- Physics Laboratory 1 & II
- Independent Project

Science & Human Society

- History & Philosophy of Science
- Organisational Behaviour
- Fundamentals of Management
- Radiation & the Environment
- Energy & the Environment
- Population Dynamics
- Environmental Pollution
- Natural Resources
- Introduction to General Linguistics

YOUR DEGREE - EDUCATION OR TRAINING'

'Physics' in your degree title?

A Physics degree makes a statement. It serves notice that you approach problems rationally and without prejudice, and are fluent with symbols and computation. Just what employers want! In most walks of life reasoning and creative ability are more important than narrowly detailed knowledge or specialised skills. On graduation you can enter the private or public sectors as a professional physicist or, with a year or two's postgraduate training and experience, can become a chartered engineer, an actuary, a teacher, a science journalist, . . . A physics degree is a very acceptable passport.

There is a central core of material and techniques which you must study to qualify for this passport. At QMW we teach this in our Core Physics courses. If you want the word 'Physics' in your degree title, you must take these courses. They are:

From Newton to Einstein	Electric & Magnetic Fields
Quantum Physics	Quantum Mechanics I
Waves & Optics I	Statistical Physics
Mathematical Techniques I	Mathematical Techniques II
Physics Laboratory I	Nuclear Physics
Thermal Physics	Electromagnetism

You may begin to study these courses in your first term, or in subsequent years. This depends on your preparation and your A-level background—more of this later. First we describe the UCCA codes which provide an explicit training in physics.

UCCA Codes in Physics - links with fundamental research

Many of our courses bring you straight to the heart of the matter. Teachers who are also distinguished in research and scholarship describe the latest developments and technology. Subjects in which QMW has an especially high reputation are listed as UCCA codes. Some of these are shown opposite.

Physics (F300)

Research, ranging from experimental studies of antimatter (Professors David Bugg and Peter Kalmus). neutrinos and quarks (Professor Tony Carter) to the fabrication of electronic devices out of single molecules (Professor Guy Wilson), allows us to offer a wide range of options outside the Core. Many students will select Electronic Materials, Solid State Physics, Elementary Particle Physics and Cosmology. Their Projects will be carried out in a research laboratory, perhaps in industry. Incidentally. Peter Kalmus runs the Physics Section of the British Association and arranges lectures for schools at the Royal Institution in London.

Theoretical Physics (F320)

Professor John Charap an authority on gravitational theory, and Professor Michael Green FRS lead the elementary particle theory group; Mike's pioneering work on the theory of superstrings is known and admired worldwide. with the award of the Maxwell Prize in 1986 and the prestigious Dirac Medal in 1989. Professor Geoffrey Sewell's work in the foundations of statistical mechanics has led to a fundamental understanding of the thermodynamics of black holes. Students should have a good grounding in mathematics, and will learn more in such courses as Applied Symmetry and Partial Differential Equations before applying these tech niques in courses including Statistical Physics. Electromagnetism, Physical Dynamics, Relativity & Cosmology and Fluid Dynamics.

Astrophysics (F526)

Professor Peter Clegg, Mission Scientist for the Infrared Astronomical Satellite (IRAS) and Infrared Space Observatory (ISO), leads a team which builds and operates instruments for satellite and ground-based telescopes, and studies objects from planets to quasars. Students can carry out original observations from our rooftop observatory, and will add the astronomy astrophysics courses to the Physics Core. Graduates can carry on to take an MSc in Astrophysics which we also teach both full-time and part-time.

The spreading of dislocations from a Frank-Read source

Combined UCCA Codes putting Physics to work

Physics makes an ideal partner for many other subjects, from Archaeology to Zoology. Not all have an UCCA code: in consultation with your Adviser you prepare an individual programme for each academic year. Some of these combinations offer excellent career opportunities. Amongst them are:

Physics and Economics (FL31)

Macro- and micro-economics, combined with the core physics courses, lead to managerial and administrative careers needing a technical background—the usual route for ambitious graduates in continental Europe and now gaining ground in Britain. A combination of science and arts A-levels, including mathematics, is desirable for this programme.

Physics and Electronics (F3H6)

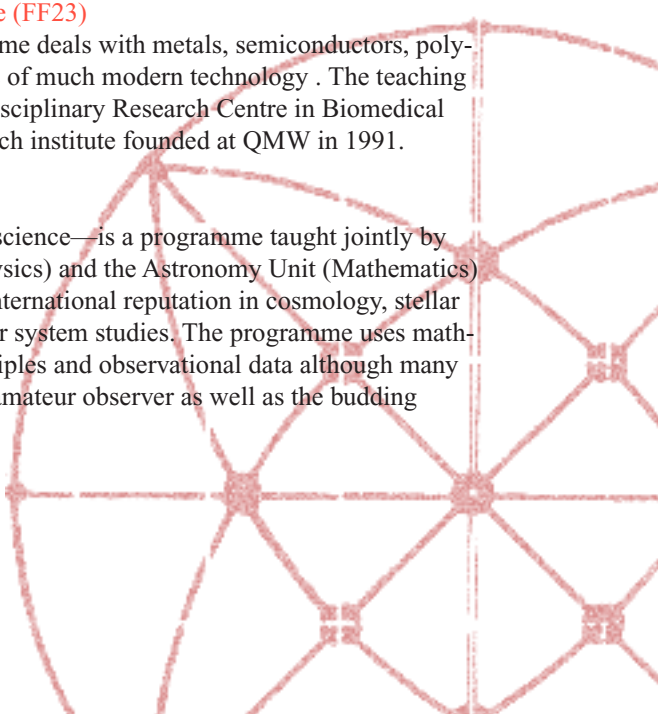
Here again the teaching is inspired by research at QMW. Professor Derek Martin, prize-winning instrument designer, and Professor Peter Clarricoats FRS, antenna design engineer, teach in this programme which in cludes such courses as Circuits & Digital Logic, Telecommunications, Optoelectronics and Control Systems Technology. Projects may be carried out in industry or in the College's R&D laboratories.

Physics and Materials Science (FF23)

This vocational programme deals with metals, semiconductors, polymers and ceramics—the basis of much modern technology . The teaching is closely linked to the Interdisciplinary Research Centre in Biomedical Materials, a major new research institute founded at QMW in 1991.

Astronomy (F500)

Astronomy—the oldest science—is a programme taught jointly by the Astrophysics Section (Physics) and the Astronomy Unit (Mathematics) which have given QMW an international reputation in cosmology, stellar and galactic physics. and solar system studies. The programme uses mathematics to link physical principles and observational data although many courses are accessible to the amateur observer as well as the budding professional.



The stereographic projection of a cubic close-packed structure

Interdisciplinary studies at QMW - the way ahead

New sciences—biotechnology, ecology, space science—are blurring traditional divisions. That's why the school curriculum is changing. Double-certificate GCSE. now replacing the separate sciences, is already stimulating student demand for interdisciplinary courses. QMW is developing programmes which encourage students to explore the common aspects of science, and interactions between science and society.

Physics with Business Studies (F3N1)

Marketing, Accounting & Finance and Organisational Behaviour are some of the courses in this programme. With the City only a mile away students are often able to arrange vacation employment to coincide with project work. Your Project will involve a business situation—perhaps a bank's decision on investment in new technology—emphasising the links between the City and the University of London.

Physics with Computing (F3G5)

All students at QMW are encouraged to become computer-literate, but this programme goes further. Using modern facilities in the Physics Department (VAX computers, a PC network, transputer-based parallel processing systems) students learn how computing helps science and technology. Courses include Computing in Physical Science, Microproces sor Applications, Numerical Programming and Computer Architecture. You can take QMW's MSc in Information Technology after graduating.

Physics & the Environment (F374)

This programme provides a sound scientific understanding of major environmental issues: natural resources, pollution and climatic processes. There is a large and unsatisfied demand for graduates in this area from the Meteorological Office, environmental agencies, industry and the medical sector. Graduates can take our MSc course in Radiation Physics, a necessary qualification for a career as a hospital physicist.

TEACHING AND LEARNING

Teaching Methods at QMW

Universities teach mainly by lectures and QMW is no exception. A good lecturer with interesting demonstrations can be an inspiration. We use several other methods though: problem classes, small group tutorials for individual tuition, private study (reading assignments, essays and problems) and laboratory classes. The number of course contact hours varies, from a one hour weekly 'supervision' in an independent Project, to six or eight hours when practical classes are included.

An innovative method being developed at QMW is peer teaching where students take turns in giving short presentations to small groups under the guidance of their tutor.

Personal computers are provided in the Physics Department so you can write reports, analyse experimental data and run the computer teaching programmes which are available in some courses. Learning to use a PC is one of your first tasks as a fresher.

Assessment and Prizes

Most courses are assessed by a combination of coursework and final written examination. Some courses have no final examination and are examined entirely by coursework including formal reports and perhaps an oral presentation. In a few cases where the subject is particularly appropriate (introductory mathematics, for example) assessment is by a series of graded tests taken at intervals during the semester.

The Physics Department offers a number of Prizes and awards. They include the Renishaw Prize for project work, the EJ Irons and the Wignell Prizes for first and second year students, and the Granville Prize (currently of £500) for the best Physics graduate of London University. For a number of years QMW has monopolised this Prize, winning it as often as the other London Colleges combined.

The Teaching Calendar

QMW operates the semester system. The teaching year is divided into two halves (the Latin semestris meaning 'six months') and most courses are completed in one semester. The semesters are not six months long, but 12 weeks. The first semester occupies the whole of the first term, up to Christmas. Before the second semester, which continues to May with a break at Easter, you choose a new selection of courses. Examinations in June, for those courses which have them, are followed by a short period often used to teach a single intensive course (such as computer programming). or to prepare for a final-year Project. During the summer many students take a vacation job which, if appropriate, can develop into an independent Project.

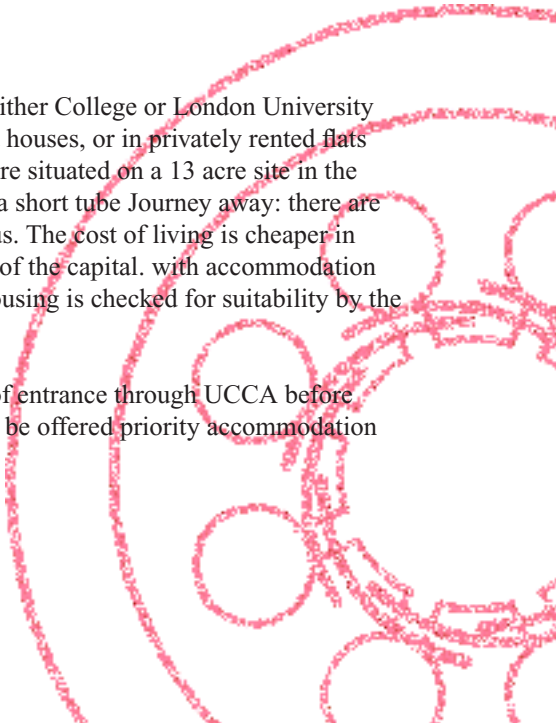
Study Abroad Programmes

The Physics Department operates exchange programmes which enable some students to spend a semester, or a year, studying at a university in Europe or the United States. Courses taken abroad fulfil degree requirements in the same way as courses taken at QMW. Exchanges with the University of Salerno, Italy began in 1990: agreements with the University of Tubingen, Germany and the University of the Pacific. California will start in 1991. and an exchange programme with the University of Toulouse, France will begin in 1992.

Living in London

Accommodation is available in either College or London University Halls of Residence, in College-owned houses, or in privately rented flats and bedsits. The main College Halls are situated on a 13 acre site in the leafy setting of South Woodford, just a short tube Journey away: there are other student residences on the campus. The cost of living is cheaper in east London than in many other parts of the capital. with accommodation more plentiful and easy to find. All housing is checked for suitability by the Accommodation Office.

Applicants who accept an offer of entrance through UCCA before August, and live outside London, will be offered priority accommodation in Halls.



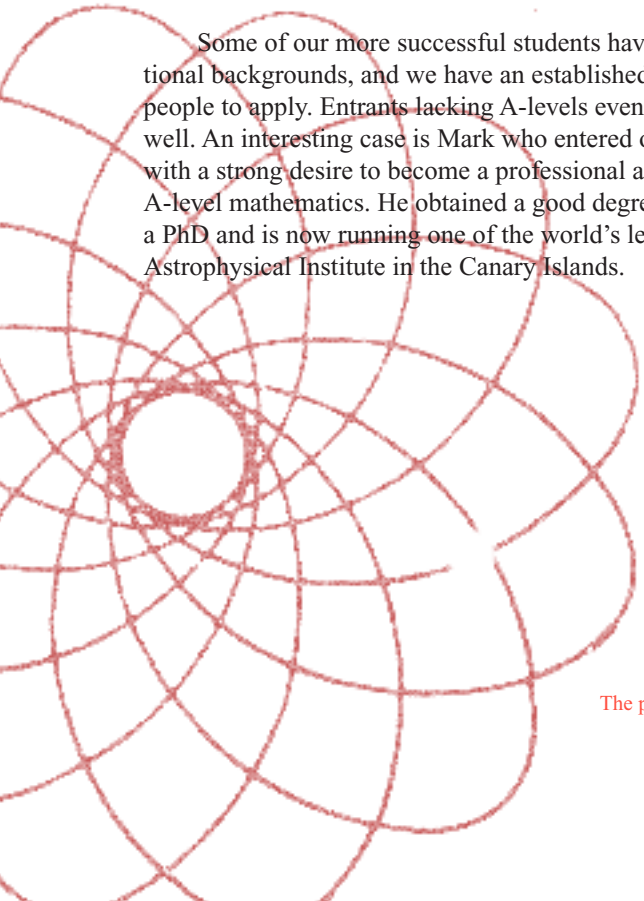
A cavity magnetron

ADMISSION REQUIREMENTS

We seek good A-level grades in at least two subjects (or AS-level in four subjects). If only two A-levels are taken they should both be sciences but subsequent A-levels can be in non-science subjects. For UCCA codes with 'Physics' in the title, both Physics and Mathematics at A-level are preferred although they are not mandatory. Any student at QMW can construct a stimulating and intellectually challenging degree programme.

Our experience over the years has shown that the most important factor in a successful university career is motivation; with the broadening of the school curriculum and its increasing emphasis on skills at the expense of detailed content this will become increasingly so. We therefore place great emphasis on interviewing all our UCCA applicants and inviting them to visit the Department and College. In most cases a conditional offer is posted the day after interview.

Some of our more successful students have had unconventional educational backgrounds, and we have an established policy of encouraging such people to apply. Entrants lacking A-levels even in key subjects can also do well. An interesting case is Mark who entered our Astronomy programme with a strong desire to become a professional astronomer but without A-level mathematics. He obtained a good degree, went on to complete a PhD and is now running one of the world's leading telescopes at the Astrophysical Institute in the Canary Islands.



The path of a particle in a precessing orbit

The following are *desirable* A- or AS-level subjects for the various UCCA codes, *in addition to* Physics and Mathematics which are recommended for all programmes leading to a degree with 'Physics' in the title.

Physics (F300) Astrophysics (F526) Physics and the Environment (F374)	English, a modern language or a second science.
Theoretical Physics (F320)	A second mathematics A-level.
Physics and Electronics (F3H6)	Electronics or a second mathematics A-level
Physics and Materials Science (FF23)	Chemistry
Physics with Computing (F3G5)	Electronics or Computer Science
Physics with Business Studies (F3N1)	English, a modem language or Economics
Physics and Economics (FL3 1)	Economics
Astronomy (F500)	English, a modern language or a second mathematics A-level

Students with different combinations are encouraged to apply with a view to constructing an individual degree programme. Contact our Admissions Tutor Dr Reg Gibson for more information

The electron-orbital scheme of benzene

QMW AND ITS SURROUNDINGS

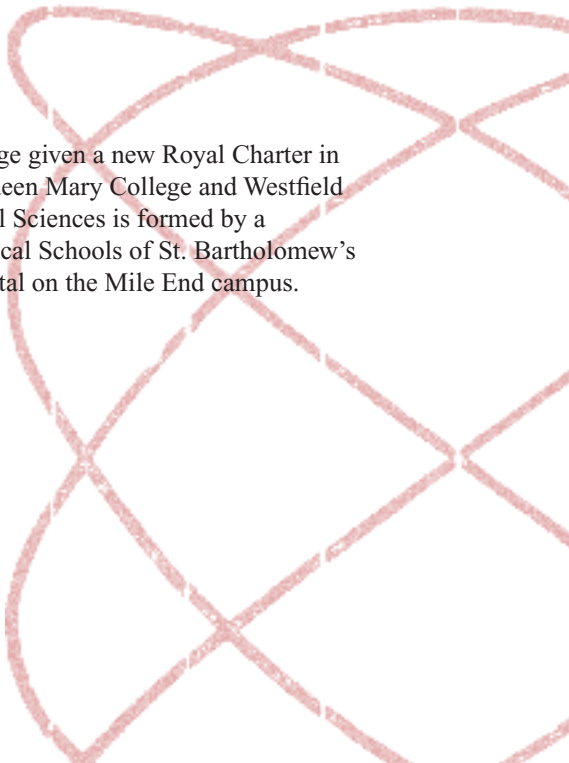
QMW is one of the five multi-faculty colleges of the University of London with about 5,000 students from the whole of the United Kingdom and beyond. Nearly 20 per cent are from overseas, while only one in four is a Londoner. This diversity of backgrounds and cultures matches the College's situation in the heart of the East End near the Docklands Development.

The past

The former Queen Mary College had its origins in the technical schools of the People's Palace, an innovative philanthropic attempt to provide East London with an institution offering education as well as social, and cultural activities. It was admitted to the University of London in 19 15. Queen Mary College took its name in 1934 on the presentation of the Royal Charter by Queen Mary, and in 1985 celebrated its centenary. The College has attained great distinction in teaching and research whilst maintaining a pride in its origins. The area is now experiencing a dramatic change with the development and rehabilitation of the Docklands, putting QMW at the centre of one of the most exciting areas of London.

The present

Queen Mary and Westfield College given a new Royal Charter in 1989, is the result of the merger of Queen Mary College and Westfield College. The Faculty of Basic Medical Sciences is formed by a confederation of QMW with the Medical Schools of St. Bartholomew's Hospital and the Royal London Hospital on the Mile End campus.



A Lissajous figure

The future

QMW is experiencing a major expansion in teaching and research having rebuilt the campus to twice its former size—the biggest development in U.K. education in a decade. The Faculty of Basic Medical Sciences occupies a new £12m building opened by the Princess Royal in October 1990. Construction is currently under way for a building to house the enlarged Arts Faculty arising from the merger with Westfield College. These developments will add further distinction and variety to the College's academic life. Generous donations have allowed the College to build new student residences on the banks of the Regents Canal and others are under construction elsewhere on the campus.

The surroundings

Along the eastern boundary of the campus runs the Regents Canal. Starting on the canalside path, overlooked by the new College student residences, joggers and cyclists can follow the canal to the West End and beyond with only brief diversions on the public highway. Hugging the canal's eastern bank is the Lee Valley Park which runs as far as the Thames in the south, and can be followed north out to the Essex countryside.

Further east the London City Airport brings Europe's major cities within easy reach; a mile or so to the south, past the Docklands Light Railway with its direct connection to the City of London, lies the Thames. Through the foot tunnel, a marvel of Victorian engineering, is the Cutty Sark, Greenwich Park and the Old Royal Observatory where our students use the historic 28" refractor.

Westward the Mile End Road leads to Whitechapel, Aldgate and the City. Home of the explorer James Cook: birthplace of the Salvation Army; site of Britain's oldest bell foundry, newest mosque and best kosher restaurant—the road is a lively microcosm of London's history.

RESEARCH IN THE DEPARTMENT

In the Physics Department teaching goes hand in hand with research. In its survey of Universities in 1989, the Universities Funding Council ranked QMW amongst the best Physics Departments in the United Kingdom, with research of national and international standing.

• Experimental Nuclear and Particle Physics ranges from studies of phenomena at ultra-high energies to measurements of the nuclear properties of constructional materials. Experiments are conducted at international laboratories: the European centre CERN in Switzerland, the German laboratory DESY in Hamburg and the Rutherford Appleton Laboratory in Oxfordshire. The group participated in the Nobel Prize winning experiment which discovered the W and Z bosons at CERN.

• Astrophysics. The group, one of the largest in the UK, operates a programme of ground-based and satellite observations at infrared and millimetre wavelengths, developing new instrumentation for the major British telescopes in Hawaii, and for satellites such as the forthcoming European Infrared Space Observatory (ISO).

• Molecular Electronics and Polymer Physics. Working closely with industry, members of the group study the electrical, mechanical and optical properties of novel materials. An electron-beam lithography laboratory was opened in 1990 for fabricating circuit components in a programme to investigate the feasibility of creating molecular electronic devices.

• Theoretical Physics. A major area of research is the theory of fundamental interactions, particularly superstring theory which promises to unify all the forces of nature, including gravity, into a single ‘superforce’. Other work is in general relativity, quantum and statistical mechanics, and the study of materials with technological relevance such as high temperature superconductors, colloidal suspensions and random media.

• Engineering Physics. With strong ties to our astrophysicists, this group conducts research into advanced communication and receiver systems and related topics, in collaboration with the Faculty of Engineering and industrial research laboratories.

• Medical Radiation Physics. This group, with its visiting staff from the Royal London and St. Bartholomew’s Hospitals, is concerned with the application of techniques in nuclear physics to biomedical problems. These range from studies of molecular binding of radioisotopes to the development of absolute dosimetry standards.

Above and back cover :
Sketches by Felix Topolski of a lecture in the Physics Lecture Theatre


$\left(\frac{\partial z}{\partial u}\right)_x \cdot \left(\frac{\partial x}{\partial z}\right)\left(\frac{\partial z}{\partial u}\right) = -1$
$dz =$