

Department of Physics, Royal Holloway University of London

The Department is one of the major centres for Physics teaching and research in the University of London. In the 2008 Research Assessment Exercise 90% of our research was judged to be of international quality, with 55% internationally excellent or world leading.

Profile

Our research strengths range from studies of the fundamental properties of matter at the lowest temperatures and on nanometre scales to elementary particles at the highest attainable energies. Experimental research is carried out in the Department's Tolansky and Wilson Laboratories, and at major international centres, including CERN and the STFC Harwell Science and Innovation Campus.

The two largest research areas are in the Centres for Particle Physics and Condensed Matter Physics. The research is generously supported by the Engineering and Physical Sciences Research Council (EPSRC), by the Science and Technology Facilities Council (STFC), by the European Commission, the Royal Society, the National Physical Laboratory, and by industry. Much of the research is carried out in collaboration with other universities in Europe and worldwide, creating a pleasant international atmosphere in the Department.

The Department is part of the Physics in the South East Network (SEPnet) funded by the Higher Education Funding Council of England (HEFCE) from September 2008.

Research

Centre for Particle Physics

Current work is focused on several projects. At CERN, the ATLAS experiment is beginning to take data at the Large Hadron Collider. Our activity is centred on searches for the Higgs boson and evidence of supersymmetry or extra dimensions, and on top physics. We have particular expertise on the area of statistical analysis of data and on the ATLAS high level trigger.

The Centre also contains the John Adams Institute for Accelerator Science, a joint initiative between Royal Holloway and Oxford University, created in 2004. Work has concentrated on advanced beam diagnostics at PETRA (DESY), ESA (SLAC) and ATF (KEK) with new initiatives at CTF3 (CERN) and Diamond (Harwell). The work of several members of staff bridges across experimental particle physics and the JAI and there are eleven academic staff in total in the two groups.

SEPnet funding has been used being used to establish a particle physics phenomenology group at Royal Holloway under the umbrella of the NExT Institute, which aims to provide a close collaboration between experiment and theory. Our collaborating partners in NExT are Southampton and Sussex Universities and the Particle Physics Department at the Rutherford Appleton Laboratory (part of STFC). Five lecturer/fellow positions leading to permanent lectureships have been filled at Royal Holloway (two posts), Southampton (two posts) and Sussex (one post). The two Royal Holloway fellows joined

the Centre for Particle Physics in January 2009 and have expertise in LHC physics and particle astrophysics.

Centre for Condensed Matter Physics

Condensed Matter Physics consists of two interlinked sub-groups: Nanophysics and Low Temperature Physics. In the Low Temperature Physics Group we study the emergent properties of model quantum systems (quantum fluids and solids, strongly correlated electron systems). We use neutron and synchrotron x-ray scattering at the nearby ISIS and Diamond facilities, as well as other international facilities, to study quantum magnetic systems, and these provide an ideal test bed for the theory of strong correlations. The group is active in developing new techniques such as NMR using SQUIDS and current sensing noise thermometry, and is part of the newly formed (from January 2009) European Microkelvin Collaboration. Extended low temperature infrastructure to allow improved access for new collaborations is under development.

A research theme across the Centre is experimental quantum information processing. This involves projects on superconducting qubits with novel read-out techniques, superconducting cavity QED, and qubits based around electrons on the surface of helium. The Nanophysics and Nanotechnology Group has extensive fabrication facilities and studies hybrid metallic nanostructures (including superconducting/ferromagnetic and normal/ferromagnetic devices with spintronic applications), semiconductor nanostructures (with applications including THz imaging). It has also developed nano-collimators for scanning x-ray microscopy.

The Centre comprises thirteen academic staff, and its research is supported by three permanent research officers for low temperature physics, nanofabrication and crystal growth.

Theoretical Physics

The theoretical physics group currently spans the Departments of Physics and Mathematics and consists of seven academic staff working mainly in the areas of theoretical quantum information processing, atomic theory and quantum chaos, with some activity in the theory of condensed matter. This latter strand is about to be strongly developed through the establishment of this new activity in theory of strongly correlated condensed matter.

Centre for Theory of Strongly Correlated Condensed Matter

We are establishing a new research activity in the theory of strongly correlated condensed matter. This is an initiative between the University of London and facilities on the Harwell Science and Innovation Campus.

A key mission will be strong interaction with facilities users, as well as with experimentalists in the University of London groups and elsewhere, to support an environment for world class research from fundamental studies of model systems to the development of new functional materials based on strongly correlated quantum matter.

Two lecturers/fellows have been created at RHUL, with SEPNET and STFC support, leading to permanent lecturer posts, subject to a three year probation. They will join Dr Andrew Ho (EPSRC ARF) and Dr Priya Sharma (part-time Leverhulme Fellow), and Dr Jorge Quintanilla (University of Kent/ISIS). It is anticipated that the new lecturers will spend some fraction of their time on the Harwell campus.

We expect to further support this initiative in a number of ways. Firstly we are seeking to fill a part-time Chair in Theory of Condensed Matter. Further, Professor Joerg Schmalian, DoE Ames Laboratory and Iowa State University, has been appointed as a Visiting Professor. We aim to establish an international visitors programme. In addition the theory activity at RHUL will join the Thomas Young Centre, the London Centre for Theory and Simulation of Materials. The group will also be linked to regional theoretical and experimental activity in quantum matter, quantum coherence and nanoscience through SEPnet.

Biodiagnostics

The application of new instrumentation for studies of biological systems and potentially for medical diagnostics is a developing research strand. These instruments and devices are in many cases a “spin-out” from the fundamental research of the Condensed Matter Physics group. Examples are microTesla NMR using superconducting detectors, and THz detectors based on quantum dots. A number of inter-disciplinary projects are being pursued. The planned merger of RHUL with St George’s University of London Medical School is likely to strengthen this activity further.

Vision and Signal Processing

Work covers a variety of applications including vehicle guidance, imaging in forensic and food industry applications, ‘blind’ separation of superimposed signals and automatic evolution of analogue electronic circuits.

Research facilities and partners

Major facilities in the Department include the London Low Temperature Laboratory and Ultra-low Temperature Facility; the Nanotechnology Laboratory and Clean Room; an accelerator laboratory; a high-power laser laboratory; X-ray topography facilities and CAD; data analysis and extensive computer networking facilities. The Centre for Particle Physics has excellent computing facilities including Grid computers.

National and international collaboration is a key element of our research strategy. Major centres where we have collaborations include CERN (Geneva), Stanford (California), ILL (Grenoble), ESRF (Grenoble), CEA Saclay (Paris), HZB (Berlin), FRMII (Munich), DESY (Hamburg), KEK (Japan), as well as ISIS and Diamond on the Harwell Campus and the Cockcroft Institute at Daresbury. Industrial collaborators include Oxford Instruments, TMD, and the National Physical Laboratory.

SEPnet

In June 2008 HEFCE announced that it is providing £12.5M over five years for a major initiative to support physics in the south-east of England, called SEPNET. Total funding, including resources provided by the universities and partner organisations is £27.8M. The partners in SEPNET are Royal Holloway and Queen Mary within the University of

London, the Universities of Kent, Southampton, Surrey and Sussex, and STFC. The Universities of Oxford and Portsmouth are associate members. SEPNET supports four strategically important research themes where significant opportunities for synergy have been identified: atomic and condensed matter physics, particle physics, astrophysics, and radiation and detector instrumentation. Royal Holloway is using the opportunity provided by SEPNET to enhance research in theoretical condensed matter and particle physics, with a strong emphasis on collaboration with the experimental work already in place. A graduate school, an outreach programme to stimulate interest in physics in schools across the region and an employer engagement and knowledge transfer programme have been established.

Degree programmes

The undergraduate intake is around 60 per year. The Department runs a three year BSc programme and a four year MSci programme. Typically half the cohort will proceed to the MSci. The MSci programme is taught through a University of London consortium (KCL, QMUL, UCL and RHUL) and offers a wide diversity of courses. We operate a system of competitive summer internships in research laboratories for the best students, both in RHUL research laboratories and at the National Physical Laboratory. PhD programmes are funded by EPSRC Doctoral Training Account and Project studentships, STFC, EU (Marie Curie), SEPnet. A two year MSc programme targeted at students from mainland Europe will start in October 2010.