1. Introduction

Preparation of the Report

This report describes and reviews the programmes of Learning, Teaching and Assessment offered by the School of Physics and Astronomy during the current session 2011-12. Preparation of the report was assigned by the Head of School, Professor Andrew Long, to the Convenor of Learning and Teaching, Professor Martin Hendry, who worked with a small group of academic staff members to prepare the initial draft.

The initial draft of the report was made available in mid-December to all academic and research staff, and to all undergraduate and PGT students, via the School intranet and Moodle pages. Comments were gathered from students and staff within the School, and also from Dr Mary McCulloch in the Learning and Teaching Centre. After assessing input from all parties, the final draft of the report was submitted to the Senate Office in January 2012.

1.1 Range of Provision

1.1.1 B.Sc. Honours and M.Sci.degree programmes

The B.Sc. Honours and integrated Masters (M.Sci.) degree programmes offered by the School of Physics and Astronomy are awarded to students undertaking the relevant degree programme. The degrees available are as follows:

Single honours (B.Sc. and M.Sci.)

Physics
Theoretical Physics[1]
Physics with Astrophysics
Chemical Physics[2]
Chemical Physics with Work Placement (M.Sci. only)[2]

Joint honours (B.Sc. and M.Sci.)

Applied Mathematics and Astronomy[3]
Applied Mathematics and Physics[3]
Astronomy and Mathematics[3]
Astronomy and Physics
Computing Science and Physics[4]
Mathematics and Physics[3]
Physics or Astronomy and Arts subject[5]

Honours B.Sc. degrees are obtained after 4 years of study and attract at least 480 credits. M.Sci. degrees are offered as 5 year programmes and attract at least 600 credits.

1.1.2 B.Sc. designated degree programmes

Students may obtain a designated degree after 3 years of study in which they accumulate 360 credits. Those students who do not meet the honours entry requirements may be able to take level

[1] M.Sci. programme introduced in session 2008-09; B.Sc. programme introduced in session 2010-11
[2] Offered with the School of Chemistry
[3] Offered jointly with the School of Mathematics and Statistics
[4] Offered jointly with the School of Computing Science
[5] Offered, as an M.A. degree, with the College of Arts and Social Sciences. Only available in certain subjects.

3 courses to complete a designated degree in a named subject or subjects. To obtain a degree in a named subject requires at least 80 credits at level 3 for a single subject or 60 credits at level 3 for each subject in a joint degree.

The following designated degrees involving Physics and Astronomy components are offered by the College of Science and Engineering:

Applied Mathematics and Astronomy
Applied Mathematics and Physics
Astronomy and Mathematics
Astronomy and Physics
Chemical Physics
Mathematics and Physics
Physics
Physics with Astrophysics

(Note that Theoretical Physics is *not* available as a named B.Sc. designated degree).

1.1.3 Qualifying non-honours courses

Entry to the degree programmes listed in the previous sections is dependent on courses taken at Level 2 and in some cases also those taken in Level 1. A summary of requirements for the different programmes can be found in the Programme Guide given to students at the start of each session. A copy of the latest edition of this Programme Guide is included among the supporting documentation.

The qualifying courses offered in the School of Physics and Astronomy at Level 2 are:

Physics 2 (60 credits, runs over both Semesters[6])
Astronomy 2 (30 credits, runs over both Semesters[6])

Entry to any degree programme in level 3 is based on performance at Level 2, as well as additional generic College and University requirements.

The School offers additional Level 2 courses which are not required for entry into the honours programmes. These are all 10 credit courses:

Physics 2T: C programming under Linux (runs in Semester 1)
Exploring the Cosmos 2X (runs in Semester 1)
Exploring the Cosmos 2Y (runs in Semester 2)

The School also offers the following courses at Level 1:

Physics 1 (40 credits, runs over both Semesters)
Astronomy 1 (40 credits, runs over both Semesters)
Exploring the Cosmos 1X (20 credits, runs in Semester 1)
Exploring the Cosmos 1Y (20 credits, runs in Semester 2)

Service teaching is provided for students from the School of Engineering, in the form of the Level 1 Physics EE1 course (20 credits) offered as part of BEng/MEng degrees. Further service teaching is

[6] An additional 30 credits of Level 2 Mathematics courses are required for entry to Joint Honours Astronomy degree programmes and to all Physics degree programmes apart from Chemical Physics, where only Mathematics 2A and 2B are required for entry.

provided to IBLS students at Level 2 (10 credits) and the School also contributes to the 20 credit courses Science Fundamentals 1X and 1Y administered by the School of Chemistry.

Finally, in Session 2011-12 the School introduced a new 20 credit Level 1 course, entitled Introductory Physics, designed exclusively for international exchange students (principally from North America) who are not majoring in Physics. The syllabus for this course is aligned with the syllabus for MCAT Physics and the mode of delivery involves approximately 35 hours of lectures, tutorials and laboratories supplementing weekly reading and online assignments.

1.1.4 PGT programmes

In session 2010-11 the School introduced six new postgraduate taught programmes which largely draw upon existing M-level teaching provision within the School supplemented by an extended 60-credit research project. Students therefore undertake a minimum of 180 credits and upon successfully completing the programme of study and meeting the University generic PGT regulations students are eligible for the award of MSc. The M.Sc. programmes offered by the School are as follows:

Astrophysics
Theoretical Physics
Physics: Advanced Materials
Physics: Energy and Environment
Physics: Global Security
Physics: Life Sciences

A copy of the latest edition of the Programme Guide for our M.Sc. programmes is included among the supporting documentation.

1.1.5 External accreditation and recognition

The Institute of Physics (IoP) accredits all of our Physics B.Sc. and M.Sci. degree programmes, including our joint degrees, and recognises our Astronomy undergraduate programmes. The last IoP accreditation visit to Physics and Astronomy took place in 2008. Accreditation of our degrees was duly granted with a very favourable report on the Departmental practices. The Departmental submission and the subsequent IoP report from 2008 can be found in the supporting documentation.

Since our last PSR Physics and Astronomy has engaged fully with the IoP Project Juno[7]. This was established by the IoP in 2007 in response to best practice identified from the Institute's "Women in University Physics Departments: A Site Visit Scheme", which ran from 2003-05 and which visited Physics and Astronomy at Glasgow in 2004. The aim of Project Juno is to recognise and reward departments that can demonstrate they have taken action to address the under-representation of women in university physics and to encourage better practice for both women and men. There are three Levels of Juno awards:

- **Supporter**. The department starts its Juno journey by endorsing five principles and making a commitment to work towards Practitioner and then Champion.
- **Practitioner**. The department demonstrates that its Juno journey is well underway. Qualitative and quantitative evidence is gathered and its initial action plan demonstrates how the department aims to achieve Champion status.

[7] See http://www.iop.org/policy/diversity/initiatives/juno/index.html for further information.

- **Champion**. The department demonstrates that the five principles are embedded throughout the department. Further evidence is gathered and its action plan demonstrates how the department will continue to further good practice.

The School was awarded Juno Practitioner status in 2010. The School subsequently applied for Juno Champion status in 2011 and was awarded this accolade in Oct 2011, the first such School/Department in Scotland and only the sixth in the UK. A copy of the School's Juno Champion submission and the report from the IoP's Juno Committee is included in the supporting documentation.

1.2 Background Information on the School

1.2.1 The School of Physics and Astronomy was formed in August 2010 as a result of the re-structuring of the University, from Faculties and Departments to Colleges and Schools, which took place at that time. A diagram outlining the current management structure within the School is provided in Appendix 1.

Prior to August 2010 Physics and Astronomy existed as a Department within the Faculty of Physical Sciences; the Department was formed in 1986 from the merger of the Departments of Natural Philosophy and of Astronomy. These two disciplines have always historically had close ties and the merger recognised the common interests of some of the research groups within the two original departments. With regard to teaching, both disciplines have benefited significantly from the contact with the other in the 25 years since the merger took place.

1.2.2 The School now resides within the College of Science and Engineering, alongside the Schools of Chemistry, Computing Science, Engineering, Geography and Earth Sciences, Mathematics and Statistics and Psychology. In research the School has internationally acclaimed groupings across the full spectrum of physics and astronomy, covering everything from nature's building blocks to the application of the latest scientific advances in areas such as healthcare and environmental monitoring. There are seven research groups:

- Astronomy and Astrophysics
- Institute for Gravitational Research
- Materials and Condensed Matter Physics
- Nuclear Physics
- Optics
- Particle Physics Experiment
- Particle Physics Theory

All seven groups are in active collaboration with Physics and Astronomy departments throughout Scotland via the Scottish Universities Physics Alliance[8], which was the first Scottish research pooling initiative to be established in 2004.

1.2.3 In the Research Assessment Exercise 2008, 60% of the School's research outputs were judged to be of international standard (world leading 4* or internationally excellent 3*), which ranked Physics and Astronomy at Glasgow in the top 10 of UK departments – a position which we have also consistently maintained for several years in various national student barometers. We pride ourselves in the training we offer our graduate students both in their scientific and personal

[8] http://www.supa.ac.uk

development, equipping them for successful future careers. Moreover our excellent quality research invigorates our teaching at all Levels.

1.2.4 The School of Physics and Astronomy has 42 academic teaching staff (including 3 University Teachers), 70 research staff, 25 technical staff and 18 secretarial, administrative and support staff. Academic teaching duties are allocated by the School Registrar (Personnel) in consultation with the Convenor of Learning and Teaching and the Head of School, taking into account the School workload model. The workload model is described in the supporting documentation and covers staff commitments in teaching, research and administration.

1.2.5 Student numbers, for Session 2011-12, for the full range of our undergraduate and taught postgraduate courses (with the corresponding numbers for Session 2006-07 for comparison) are given in Table 1 below:

Table 1: Student numbers in Physics and Astronomy

Course / Level	2011-12	2006-07
Physics 1	232	169
Astronomy 1	139	75
EXCOS 1	251	274
Introductory Physics	6	n/a
Physics 2	155	63
Physics 2T	24	13
Astronomy 2	65	27
EXCOS2	15	31
Physics 3	82	47
Physics 4/5	98	50
Astronomy 345	58	36
PGT Masters	14	n/a

The Staff Student ratio for taught student FTEs in Physics and Astronomy, Session 2011-12, is therefore approximately 1:11.

1.2.6 Physical resources and infrastructure

- Lectures for most classes in Physics and Astronomy are held in the Kelvin Building, although lecture theatres are under the control of the Central Room Booking service which sometimes means locating classes in other buildings. The substantial growth in our class sizes over the past 5 years (as is evident in Table 1) has placed considerable pressure on the lecture space available and in particular prompted our decision, from Session 2008-09, to introduce a second Physics 1 lecture daily at 1pm. This change in our provision, and its impact on both staff and students, is discussed further in Section 3.
- Laboratory classes for Physics are also held in the Kelvin Building, in teaching laboratories located over three Levels of the building. These laboratories have been completely

refurbished since our last PSR and now provide a flexible, modern and well-equipped workspace which we believe has significantly enhanced the student experience of laboratory teaching. Astronomy laboratory classes are held at the University Observatory, at Acre Rd in Summerston. The Observatory is equipped with excellent modern optical and radio telescope facilities and has also been partially refurbished since our last PSR. The refurbishment remains incomplete, however, and its completion is now an urgent priority in view of the dramatic increase in Astronomy student numbers – particularly at Honours level – over the past 5 years.

- Small group teaching and supervisions generally take place in staff offices, although some small teaching rooms and conference rooms, as well some 'break out' flexible space in the refurbished physics labs, are also available. Booking of these spaces is administered by one of our research and teaching support secretarial staff. A general shortage of suitable rooms for small group teaching remains a matter that is raised regularly in the annual course monitoring reports completed by class heads.
- The School has a small lecture room equipped with state-of-the-art video conference facilities which are used in support of SUPA postgraduate teaching that is shared with our SUPA partner institutions across the country. This room is also used for some PGT courses that are taught solely by University of Glasgow staff, but which are available to postgraduate research students at other institutions as well as to M.Sc. students in Physics and Astronomy at Glasgow.
- The School provides to students excellent IT facilities, although maintaining the hardware at an appropriately modern specification presents an ongoing logistical and financial challenge. Currently around 150 desktop PCs are supported in three computer clusters in the Kelvin Building and one cluster at the Observatory, whilst further PCs are located in the Physics honours laboratory. In addition our usual practice is to make available to our M.Sci. students – and now also to the M.Sc. cohort – a laptop computer with basic software (office, LaTeX, acrobat etc) installed and more specialised software packages (e.g. MATLAB, Labview) normally also available as required. These laptops are intended primarily to support the students' project work but the machines are made available for the entire session. Wireless access is provided throughout the Kelvin Building and access codes are made available via moodle to students at all Levels.
- The School maintains a library within the Kelvin Building that includes a wide range of textbooks and monographs, as well as journals spanning many fields of physics and astronomy. An extensive library of astronomical textbooks, bequeathed to the School by a former graduate student, is also housed at the Observatory. The student societies Astrosoc and Physoc also maintain a small library of textbooks that cover most of the core undergraduate courses.
- Financial resources for teaching and learning are allocated by the Head of School, in the light of discussions with the School Management Team. Each year teaching funds within the School are allocated to laboratory heads at the start of the session for maintenance and/or equipment purchase.

2. Overall Aims of the School's Provision

The University of Glasgow has a clear mission: to undertake world-leading research and to provide an intellectually stimulating learning environment, thus delivering benefits to culture, society and the economy.

Within this context, the overall aims of the School of Physics and Astronomy are

- To carry out research of world class and use it to maximum advantage for Scotland the United Kingdom
- To provide training of the highest calibre at both specialist and general Levels.

These School aims are supplemented by a series of specific objectives in the area of learning, teaching and assessment:

- To maintain the excellence of our teaching at all Levels as measured by our performance in the NSS and ISB
- To further increase student retention at the Level 1 to 2 and Level 2 to 3 transitions in physics and in astronomy over the next three years
- To consolidate our position in the relevant national league tables
- To complete the refurbishment of our laboratory teaching space by modernising the Observatory as funds permit
- To consolidate our new PGT courses and grow the number of students on them
- To continue to innovate in teaching methods and to use these innovations to maximise the efficiency and effectiveness of our teaching
- To increase the effectiveness of our recruitment at both UG and PGT Levels
- To contribute to new developments in school physics education through engagement with national organisations.

The School's aims and objectives are closely attuned to the University of Glasgow's Learning and Teaching Strategy for 2011-2015, with its four guiding principles:

- Excellence
- Fostering investigative learning through research-led teaching
- Inclusion, access and opportunity
- A truly supportive environment

Moreover our specific teaching objectives overlap strongly with the areas of current priority identified in the University's Learning and Teaching Strategy, where particular emphasis is being placed:

- Student Retention
- Assessment and Feedback
- Recruitment and Admissions
- Embedding Graduate Attribute development in our provision
- Sustainable Postgraduate Taught (PGT) Growth
- Innovation in our Provision

3. The Student Learning Experience

The starting point for this review is the programme specifications for the degrees to which the School of Physics and Astronomy contributes and copies of these programme specifications are to be found in the supporting documentation. These specifications were, in the main, produced in Session 2007-08, when the University of Glasgow was undertaking a major review of its academic structures[9]. As part of that process Physics and Astronomy carried out a "vertical integration" exercise to re-assess the aims and objectives and syllabus of its courses at all Levels – as well as ensuring the proper alignment of each course with the structures that were defined and introduced across the University at that time, and with the appropriate SCQF descriptors. Consequently the degree programmes and courses associated with our teaching at all Levels have well documented aims and intended learning outcome, as required for approval of these programmes and courses via the appropriate Boards of Studies within the University.

3.1 Aims

3.1.1 Description of our approach and practices

Our programme aims comprise two elements: an overall description of the discipline(s) that seeks to capture the general aim of the programme, followed by a more detailed set of aims that is tailored to the specific range and level of activities and experiences that students undertaking the programme will encounter and engage with.

To illustrate the content of these two elements in practice, consider for example our single Physics degree programme specifications in their B.Sc. Honours and M.Sci. forms. The "programme aims" section of the specification document for our B.Sc. Physics degree begins with the following general statement:

"Physics involves the experimental and theoretical study of matter and energy and their interactions, ranging from the domain of elementary particles, through nuclear and atomic physics to the physics of solids, and ultimately to the development of the universe itself. The laws of physics form the basis of most branches of science and engineering and are the foundation of modern technology. In this B.Sc. programme we aim to give the student an understanding of the principles and methods of modern physics, and the skills to apply this understanding to a range of theoretical and experimental problems. In order to illustrate this, we draw on a wide variety of research and applications including work performed in the School of Physics & Astronomy".

The equivalent general statement in the specification document for the M.Sci.Physics degree programme is as follows:

"Physics involves the experimental and theoretical study of matter and energy and their interactions, ranging from the domain of elementary particles, through nuclear and atomic physics to the physics of solids, and ultimately to the development of the universe itself. The laws of physics form the basis of most branches of science and engineering and are the foundation of modern technology. In this M.Sci. programme we aim to give the student an <u>in depth</u> understanding of the principles and methods of modern physics, and the skills to <u>analyse and solve</u>[10] a range of theoretical and experimental problems. In order to illustrate this programme, we draw on a wide variety of research and applications, including work performed in the School of Physics & Astronomy"

[9] As noted in Section 1.1.4, our PGT programmes were introduced later, in Session 2010-11. The specifications for these programmes were approved by the University in spring 2010.

[10] The underlining is added only here, to emphasise the difference between the general statement of programme aims for our B.Sc. and M.Sci.degrees.

For the B.Sc. Physics degree programme the "programme aims" section then continues with the following specific aims:

1. *To present an integrated course of study which provides the student with knowledge and understanding of key principles and methods of modern physics;*
2. *To provide the opportunity to study in depth a choice of topics relevant to current developments in physics and its applications;*
3. *To provide training in the principles and practice of physical measurement techniques and scientific data analysis, and give the opportunity for the student to apply these in performing an extended project;*
4. *To develop the student's transferable skills, concentrating on work in a group, the writing of reports on group and individual project work, and in verbal communication of such results;*
5. *To develop the students' ability to work effectively and to reinforce their individual responsibility for their own learning.*

The M.Sci. Physics specification document, on the other hand, presents the following specific aims:

1. *To present an integrated course of study which describes, analyses and relates the principles of modern physics at a level appropriate for a professional physicist;*
2. *To provide the opportunity to study in depth a choice of advanced treatments and applications of aspects of modern physics and astronomy;*
3. *To provide training and experience in the principles and practice of physical measurement techniques, using advanced instrumentation where appropriate, and in the critical analysis of experimental data;*
4. *To develop problem solving abilities, critical assessment and communication skills, to a level appropriate for a career of leadership in academia or industry, and to give students the experience of group work;*
5. *To offer the opportunity to apply measurement, problem solving and critical assessment, and communication skills in performing and writing a report on an extended and demanding project;*
6. *To encourage students to work effectively, to develop a professional attitude to what they do and to take full responsibility for their own learning.*

3.1.2 Evaluative Statement

The aims are very similar for all of our programmes. All begin with essentially the same overarching description of the discipline that captures the underpinning nature of Physics (and for our Astronomy programmes the close interconnection of Astronomy and Physics) for all of the sciences and the importance of Physics applications for all of society – thus capturing succinctly the subject's own broad aims. The IoP website front page, for example, states that "Physics is central to our society. The Institute of Physics aims to advance Physics for the benefit of all. ". The general description gives a clear indication of the range of the programme with the appropriate emphasis on giving the student understanding and skills related to the principles and methodology of the science. This is true for all of the programmes we offer.

As indicated by the phrases underlined above, these broad aims are written slightly differently for our Masters level programmes, where it is appropriate that we highlight the greater depth of material that the M.Sci. and M.Sc. students encounter and the more advanced analytical capabilities expected of these students. This discrimination between the degree programmes is also an appropriate reflection of the greater capabilities which the Masters level students are expected to demonstrate, which can be seen from the higher entry and progression requirements for our M.Sci. and M.Sc. programmes.

As noted in Section 3.1.1, in addition to these overall aims there are also more detailed specific aims associated with each programme. These aims have been written to be consistent with the QAAHE subject benchmark statements and the IoP's "Core of Physics", and are closely mapped to the SCQF level descriptors. We believe that these aims accurately reflect what the students will encounter and what capabilities they can be expected to acquire when they undertake a Bachelors' or Masters' degree programme. They are expected to graduate with detailed knowledge of a wide range of physical principles and be able to apply these in many areas of Physics and in other fields. Furthermore the students are expected to demonstrate: (i) experimental skills for taking measurements and analysing data, and (ii) problem solving capabilities. Written and verbal communication skills are developed through practical projects. In general, and completely in line with the SCQF level descriptors, our Masters level students are expected to develop greater analytical abilities, study more advanced material, demonstrate a higher level of leadership and show a greater responsibility towards – and increased ownership of – their learning. Our Designated degree programmes also have programme specifications with aims which similarly reflect the appropriate benchmark statements and SCQF levels with appropriate differentiation from the wording adopted for the B.Sc. Honours and Masters level programme specifications.

3.2 Intended Learning Outcomes

3.2.1 Description of our approach and practices

The intended learning outcomes (ILOs) for all of our degree programmes can be found within the specification documents that are included with the supporting documentation. These are designed to reflect the core attributes of a graduate of the programme in question and seek to summarise what such a graduate should be able to do or demonstrate, in terms of particular knowledge and understanding, skills and other attributes.

As an illustrative example the ILOs for our M.Sc. degree programme in Theoretical Physics are presented below:

Knowledge and Understanding

On completion of the programme the student will be able to:

- *Understand and apply a range of basic mathematical methods which are useful in solving quantitative problems in physics;*
- *Understand and describe the key concepts which underpin current knowledge in wave phenomena, quantum mechanics, thermal physics, circuits and systems, electromagnetism, solid state physics and nuclear and particle physics, applying these concepts to analyse and solve quantitative problems;*
- *Understand and describe the key physical concepts which underpin current knowledge across a subset of more specialist (H-level) topics drawn from: numerical methods, modern optics, medical imaging, semiconductor physics, magnetism and superconductivity, electronic signals transmission, particle physics, nuclear physics, stellar structure and evolution, high energy astrophysics, galaxies and cosmology, circumstellar matter, astronomical instrumentation and data analysis. Apply these concepts to analyse and solve quantitative problems;*
- *Demonstrate a deeper understanding of more advanced physical concepts across a subset of more specialist (M-level) topics drawn from: advanced quantum mechanics, electromagnetism, statistical mechanics, imaging and microanalysis, dynamics and relativity, detectors for nuclear and particle physics, general relativity and gravitation, plasma theory and diagnostics.*

Skills and Other Attributes

Subject-specific/practical skills

On completion of the programme students will be able to

- *Programme straightforward procedures in a high level computer language and use computers to solve physical problems;*
- *Plan and carry out experimental investigations, using standard and complex or advanced experimental equipment and apparatus, of complex physical systems or processes, demonstrating logic, initiative, planning and decision making skills in solving problems encountered;*
- *Analyse, interpret and critically evaluate experimental data, make a quantitative evaluation of the errors inherent in the experimental measurements and draw valid conclusions from the results of experimental investigations;*
- *Apply computer software to analyse experimental data and to write scientific reports;*
- *Recover, evaluate and summarise the professional literature and material from other sources concerned with a chosen area of physics or astronomy, and prepare a written analysis of the current position in the chosen area, which should include a critical comparison of the material and a discussion of likely future developments;*
- *Plan the course of action required to achieve self-defined goals in an open-ended physics project;*
- *Make appropriate safety assessments for experimental procedures.*

Intellectual skills

On completion of the programme students will be able to:

- *Describe and analyse quantitatively processes, relationships and techniques related to the areas covered in the contributory courses;*
- *Write down, and where appropriate either prove or discuss the underlying basis of, physical laws related to topics in these areas;*
- *Analyse critically, and solve using appropriate mathematical tools, advanced or complex problems, which may include unseen elements, related to topics included in the course component outlines;*
- *Demonstrate a critical awareness of the significance and importance of the topics, methods and techniques discussed in the lectures and their relationship to other concepts in courses which have been taken.*

Transferable/key skills

On completion of the programme students will be able to:

- *Give an oral account of experimental work performed and conclusions drawn from it;*
- *Prepare a detailed written report on an experimental investigation;*
- *Apply logical analysis to problem solving;*
- *Make a preliminary definition of goals to be achieved during open-ended project work and revise these goals and strategies for completion of the work in the light of results achieved and difficulties encountered;*
- *Write a report on an extended piece of project work, which should include a critical evaluation of the significance of the work, and how it compares with earlier work done in the same area;*
- *Prepare an abstract of experimental or project work performed in the accepted scientific format;*

- *Prepare and present audio-visual presentations and posters summarizing the results of a project;*
- *Appreciate open problems typical of business situations;*
- *Interact positively with colleagues in a group context;*
- *Apply team-working skills to address a complex physics problem and contribute significantly to the work of a group tackling such a problem, combining their own work constructively with the work of others;*
- *Contribute to the management of a group engaged in project work;*
- *Combine with colleagues to prepare and deliver a presentation and report of group work.*

3.2.2 Evaluative statement

As was the case for our programme aims, the ILOs for all of our programmes have been written in the light of the relevant QAA subject benchmark statements and are also fully consistent with the SCQF level descriptors appropriate to each programme. Our recent successful completion of the IoP accreditation process provides further validation of the appropriateness of our programme ILOs. Moreover, as we discuss in more detail in Section 4 below, the accreditation exercise also involves scrutiny of the effectiveness of our procedures for ensuring that students, staff and external examiners have a clear and shared understanding of the aims and ILOs of our programmes and courses. We believe that the School has effective and robust measures in place for ensuring this shared understanding – a view that receives support from the very favourable IoP accreditation panel report that we received in 2008. Similarly our recent success in achieving Juno Champion status also validates this view.

3.3 Assessment, Feedback and Achievement

3.3.1 Description of our approach and practices

(A) Overview of assessment procedures, including recent changes

Assessment of courses and programmes within the School of Physics and Astronomy is carried out by a range of methods, both formative and summative. As a starting point to our review of this topic we refer the reader to Appendix 2 which summarises the weightings of the different summative assessment components for the courses and degrees offered by the School.

Since our last PSR we have undertaken a significant redistribution of the summative assessment weighting for most of our courses at Level 1 and 2. Essentially we have shifted the balance of summative assessment for these courses from being predominantly weighted towards the degree exam, to instead being split more evenly between degree exam(s) and continuous assessment components – the latter, as before, including a significant laboratory component.

There were several academic and logistical drivers for this significant change, for which we sought and obtained approval from the Science Taught Programmes Committee (STPC) Board of Studies in spring 2008. The main initial driver was our concerns about the potential impact of the University's academic restructuring, which has moved the end of Semester 1 examination diet from mid January to early December. Specifically we sought to avoid our non-Honours students (and particularly those in Level 1) encountering a degree exam, which carried most of the assessment weighting for that course, only 11 or 12 weeks after the start of the session. At the same time as introducing more continuous assessment at Level 1 and 2, we also converted our Level 1 and 2 Physics courses and our Level 1 Astronomy course from single semester, so-called "short, fat" courses to "long, thin" courses that run over both semesters, with degree examination paper(s) assessing the entire session's

material in the May/June diet[11]. These proposals were developed by the "Level 1 and 2 working party" set up by the Physics and Astronomy Teaching Committee in the autumn of 2006. (See also Section 3.4 below).

For our Honours lecture courses at Levels 3 to 5 (i.e. for both H-level and M-level courses) in Physics and Astronomy the summative assessment is currently 100% weighted on the degree examination. For all such courses the degree examinations (first sitting) take place in the April/May diet.

(B) Examination procedures

The preparation, checking and reviewing of degree examination papers is described in more detail in Section 4. Lecturers for a given course, or course component, set degree exam questions (or where applicable continuous assessment components) for their own course based on the ILOs of the lecture course (or course component) they have delivered. Full details of the assessment scheme to be adopted for the course – including the weighting and timing of the different components and the structure and rubric of the examination papers – are provided to students at the beginning of the session via moodle, course guides and face-to-face introductory lectures[12]. Examples of this course documentation, and the information contained therein, for a range of our courses are included in the supporting documents that accompany our submission. A subset of recent past degree exam or class test papers, with detailed model answers and marking scheme, are made available to the students (usually via moodle, although degree exam papers can also be obtained from the GU library).

Degree examinations at Levels 1 and 2 normally comprise questions from each lecture course component and students can answer a choice of questions. For Physics 1 and Astronomy 1 the examination consists of two 90-minute papers, on material taught in Semester 1 and 2 respectively. A similar model is being adopted for Physics 2 this session, while Astronomy 2 (which is a 30 credit course with only 4 lecture course components, compared with 9 for Physics 2) consists of a single paper of 120 minutes. The duration of each of these examinations is consistent with the allowed duration calculated from the algorithm developed by the University's Academic Structures Implementation Group (ASIG), taking into account the assessment weighting and total credits of each course.

For Levels 3-5 the degree examination format for each lecture course is somewhat different, with both shorter compulsory questions and a choice of longer questions. In Physics, where each lecture course is 10 credits, the degree examination is of 90 minutes' duration; in Astronomy (15 credit lecture courses) the examination is of 120 minutes' duration. These timings are somewhat longer than a strict scaling of the ASIG algorithm would allow, but the adoption of longer examinations was approved by the STPC on the grounds that for highly technical, mathematical subjects such as Physics and Astronomy additional reading time is required at the beginning of the examination. In both the Physics and Astronomy examination formats the compulsory questions attract 40% of the

[11] Our Level 2 Astronomy course already ran over both semesters so required no change in this respect – although, like our other core Level 1 and 2 courses, we did increase its fraction of continuous formative assessment. However we have retained the single semester structure, with exams at the end of each semester, for our EXCOS1 and EXCOS2 courses, as well as for Physics 2T and our other service teaching.

[12] Although the introduction of myCampus has in principle, removed the need for face to face class enrolment, at the start of Session 2011-12 our Class Heads continued to arrange introductory lectures or welcome meetings. These provided opportunities to independently acquire class information – which was considered vital in view of the unreliability of myCampus – and to foster from the outset a keen sense of class community and excellent staff-student relations, which we believe is one of the key strengths of our provision across all Levels.

marks while the optional questions attract 60%. Together these questions are designed to test the student's overall knowledge of the course and also to probe the deeper understanding of specific important aspects of it.

(C) Provision of practical work

Practical work forms a significant element of assessment in Physics and Astronomy at all Levels. In the pre-honours classes at Levels 1 and 2 students carry out set experiments and/or IT tasks, with each experimental record being marked and feedback given. In addition a number of formal reports are required to be submitted on experiments of the student's choice. Increasing emphasis is given to experimental errors and the accuracy and precision of measurements at Level 2, where specific training in the mathematical treatment of errors is provided via a short series of lectures. In Level 2 Physics library- and internet-based literature searches are also introduced as part of a group seminar project, where a small group of students together prepare and deliver an oral presentation on a cutting-edge research topic.

In Levels 1 and 2, and more recently in level 3, students generally carry out practical work in pairs. In the level 3 Physics laboratory a greater degree of independence is expected of the students in terms of carrying out the experiment and analysing the data without detailed direction. Thorough feedback is given on the completed experimental record, which is marked via a face to face oral interview; the students are encouraged to describe the work they have done and defend their results and analysis in this oral session. Mark sheets for the various classes, which detail the assessment and indicate what formative feedback is provided, are included in the accompanying documentation.

In the Honours years students are subjected to formal project work for the first time in these degree programmes (all Astronomy practical work in level 3 and above is in project form). The project work takes a range of forms:

- 20 credit Level 3 Group projects, in Physics and Theoretical Physics, carried out by groups of 6-8 students.
- Astronomy observational (telescopes), laboratory and computational projects in groups of 1-3 students.
- Astronomy seminar project comprising literature search, oral presentation and written report.
- 20 credit M-level project carried out by M.Sci. students at level 4, and also generally by M.Sc. students as part of their initial 120 credits of contributing courses.
- 20 and 30 credit H-level projects carried by B.Sc. Honours students at level 4. (20 credit projects are carried out by joint honours Physics and Chemical Physics students; 30 credit projects are carried out by single honours students).
- 40 credit M-level project carried out by M.Sci. students at level 5.
- 60-credit M-level project carried out by M.Sc. students during the summer, after satisfying the University's generic PGT progression requirements.

Project assessment weightings vary slightly among the above examples but there is always a formal written report component and in several cases an oral presentation is also summatively assessed, with some opportunities for peer assessment also having been introduced since our last PSR. Procedures for assuring the robustness, reliability and objectivity of project assessment are discussed in Section 4 and 5.

(D) Opportunities for formative assessment

In addition to the summative assessment schemes summarised in Appendix 2, there are numerous opportunities provided for students to obtain formative feedback on their progress throughout their degree programme.

In Level 1 Physics the class workshops, which are held once every two weeks throughout both semesters, comprise two parts. The second part of each workshop is a short class test consisting of 10 multiple choice questions on current topics in the Physics 1 lecture course components; these class tests together contribute 20% to the overall summative assessment for Physics 1. The first part of each workshop consists of a full class tutorial, in which students can work through pre-assigned problems and a large number of staff and postdocs are present to answer questions and provide feedback. In addition, Physics 1 students undertake a regular series of online formative assessment exercises known as "Mastering Physics" which is linked to the course textbook. Optional "drop-in" tutorials involving staff members, and a short series of peer-to-peer tutorials involving volunteer tutor from the Honours classes, are also provided.

At Levels 1 and 2 all lecturers give revision lectures based on example problems (roughly one revision lecture for every 10 lectures). In both Level 2 Physics and Astronomy there are whole-class tutorials scheduled at regular intervals throughout the session. In Level 1 Astronomy these whole-class tutorials take place on alternate weeks and (in a similar manner to the Physics 1 class workshops) allow students to work through problems assigned from the tutorial handbook with a number of staff and graduate students on hand to answer questions and provide formative feedback. Additionally some tutorials make use of PRS handsets, which provide students with instant feedback on "pop quiz" multiple choice questions. Indeed PRS handsets and MCQs are used regularly within lectures across a range of lecture courses – particularly at Level 1 – and have proven popular with students.

In both Physics and Astronomy degree programmes from Level 2 onwards students (including our new cohorts of PGT students) also meet regularly, usually at fortnightly intervals, for a small group supervision session. Each group, typically comprising about 6 students, is facilitated by a staff member (or in some cases at Level 2 an experienced postdoctoral researcher). These sessions are intended to complement the lecture material in a manner that the students can undertake self-assessment and take advantage of the small staff student ratio of the sessions. The normal procedure adopted by most supervision groups is for set problems to be attempted beforehand by the students and then worked through during the supervision session. These problems are drawn from example sheets which are distributed by the course lecturers via moodle (with model answers provided at a later date, usually also via moodle). Students are also encouraged to discuss any aspects of the lecture material in supervisions and – particularly for Honours students – they also serve the purpose of providing students with advice on career development, CV building, applying for postgraduate research positions etc.

Class exams are important sources of formative assessment at level 3 in the Physics and Astronomy degree programmes. These examinations come quite soon after the students have formally gained entry into their chosen degree programme. The students are therefore encouraged to view these exams as an indication of how they are performing in their chosen programme. In the case of students who may be experiencing difficulty, it provides a good opportunity for each student and his/her class head and/or adviser of studies to review how they are coping with their course. As a result it may be that a more realistic assessment is made by the student of their preferred course of study e.g. changing from M.Sci. to B.Sc. degree. The normal procedure for providing feedback from the Level 3 class exams is that marked scripts are returned to students in tutorial/supervision sessions with depersonalised verbal feedback given to the group as a whole, followed by a more individual one-to-one discussion with each student as requested.

3.3.2 Evaluative statement

As described in detail in Section 3.3.1, the range of assessment methods adopted in the School of Physics and Astronomy has widened significantly for most of our junior courses since our last PSR took place. Specifically, a greater proportion of the assessment weighting is now attributed to continuous assessment for these courses. When these changes to our assessment were being developed they were discussed fully with students via our Student-Staff Liaison Committees, as well as inviting individual student comments on the proposals via our undergraduate moodle sites. We also consulted widely with our external examiners and with external industrial and schoolteacher advisors. The feedback received on the proposed changes was uniformly positive. We believe that the recent grade profiles for these courses, and in particular the proportion of our Level 1 and 2 students who have progressed onto Honours and M.Sci. programmes in our School (see also Section 3.6 below), have vindicated these changes in the assessment weightings.

The summative assessment for our Honours lecture courses is currently 100% weighted towards the Degree Examination. However the School Teaching Committee has begun exploring possibilities for introducing a component of continuous summative assessment for these courses, in the form of regular homework assignments. The practice across the UK sector shows a wide degree of variation in this respect: some other Physics Departments operate exactly as we do, with the entire honours assessment based on performance in the degree examination, but a number of other Departments have introduced some form of continuous assessment at honours – usually at the level of about 10 or 15% of the overall grade. In our most recent discussions with students, via the SSLCs and focus groups with recent graduate students, it has become apparent that this issue may be relevant to our performance in the National Student Survey. The School's recent NSS results are summarised in Section 3.7 below, and are broadly very good. However, in keeping with the University as a whole (and indeed consistent with other Physics and Astronomy departments across the country) our weakest NSS results are in the area of Assessment and Feedback. The student views which we have gathered indicate that the absence of a summative continuous assessment component in our honours and masters lecture courses is a major contributing factor to our weaker performance in this area. In its October 2011 meeting, therefore, the School Teaching Committee prioritised the further investigation and resolution of this issue and, if deemed appropriate after completion of this investigation, to present proposals at its next meeting for the introduction of a limited continuous assessment component in our Honours lecture courses (or a specified subset thereof).

The School's provision of practical work was described in some detail in part (C) of the previous section. The range of provision of practical courses, and the manner in which these courses develop in depth and degree of independent work as students progress through their degree programme, help to ensure that they are an effective vehicle for the embedding of transferable skills and graduate attributes. The success of our practical courses in this regard is further evidenced by our recent NSS results (see Section 3.7). In 2011, for example, we achieved above-benchmark scores on questions 19-21: "The course has helped me present myself with confidence", "My communication skills have improved" and "As a result of the course, I feel confident in tackling unfamiliar problems". Similar results were also obtained in each of the previous three years.

All assessment components of our courses are fully compliant with the University's Code of Assessment. In our junior classes the practice has generally been to mark assessment components numerically, allowing a straightforward weighted aggregation to obtain an overall percentage score. These scores are then converted to 22pt scale grades according a straightforward mapping. Course documentation explains this process clearly and succinctly to students.

At Honours and Masters level degree examination papers are marked numerically, re-scaled to a percentage score, and converted to 22pt scale grades according the same mapping applied at junior levels. Other assessment components (e.g. laboratory projects) are marked directly on the 22pt

scale. Markers are supplied in advance with the University's grade descriptors as a guide to their practice; this same information is made available to students via moodle and other course documentation – e.g. the guide to Honours and Masters Projects, which sets out in thorough detail the procedures adopted for marking and moderation of project work, as well as deadlines for its submission and information on the nature and timing of feedback available to students. Comments from our external examiners give us confidence that these marking and moderation procedures are robust and effective. The procedures adopted by the School for aggregation of grades, and the determination of overall degree classifications in our B.Sc. and Masters programmes, are also fully consistent with the Code of Assessment; they are detailed in a short memo that is made available each session to students on moodle. A copy of this memo is included among the supporting documentation. This memo is also highlighted to students at the SSLC.

After examinations have taken place, marking is carried out based on a rigorously prescribed procedure, or marking scheme. From Session 2010-11, and following discussion with the external examiners, all markers are now required to complete a short pro forma providing commentary on the question(s) they have marked. This commentary should include an assessment of any perceived anomalies in the distribution of marks, and any gross imbalance in the number of attempts at each question in cases where a choice of questions was available. The commentary should also indicate any remedial action which the marker intends to take when teaching the course the next time. The meetings with the external examiners at which grades and awards for courses and degree programmes are finalised are extremely important for enhancing subsequent curriculum design. At the external examiners meetings the current year's grade profiles are studied, and compared to previous year's results. Any issues with particular lecture courses or assessments are discussed and investigated if discrepancies are noted.

We believe that the feedback we provide on formative and summative assessment is generally prompt and effective. In order to achieve this in some cases we make use of electronic resources – either to assist with the efficiency and transparency of the submission of assessments or to ensure its timely marking. For example, the series of eight continuous assessment workshops in Physics 1, which run at fortnightly intervals through both semesters, involve a short set of 10 multiple choice questions which are completed by students at each workshop. These are marked via an optical character reader (using the same software that we employ to capture and process student questionnaire returns) and generally marks are returned to students, together with generic feedback, before the next workshop takes place.

The deadlines for the late submission of assessed work are communicated clearly and unambiguously to students via moodle and other course documentation, and are applied consistently across all courses – in line with the University's Code of Assessment. Class Heads make regular announcements via moodle to reinforce this message and it is also conveyed frequently face-to-face. For example the Level 1 Astronomy tutorials take place fortnightly and students are required to hand in assignment questions for marking every two weeks. Generally these are returned, with individual written feedback, at the next tutorial. Students are given clear instructions on the procedure and timing for handing in their assignment questions, both verbally at the tutorials and also via moodle. The same information is also available in the course documentation.

Students also receive guidance in their course documentation and via moodle on the University's policy on plagiarism and referencing the work of others. The use of turnitin has been promoted, as a formative exercise, with some of our assessment components and students are generally required to sign a statement confirming that they have not knowingly violated the Unviersity's policy on plagiarism. Our Honours students receive a lecture on "Working with the literature" that reinforces this good practice and presents guidelines on how to gather, organise and present a scientific bibliography, using standard tools and referencing systems.

3.4 Curriculum Design, Development and Content

3.4.1 Description of our approach and practices

(A) Curriculum structure and design principles

Physics and Astronomy are subjects which involve the development of ideas and the techniques to apply them in a continuous progression from Level 1 to graduation. Courses at the higher Levels build on material in those which have gone before. Thus, our B.Sc. and M.Sci. programmes are planned as a coherent, progressing whole over 4 and 5 years respectively. The College entry system means that there is a relatively small proportion of Physics or Astronomy at Level 1 (one third of the total curriculum in each case), and that Level 2 does not involve complete concentration on the core subjects (only 50% of the year involves Physics 2 and 25% Astronomy 2). Nonetheless the Level 1 and Level 2 courses in Physics are designed to lay the groundwork in mechanics, oscillations, electromagnetism, thermal physics and properties of matter and offer a largely descriptive introduction to quantum phenomena. In Level 1 and Level 2 Astronomy courses basic positional and observational astronomy, together with stellar astrophysics, cosmology and basic relativity, are treated thoroughly.

The level-3 course in Physics is in many ways the key to the Physics programmes, as it includes core courses at H-level (SCQF 10) in quantum mechanics, waves and diffraction (including Fourier methods) and thermal physics. The H-level course in electromagnetism is now included at level 4, as more preparatory work on this core topic is performed at Levels 1 and 2 than for other core areas. Students in both H and M streams study material at level 4 which applies the core material studied at level 3, particularly quantum mechanics, in a wide variety of contexts in condensed matter, atomic, nuclear and particle physics. In addition, at Levels 4 and 5 M.Sci. students develop and deepen their understanding of certain subjects, notably quantum mechanics and statistical physics to the appropriate level (SCQF 11). B.Sc. and M.Sci. students are also able to specialise in topics which interest them by taking elective courses at H- and M-Levels, subject to the limits set by the College's generic degree regulations. A similar approach is adopted for our M.Sc. programmes: a relatively small number of core, compulsory, courses are delivered, mainly in Semester 1, and these are supplemented from a larger number of elective courses drawn (subject to the generic PGT regulations for M.Sc. programmes) from our entire range of M-level and H-level provision.

Progression through Honours in Astronomy is somewhat different in that the astronomy lecture courses at level-3 and above are taught in a 2-year cycle. B.Sc. and M.Sci. students start in both halves of the cycle and all teaching encompasses level 3 and level 4 (and in some cases level 5) students studying together. There are both H and M courses offered each year but the M-level courses are available only to Level 4 and Level 5 students.

Mathematical competence is integral to the training of our students. To undertake an honours degree programme that includes Physics or Astronomy, a student is required to take 40 credits of Mathematics in first year and normally a minimum of 30 credits in second year (although a significant subset of students may take up to 60 credits, to retain the option of pursuing a single or joint Honours Mathematics degree programme). These Level 1 and 2 courses are taught by the School of Mathematics and Statistics, and are designed without Physics and Astronomy students particularly in mind. We therefore find that some local reinforcement of the relevant mathematical ideas is necessary and in the Physics programmes there is material specifically concerned with applications of mathematical techniques to Physics problems in years 2, 3 and 4/5.

In many undergraduate Physics and Astronomy courses, laboratory work is integrated with lectures, and used primarily to reinforce their content. However the approach taken in Glasgow is rather different. The most important aim of the Glasgow laboratory course components, and the project

work undertaken by more senior students, is to teach a wide range of professional skills, many of which are not touched in the lecture or tutorial context. The secondary aim is certainly to reinforce the teaching of particular scientific principles, and therefore the experiments in a particular year are in general based on the material covered in that year. However it is not possible for organisational reasons to associate lecture course components and laboratory work more closely than this. As well as the obvious skills of making measurements, interpreting data, evaluating the experimental uncertainties and planning the experiments, the laboratory courses build transferable skills including the writing of reports, presentation of results both orally and by poster, and development of group working skills – both in pairs and in larger groups of 6-8. One further element in skills teaching is in IT, for which there is explicit, specific provision in each of the years 1 – 3.

(B) Developing and designing the content of our curricula

Teaching within the School is under the direction of the Teaching Committee (TC) on which 11 members of academic staff currently serve. Since 2010-11 the TC membership has also included a student representative. The chair of TC is the School Convenor of Learning and Teaching. The members represent a wide variety of teaching, and related administrative, interests and are drawn from across the School Research Groups as well our three University Teachers. The TC meets formally 2 or 3 times per annum, with extra meetings as required, and reports to the Academic Staff Committee (ASC) and regularly to the School Management Team (SMT). Since 2008 the Convenor of Learning and Teaching has been an *ex officio* member of the SMT.

The functions of the TC may be broadly divided into two categories:

1. to monitor the teaching in progress and analyse and deal with any immediate problems which arise in our provision;
2. to take a strategic view of Physics and Astronomy programmes and initiate any curriculum development which is deemed to be necessary.

Minor curriculum or assessment changes are generally considered and approved by the TC on the basis of papers prepared e.g. by Class Heads. Such minor matters are rarely referred to the ASC, but may go to the SMT for their consent.

The procedure for major curriculum development is generally as follows. When the need for this becomes evident to the TC, a Working Party is set up to frame detailed proposals. The Working Party reports to the TC, which considers the issues in detail. If both TC and SMT are happy with the proposals, TC puts them before an ASC meeting for final approval by the School. In many cases, they will then proceed to the College Board of Studies (formerly the STPC Board of Studies).

Since our last PSR there have been two major Working Parties set up to manage our response to the changes in the University's Academic Structures introduced from session 2008-09:

- A "Level 1 and 2 Working Party" (see also Section 3.3 and Section 3.6) was set up to oversee curriculum and organisational developments in our core junior classes – and in particular the redistribution of assessment weighting and the conversion of these classes to the "long thin" model running over both semesters.
- An "Honours Working Party" was set up to oversee curriculum and organisational developments in Honours – and in particular the smooth transition of our Honours Physics and Astronomy provision to individual, distinct 10- and 15-credit lecture courses, together with the range of laboratory and project courses listed in Section 3.3.1. A significant aspect of the Honours Working Party's remit, which involved substantial interaction (via TC) with the Level 1 and 2 Working Party, was to carry out a review of the degree of "vertical integration" of our undergraduate provision across all Levels.

Other Working Parties have been set up to: develop and introduce (for Session 2010-11) our new PGT programmes; oversee the refurbishment of our Physics laboratory space; analyse and respond to the problems of managing large student numbers at all levels; to further develop and embed from Level 1 onwards our students' problem solving skills. (This last Working Party is still active and will report to TC in late Spring 2012).

3.4.2 Evaluative statement

The Physics benchmark statements[13] for Honours B.Sc. and for M.Sci. and M.Sc. degrees form an essential background against which we can judge whether or not our degrees fully conform to accepted national standards, thus also providing a measure by which we can evaluate the success of our approach to curriculum design.

When the benchmark statements were first introduced in 2002, we checked carefully that all elements of the statements were covered in the courses. This was partly in preparation for the next accreditation of our courses by the Institute of Physics (IoP), which took place in 2003; as a result of this process all our Physics degree programmes were accredited and (as noted above) accreditation was awarded again in 2008. The accreditation process also involved a rigorous check that our courses teach the "Core of Physics" specified by the IoP, which concentrates on coverage of all the elements of the basic Physics curriculum. Once again the visiting IoP Accreditation Panels have been entirely happy with our performance in this area. Thus we are very confident that the content of our programmes, and our processes for their design, encourage achievement of their ILOs across their full range of knowledge, understanding and skills.

As was discussed briefly in Section 3.4.1, since our last PSR an Honours Working Party was set up to oversee the transition of our Honours and M.Sci. programmes to a form fully consistent with the University's new academic structures, which were fully introduced from session 2008-09. As part of the remit of that Working Party, student workloads were carefully re-evaluated, in terms of student learning hours (1200 for a typical year's study), for each programme and its constituent courses. The learning hours for the various individual courses contributing to each programme were calculated using carefully evaluated multipliers to raise the associated number of contact hours to the total learning hours expected of a student. These learning hours are converted to credits, using the conversion factor of 1 credit for 10 student learning hours.

In view of the recommendations of our Honours and Level 1 and 2 Working Parties, essentially *all* of our core courses, at all Levels from 1 to 5, have been re-presented for scrutiny and approval by the STPC Board of Studies since our last PSR took place. Moreover, as was also noted in the previous section, another crucial aspect of the remit of these Working Parties was to review of the degree of "vertical integration" of our undergraduate provision across all Levels. This exercise has resulted in some reorganisation and streamlining of material, to ensure proper coverage at the appropriate Level (particularly with regard to meeting the IoP "core of Physics" requirements) and avoid excessive overlap. Given these careful re-evaluations, we are satisfied that the workload expected of our students remains realistic.

Although, with one exception, work experience is not a formal part of the various degree programmes containing Physics and Astronomy, there are many opportunities for our students to supplement their work in Glasgow with experience in the wider world. Firstly they may spend one or two semesters abroad in years 2 or 3. The curricula for such students is adjusted on an individual basis, taking into account what is offered in the remote institution, to ensure that such students are

[13] Note that Astronomy does not have separate benchmark statements but is implicitly covered by those generated by the Physics panel

not penalised when they return through not having studied the appropriate material. Rather few students take the opportunity to work in Europe, mainly because of language problems, but some others do take the opportunity to work in the anglophone Commonwealth or North America. Secondly the School has contacts with many international research facilities and short term internships may sometimes be arranged. Thirdly many students perform vacation work in the School itself, either developing teaching material or performing mini-research projects within one of the research groups. The one formal placement scheme is in the Chemical Physics with Work Placement M.Sci. Degree, in which students spend a year in industry as their penultimate year of study.

A major strength of the School of Physics and Astronomy is the effectiveness of our research-teaching linkages and the extent to which their embedding within the design of our curricula helps to foster an enquiry-led learning approach in our students. We describe some of our recent activities in this area in Section 3.7, where we review the quality of the learning opportunities within the School's programmes.

Our teaching staff are sensitive to the wide range of backgrounds of students in the School. One member of the Teaching Committee is the Special Needs Co-ordinator, responsible for focusing the School's response to disability issues. Another acts as International Student Co-ordinator, acting as point of reference for Erasmus and other overseas students interested in spending a period studying in Glasgow and a contact during their time with us. This staff member also co-ordinates requests by our home students to study abroad.

We are particularly sensitive to gender issues, as ensuring a friendly and supportive environment for the 20% or so of our students who are female is essential to the current harmony and future development of our School. Our recent success in being awarded Juno champion status by the IoP (the first such School or Department in Scotland) provides strong evidence of the significant progress we have made in this regard since our last PSR.

3.5 Student Recruitment

3.5.1 Description of our approach and practices

(A) Overview of recruitment activities within the School

The School of Physics and Astronomy is involved in a wide range of activities to raise awareness of its programmes to potential students and (for undergraduate programmes) their teachers. Many of these activities are co-ordinated through the School's Recruitment and Retention Committee, which liaises closely with the Teaching Committee and School Management Team on these issues.

There are three main University organised open days in the academic year, in September, March and June. The principal University open day is held in September and the School of Physics and Astronomy presents a wide range of displays and exhibits showcasing our teaching and research – with active involvement of many teaching staff, research staff, postgraduate and undergraduate students. The latter group acts as guides and are generally drawn from members of the Physoc and Astrosoc student societies. For the March open day, students already in receipt of an unconditional offer are invited to visit the University and the Schools where they intend to study prior to commencing their degrees in September of that year. Each student with Physics or Astronomy indicated on their UCAS form is contacted by the Head of School inviting them to attend this event.

In addition to the main University open days we regularly host, in response to specific requests, visits for individual prospective applicants. We also operate dedicated email addresses for undergraduate

and taught postgraduate enquiries: these are received by a teaching administrator and member of staff, and are usually replied to within 3 days.

Other recent recruitment activities in Physics and Astronomy aimed in particular at senior High School pupils and teachers include:

- Christmas Lectures in the Department (between 400-600 pupils)
- "Taster" week programmes involving related talks and lab visits
- Access to teaching laboratories provided for Advanced Higher project work
- Invited talks in response to requests from schools.
- Work experience visits by request from schools.
- Physics teachers open evenings, organised in conjunction with the IoP Scotland Physics Teachers support network.
- Residential summer school for Physics teachers, organised in conjunction with the Institute of Physics and the University of Edinburgh.

Events aimed at younger pupils or those who may still be deciding their future direction are also organised. We organise on behalf of the Royal Society of Edinburgh an annual series of Saturday morning masterclasses each Autumn and Spring, involving a mix of hands-on workshops and lectures for 12-13 year old pupils. Physics and Astronomy staff and students have also been active in the support and organisation of the "Accelerate" Science Challenge programme for 15-17 year olds, held each summer at Strathclyde University, and in schools visits to the Large Hadron Collider in CERN, supported by the Ogden Trust. In conjunction with STEMNET Scotland and the Physics and Astronomy graduate school, we also support and encourage our postgraduate students and early-career postdoctoral researchers to enrol as STEMNET "Science Ambassadors", who are subsequently partnered with schools. The School also contributes to the annual Pre-University Summer School (formerly access course) under a central University umbrella.

Recently the School has become heavily involved in curriculum development, working with the Scottish Education Authorities and the Scottish Government. The Convenor of Learning and Teaching is currently also a "Science in Society" Fellow for the UK Science and Technology Facilities Council, leading an international programme of astrophysics outreach to schools and the public. For several years he has led STEM enrichment activities for the Scottish Network for Able Pupils and in 2010 he was nominated by the Royal Society of Edinburgh to join the Scottish Qualifications Authority Physics Qualification Design Team, having previously acted as consultant on redesign of the Higher and Advanced Higher. Also in 2010 he was nominated by the Scottish Government to join the Mathematics Excellence Group – a strategic advisory body set up by the Cabinet Secretary. Thus the School represents the Scottish University Sector for both Physics and Mathematics on implementation of the Curriculum for Excellence.

Recruitment of overseas students has also been an area of increased activity in recent years, particularly for PGT students. The School has been involved in University-run recruitment and alumnus events in the USA, and staff from the School have made promotional visits to institutions and recruitment fairs in China and Hong Kong, India and Southern Africa.

(B) <u>From recruitment, through admission to enrolment</u>

The University normally admits students to our undergraduate degree programmes in Physics and Astronomy via the UCAS system. Students must normally meet the academic entry criteria as published in the Undergraduate Prospectus: for entry in 2012 these criteria comprise the following (for our Physics B.Sc. and M.Sci. programmes as an example):

- **Highers**: Applicants who achieved AAAB their first sitting can expect to receive an unconditional offer. Applicants who achieved between BBBB/ABB and AABB at their first sitting may receive a conditional or unconditional offer once all applications have been reviwed in March 2012. Higher at B or above is required in Physics and Mathematics.
- **A-Levels**: ABB, including B or above in Physics and Mathematics
- **IB**: 32 points

Faster route admission to our B.Sc. and M.Sci. programmes is also possible, based on a significantly higher level of performance at Advanced Higher, A-level or IB.

In addition to the above 'standard' routes for recruitment, the School is always willing to consider applications from potential 'non-standard' entrants. Our University Teachers (who are also advisers of studies) and other staff are routinely available to meet applicants and discuss pre-requisites, and whether these may be realistically amended to suit an individual without jeopardising prospects of successful completion of the programme of study. Examples of this in the past have been in respect of applicants whose qualifications have been gained outside the normal 5-year currency period. The School may also be able to recommend additional reading prior to admission or may take account of relevant work experience to allow an offer to be made.

On entry, students will have the opportunity to review their initial UCAS Science selection prior to commencing their degree programme. Historically this was done via a face-to-face meeting with a Senior Adviser of Studies. The introduction of myCampus for session 2011-12 saw the adoption of a pilot exercise, for admission to Science degree programmes, whereby new students completed the enrolment process online – although Adviser support was still available via email, phone or face-to-face as required to answer queries and offer guidance. A few weeks into the session, students are assigned to an Adviser selected to be in the intended subject area of main study. Thereafter the Adviser will be able to assist with the choice of courses in subsequent years. Advisers also provide pastoral care appropriately backed up by experts within the University in areas such as Special Needs, finance, counselling, accommodation and student health.

There appear to have been significant problems with the myCampus system for enrolling new students across the College of Science and Engineering, but our general perception was that it operated satisfactorily in Physics and Astronomy – as evidenced by the student numbers that enrolled on our core Level 1 courses in September 2011 (see below). We must note, however, that our relative success with the myCampus enrolment process for new Level 1 students came at a very considerable cost on staff time, principally for our University Teachers, Advisers of Studies and other senior staff within the School with responsibility for overseeing the transition to myCampus. It is our fervent hope that these (and many other) aspects of myCampus will be urgently addressed by the University in order that the recruitment and enrolment experience for September 2012 entrants (and indeed for continuing students) is significantly improved.

The "Faculty"-based entry system[14] operated at Glasgow for undergraduate programmes is very flexible, as in general students may choose different subjects from those indicated on their UCAS form. As many young people can be undecided at this stage of their career, the University system has distinct advantages over subject based entry. For students intending honours in Physics, Physics and Mathematics at Level 1 are mandatory, while students intending honours including Astronomy must take Mathematics and Astronomy, with the majority of these students taking Physics as a third subject. It follows that students intending Physics (and possibly Astronomy - if Physics is excluded)

[14] The restructuring of the University from Faculties to Colleges officially renders this term outdated, but it remains in common usage as a means of capturing the essence of the flexible system of entry to the (erstwhile) Faculty of Science that the University has operated historically, and continues to operate via the new College structure for students embarking on B.Sc. and M.Sci. degree programmes.

can have a wide choice of third subject from anywhere in Science or Arts. This third subject may be chosen to open possible alternative honours routes or because the third subject is one in which the student has a substantial, but secondary, interest.

Application and admission procedures for our PGT programmes are closely aligned with those of similar programmes across the University in being largely administered directly by the University's Recruitment and Internationalisation Office (RIO). The programmes are subject to the University's normal entry requirements: a B.Sc. 2:1 degree or equivalent in Physics or appropriate cognate subject. When our programmes were introduced for session 2010-11, our Convenor of Learning and Teaching and the M.Sc. programme leader agreed with RIO a broad range of criteria for defining what is meant by "equivalent" and "cognate subject" in the context of our programmes. In particular, these criteria were designed to be fairly "soft", in the sense that they should reduce the chance of inadvertently overlooking or rejecting a plausible candidate. Thus RIO issue conditional or unconditional offers following the agreed criteria, but if there is any doubt about a student's suitability the application is passed to the School Convenor of Learning and Teaching and the M.Sc. programme leader for a final decision.

Given the flexible nature of the course choices for our PGT programmes, and given also the difficulties students experienced with myCampus enrolment, for session 2011-12 we took considerable 'hands-on' care over the process of defining the curriculum of each of our M.Sc. students. In August and early September 2011 the M.Sc. programme leader exchanged a series of emails with each student, iterating towards an agreed syllabus that was optimally matched to the student's experience, prior knowledge and academic interests – an accounting for the constraints of timetabling, balance between semesters and other relevant factors. This initial communication also helped us to firm up as early as possible our picture of exactly how many PGT students who had accepted unconditional offers from the University were actually intending to come to Glasgow. The curriculum was then finalised via a face-to-face meeting between the programme leader and each student during the induction week at Glasgow – a meeting which also served as a personal welcome to the student from the School. In recognition of the important role which the programme leader played in this process, he was subsequently appointed as the Adviser of Studies for the M.Sc. cohort.

3.5.2 Evaluative statement

Over the past five years the number of students recruited into the (erstwhile) Faculty of Science has remained fairly stable. The effectiveness of the Physics and Astronomy recruitment strategy over this time can, therefore, be evaluated by considering the change in student numbers in our core Level 1 Physics and Astronomy courses. Figures 1 and 2 below illustrate these changes; these statistics were gathered for our recent Juno Champion submission, and comprise gender disaggregated data over an extended period of 9 years for Astronomy and 14 years for Physics.

It is apparent from Figures 1 and 2 that, after an extended period of relatively stable student numbers in Physics 1 and 2, in the past few years (i.e. since 2008) we have seen a sharp growth in numbers, which in session 2011-12 have been maintained approximately at the level of 2010-11. The School is not seeking to further increase our Level 1 numbers, as any such increase would place severe strain upon our infrastructure and resources. However, we are very keen to consolidate these numbers at the increased level we have recently achieved, as well as further boosting the proportion of our Level 1 classes who proceed to Honours and Masters programmes in our School.[15]

[15] As is explained in more detail in Section 3.6, the focus of a recent Teaching Committee Working Party was to seek to increase our retention of students within the School.

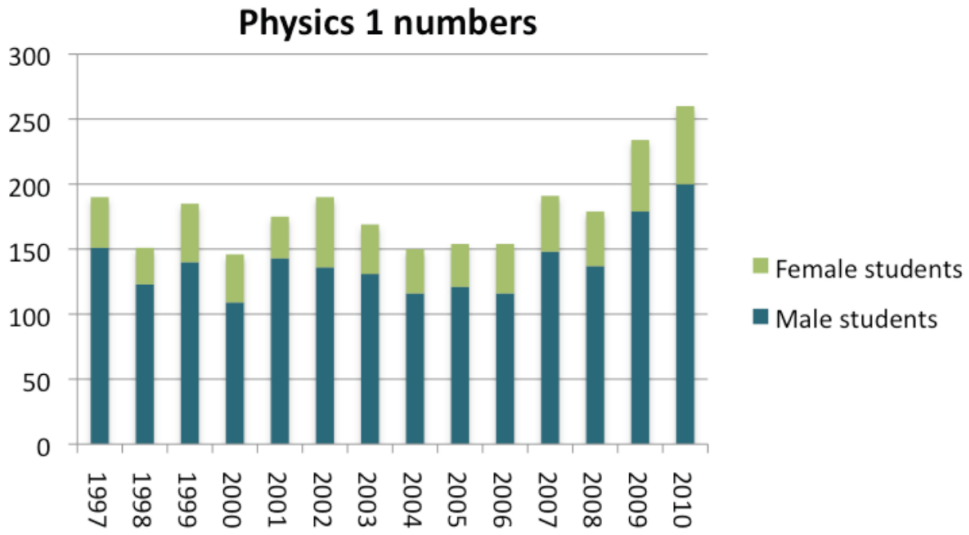

Figure 1: Historical record of the size of the Physics 1 class

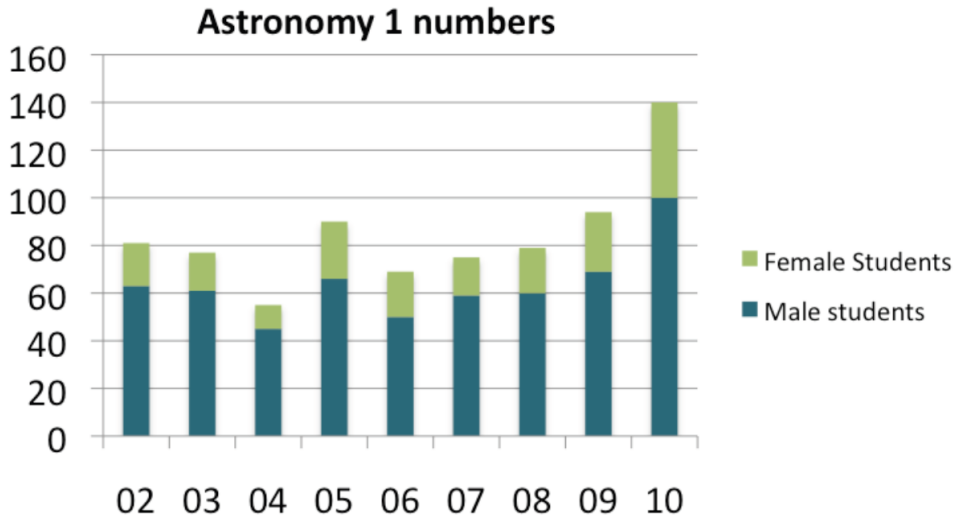

Figure 2: Historical record of the size of the Astronomy 1 class

We believe that there are a number of possible factors which may have influenced this welcome and very positive change in our undergraduate student recruitment:

- From our extensive engagement with physics pupils and teachers and with the general public, through the wide range of outreach activities described in Section 3.5.1, it is apparent to us that Physics and Astronomy have achieved a significantly greater public profile in the past few years, through the publicity for projects such as the LHC and the growing presence of high-profile physicists (e.g. Prof Brian Cox, Prof Jim Al'Khalili) in the media. It seems likely that the entire field across the UK is benefitting from this increased exposure.
- In difficult economic times the field of Physics may also be benefitting from the perception (which, based on recent IoP studies, is entirely correct!) that a degree in Physics or a related discipline has a significant positive impact on employment prospects.

- The recent increase in the volume and range of outreach activities undertaken by the School of Physics and Astronomy, including activities specifically targeted at senior high school pupils and at applicants, may in itself be impacting positively on our undergraduate recruitment. Many of these outreach activities are focussed on widening participation, particularly those undertaken by our STEMNET Ambassadors who work with a range of schools in the local area including many with traditionally low participation rates in Higher Education. The School also has an extensive track record of engagement with the University's open access programme (formerly the Department of Adult and Continuing Education), particularly in Astronomy.
- Our recent strong performance in the National Student Survey (see Section 3.7) and other similar barometers, as well as high ranking in certain national league tables (for example we achieved 2nd place in the UK in the Times 2010 Good University Guide) is likely also to have contributed positively.
- The extensive refurbishment of our laboratory space in the Kelvin Building has created a flexible and very attractive learning environment. We use this refurbished space for the main University open days. Combined with e.g. our Common Room, which we believe continues to be a major asset for open days and visits, the attractiveness of these spaces may be helping us to persuade more applicants to come to study with us.

It can also be seen from Figures 1 and 2 that the gender split of our Level 1 classes has remained relatively stable. While the percentage of female students in Physics and Astronomy is undoubtedly low compared with many other subjects across the University, and remains lower than we would wish it to be, we note that this is a sector-wide issue for Physics and related subjects. Moreover, the analysis carried out for our Juno Champion submission (see supporting documents) found that our long-term percentages of female students were in line with the national averages (22.9% for Physics and 24.6% for Astronomy, versus a national average of 21.7%).

The demographics of our student intake remain dominated by students from Scotland, although since our last PSR we have detected a noticeable increase in the numbers of students from the rest of the UK (RUK) and from Europe. (It remains to be seen whether the recent changes to RUK student fees will impact positively or negatively on this change). Given the predicted future population trends in Scotland, and also the current economic outlook for the University sector, the School recognises the importance of seeking to recruit students from further afield – and in particular international students. The strength and range of our international research collaborative links provides an important channel for building our international student numbers.

In the past year we have focussed our efforts principally on growing our international PGT numbers. We introduced a suite of 6 M.Sc. programmes in session 2010-11 and in the first year we attracted 3 UK students to 2 of these programmes. In their second year, i.e. the current session, we have increased this number to 14 students, including 7 international students paying full fees, across all 6 programmes. The programme leader, Dr Nicolas Labrosse, has pursued a vigorous strategy for international promotion of our PGT degrees, working closely with RIO and making an extended visit to several institutions in China. A further visit to the Far East is planned for early in 2012.

3.6 Student Progression, Retention and Support

3.6.1 Description of our approach and practices

Since our last PSR the issue of retention of undergraduate students from Level 1 into Level 2 and beyond has been a significant priority for Physics and Astronomy. The remit of the Level 1 and 2 Working Party (see Section 3.3 and 3.4 above), included the specific goal of boosting retention from our core junior classes and into our B.Sc. and M.Sci. programmes, and their subsequent progression through those programmes. The recommendations of the Level 1 and 2 Working Party were essentially all relevant to this goal, and included the re-organisation our Level 1 and 2 course structure and assessment weighting already discussed in Sections 3.3 and 3.4.

In addition the Working Party made several recommendations that were focussed on enhancing the social cohesion and sense of community within our junior classes, and improving the range and quality of 'hands-on' academic support available to Level 1 and 2 students. These recommendations, all of which were subsequently implemented by the School, include:

- Increased monitoring of attendance at Level 1 and 2 classes (coordinated by a Director of Learning Support)
- Improved tracking of the destination of Level 1 and Level 2 students
- Increasing the number of Level 1 and 2 social events
- Introduction of a Field trip for Level 2 Physics students
- Enhanced programme of Physoc / Astrosoc lectures and activities
- Improved maths support for Level 1 students
- Continued adoption of tutorial-led Physics 1 lab sessions, with some streamlining of content and greater focus on presentation and communication of results
- Maintenance of online deadlines calendar for better time management
- Rescheduling of P1 lectures from 9am[16]

Level 1 and 2 students who fail to meet the Progress Requirements of the relevant degree programme regulations are considered by the Science Progress Committee in August each year. Soon after the June Exam Board meetings have taken place, a warning letter is sent out to those students who look likely to be in this category. At that stage, each student's Adviser is asked to intimate to the Chief Adviser of Studies any known circumstances which may have affected the student's ability to meet the progression requirements – in which case the warning letter can be withheld. Following the results of resit examinations, any students whose performance has improved sufficiently to escape the interest of the Progress Committee are advised accordingly. The remainder can present a case, in writing, to the committee to explain their poor performance, with or without the support of their adviser. Support from the adviser can influence the decision of the Committee. The main sanction imposed in the first instance is to reduce students to part-time study. Students who have been referred to the Progress Committee in a previous session may be excluded from further study. Students who believe they have been unfairly treated by the Progress Committee can submit an appeal to the Science Appeals Committee. Again, the support of an adviser at an appeals hearing can influence the outcome.

<u>Honours and Masters entry and progression requirements</u>

At the end of their second year Physics and Astronomy students are eligible to progress into Honours for one of our B.Sc. or M.Sci. programmes if they have satisfied the relevant College and School Honours or Integrated Masters entry criteria, which are based on their performance on qualifying courses over the first two years. The current College regulations, extracted from the 2011-12

[16] It did not prove possible to move the Physics 1 lectures to another time slot since no other subject was willing to move to 9am. Instead a second Physics 1 daily lecture at 1pm was introduced, from session 2008-09.

University Calendar, are included in the supporting documentation. The current School entry criteria can be found in the current edition of the Degree Programme Guide, which is also included in the supporting documentation. Essentially these School criteria are as follows:

- **B.Sc. Designated degrees**: normally a grade "D3" or better in the appropriate Level 2 subject(s) plus an average grade of "D3" or better in Maths 2A, 2B and 2D.
- **B.Sc. Honours degrees:** normally a grade "C3" or better in the appropriate Level 2 subject(s) plus an average grade of "D3" or better in Maths 2A, 2B and 2D.
- **M.Sci. degrees:** normally a grade "B3" or better in the appropriate Level 2 subject(s) plus an average grade of "B3" or better in Maths 2A, 2B and 2D.

The inclusion of Level 2 Maths requirements in these School criteria reflects the fact that mathematics is integral to all degree programmes in Physics and Astronomy. Indeed it is also the case that entry to Physics and Astronomy courses at Level 2 has the requirement of satisfactory performance in Mathematics at Level 1. These mathematics requirements can be problematic for weaker students who may find themselves in a position where they have met the Physics or Astronomy Level 2 or Level 3 entry requirements but not the Mathematics ones. Normally such students would be required to retake the relevant Mathematics courses in order to allow progression in Physics and/or Astronomy.

Progression from Level 3 to Level 4 of a B.Sc. Honours degree programme in Physics or Astronomy requires that students obtain an average of "D3" or better on their Level 3 courses[17]. For students enrolled on an M.Sci. programme, progression to Level 4 requires an average of "C3" or better on their Level 3 courses, while progression from Level 4 to Level 5 requires an average of "C3" or better on all courses taken during their third and fourth years.

Students who are enrolled at Level 3 on a B.Sc. Designated degree programme, due to their initial failure to meet the B.Sc. Honours entry criteria, may apply to transfer to Level 4 of the appropriate B.Sc. Honours programme provided they have obtained an average of "C3" or better on their Level 3 courses. This opportunity for transfer back to the B.Sc. Honours stream effectively means that entry to Level 4 of such a programme requires an average grade of "C3" or better at *either* Level 2 *or* at Level 3 (and preferably at both); an average "D" grade at both Levels, however, will result in exit with a B.Sc. Designated degree.

The School monitors closely the performance of all students throughout their period of study. For our Level 1 classes, for example, in addition to our Class Heads and students' Advisor of Studies, the School has recently introduced the role of Director of Learning Support (DOLS) who identifies students that have poor or deteriorating performance. The DOLS sends an invitation to such students to attend a face-to-face meeting, in order to discuss possible reasons for their poor performance and to identify and provide appropriate additional academic support. Additional "drop-in" tutorials are arranged and poorly performing students are strongly encouraged to attend these. Students may also access further help from the Student Learning Service, where Effective Learning Advisors are based. The Student Learning Service helps students adjust to a new system of much more independent learning, running drop-in workshops every week of each semester. The University also employs Campus Mathematics Advisors who provide specific mathematical support.

The close monitoring of students' progress continues at Level 3 and above. For example, M.Sci. students who obtain an average "D" grade at the end of Level 3 are written to by the Class Head (acting on behalf of the Head of School) after the June Exam Board meeting. This gives the students

[17] Students on a joint degree programme will also have to meet any progression criteria set by the other subject. In particular, for students undertaking joint Honours Physics and Astronomy they are normally required to obtain an average of D3 or better on both halves of their programme separately.

an opportunity to explain their poor performance and possibly to consider transfer to a B.Sc. degree programme[18]. Similar "safety nets" and cautionary advice provide support for B.Sc. Honours students. The GPA progression requirements for Honours degree programmes are such that students who obtain an average "E" grade nonetheless have sufficient credits and GPA to graduate with a designated degree at that point. Students are allowed to progress only if they can demonstrate better performance (an average "D" grade) in the designated degree resit examinations in August. Specifically, therefore, no students are allowed to progress to Level 4 unless they have met the requirements for a Designated degree – thus providing an appropriate safety net as insurance against a possible catastrophic performance at Level 4.

3.6.2 Evaluative statement

A key element of the School's preparations for the submission of our Juno practitioner and Champion applications was the introduction of robust procedures for the collection and monitoring of data (including gender disaggregated, but otherwise anonymous, data) on student progression at all levels. As part of our full-time academic staff complement, we employ three specialised university Teachers, one of whom has the position of Director of Learning Support (DOLS0. In conjunction with the DOLS, and with other members of the teaching and support staff, a programme of detailed undergraduate student monitoring and course/lab evaluation was initiated in session 2007-08. This programme has revealed a significant increase in the numbers of students progressing from Level 1 into Level 2 and from Level 2 into Honours/Masters levels, in both Physics and Astronomy over the past five years. This increase is very welcome – and we believe can at least in part be attributed to the various measures that were put in place from session 2008-09, in response to the recommendations of our Level 1 and 2 Working Party, as listed in the previous section. Nevertheless, the increase in our class sizes at all levels has placed considerable strain on our teaching infrastructure and therefore has required careful monitoring by Teaching Committee and the School Management Team. In 2010 TC set up a small Working Party to analyse and respond to the problems of managing large classes. Among the specific recommendations of this Working Party were new guidelines on the organisation of Honours and Masters projects and better procedures for the assignment of demonstrating staff for laboratory work. The Working Party's recommendations were approved by TC and ASC in spring 2011 and were fully implemented this session. Thus, we believe that the School has a robust and effective management framework in place for:

- promoting greater retention of students into level 2 and beyond
- capturing and monitoring accurate data on student retention and progression
- supporting students' learning and career development needs throughout their progression and integrating them fully into the School's learning community.

3.7 The Quality of Learning Opportunities

3.7.1 Description of our approach and practices

Teaching within the School of Physics and Astronomy involves a range of methods of delivery: full class lectures and tutorials, practical laboratories and projects and small group teaching (tutorials and supervisions). The mode of delivery of lectures varies within the School and encompasses a range from more traditional "chalk and talk" and acetate transparencies to the use of a visualiser

[18] Although resit examinations are strictly not relevant for Honours or M.Sci. degree programmes, in the sense that it is the first diet examination grade that carries forward to the final degree classification, students who have failed to meet the necessary Honours or M.Sci. progression requirements may undertake resits at the end of Level 3 in order to attempt to meet the progression criteria from the resit diet.

and PowerPoint slides. It is left to the individual lecturers to decide on their preferred option and many lecturers use a mixture of media. Furthermore it is customary for lecturers to discuss their mode of delivery with the class, and to seek regular feedback on whether or not the mode(s) adopted are being effective. Moreover, since our last PSR the School has seen the introduction of the moodle virtual learning environment across the University. Among its many uses and functions in support of our teaching, moodle has provided an effective and efficient platform for the management and storage of teaching resources – particularly copies or summaries of lecture notes, problems sheets, past degree exam and class test papers and their associated model answers.

Lecture material is supported at all Levels by tutorials or small group supervisions which provide opportunities for students to work at problem solving and discuss directly issues arising from the lectures. Tutors and supervisors are drawn from academics, research staff and postgraduate students. In addition practical classes are used to instill practical and experimental skills and to develop more generic graduate attributes such as communication and presentation skills and teamwork abilities. The practical classes also give students further opportunities to engage with teaching staff on a one-to-one basis.

Student feedback is obtained through a number of channels, as summarised in the QA process flow chart in Appendix 3 and the supporting documentation. At the start of each academic session, Class and Laboratory Heads hold induction sessions to run through important aspects of the course with the students. At this session, and in the course guide and via moodle communications, students are encouraged to seek help whenever they encounter a problem. Another important channel for feedback, and one which has come to prominence since our last PSR, is the National Student Survey (NSS) which is completed by students in their final year. We provide a more detailed evaluation of our NSS performance in Section 3.7.2 but we note here that engagement with the NSS is a matter which the School, and our Honours Class Heads, take very seriously – providing regular and strong encouragement to our students to complete the survey in a timely manner.

The School has two student-staff liaison committees (SSLCs): one for Level 1 and 2 courses (known as Committee II), and one for all courses above Level 2 (known as Committee I)[19]. Both committees are chaired by the Head of School and the Convenor of Learning and Teaching also reports to them on teaching matters. The committees meet at least once per semester. The minutes of meetings held in the current and last two sessions are included in the supporting documentation; these minutes are posted on the School's SSLC moodle site and are available to all staff and students. Most courses have two student representatives who are chosen by their classmates. (In the event of more than two nominations an election is held). The Students Representative Council offers class representatives training for their role. The meetings are taken seriously by the staff and actions are requested and followed up at subsequent meetings.

Student feedback on lecture courses is monitored through student questionnaires (see the accompanying documentation). Summaries of the questionnaire results from previous academic years are included in the supporting documentation. The questionnaires are scanned to obtain an electronic output of the data. The School policy is to issue questionnaires to students for all lecture courses where a lecturer is giving the course for the first time, and thenceforth every other year.

[19] This represents a small change in the organisation of our Staff-Student Liaison Committees since our last PSR; previously only Level 1 courses were considered by the first Committee. The redistribution of courses across the two Committees ensures that they are better balanced – particularly as Committee 1 now also includes our PGT programmes.

3.7.2 Evaluative statement

The range of teaching and learning methods used within the School of Physics and Astronomy are well-established and prevalent across the Higher Education sector in Physics and are thus recognised by the Physics and Astronomy community, and external bodies such as the Institute of Physics and Royal Astronomical Society, as appropriate for delivering the curriculum. In essence they are tried and tested methods with which the students are familiar – although as noted in Section 3.7.1 our teaching staff are encouraged to discuss their mode of delivery regularly with their students, seeking feedback on its effectiveness, and are always open to making changes as required. The School also makes careful use of its Student-Staff Liaison Committee meetings and course questionnaires to measure the effectiveness of its teaching and support for learning. A key part of each SSLC meeting is input from the class representatives: issues and queries raised at the meeting are usually responded to immediately by the Class Heads, Convenor of Learning and Teaching and Head of School as appropriate, with specific actions set out in the minutes. Responses to these actions are addressed under "matters arising" at the next meeting, thus ensuring that the feedback loop to students is properly closed.

The effectiveness of our provision is measured in a number of different ways, including student questionnaire responses, NSS results (see below), feedback from SSLC meetings, external examiners' reports and their comments at Board of Studies meetings, reports from our Institute of Physics accreditation panels etc. The formal assessment of our programmes provides a further measure of the effectiveness of our teaching methods against the aims and ILOs of our programmes and courses.

Student questionnaires, after the results have been scanned, are returned to the lecturers and Class Heads and to the Convenor of Learning and Teaching. The lecturer will initially view the returns noting any written feedback and general patterns which may identify problems and then consulting with the Class Head as appropriate. Feedback to the lecturers is usually provided by the Class Heads who may suggest areas of improvement. The Convenor of Learning and Teaching independently analyses the results and they are discussed by Teaching Committee as required. The data from recent questionnaires confirm that the majority of students are happy with their courses and programmes.

The NSS provides another important channel for measuring the effectiveness of our teaching provision. Indeed, given the "Faculty"-based nature of our Level 1 curriculum and our relatively small numbers of international students, it is perhaps the most robust and accurate such indicator available to us. Table 2 presents the Physics and Astronomy 2011 NSS results.

Number	Question	
1	Staff are good at explaining things.	98
2	Staff have made the subject interesting.	86
3	Staff are enthusiastic about what they are teaching.	89
4	The course is intellectually stimulating.	96
5	The criteria used in marking have been clear in advance.	86
6	Assessment arrangements and marking have been fair.	78
7	Feedback on my work has been prompt.	61
8	I have received detailed comments on my work.	61
9	Feedback on my work has helped me clarify things I did not understand.	77
10	I have received sufficient advice and support with my studies.	86
11	I have been able to contact staff when I needed to.	100
12	Good advice was available when I needed to make study choices.	82
13	The timetable works efficiently as far as my activities are concerned.	90
14	Any changes in the course or teaching have been communicated effectively.	86
15	The course is well organised and is running smoothly.	97
16	The library resources and services are good enough for my needs.	98
17	I have been able to access general IT resources when I needed to.	98
18	I have been able to access specialised equipment, facilities or rooms when I needed to.	90
19	The course has helped me present myself with confidence.	82
20	My communication skills have improved.	83
21	As a result of the course, I feel confident in tackling unfamiliar problems.	95
22	Overall, I am satisfied with the quality of the course.	93

%age agree/strongly agree

Table 2: Overview of 2011 Physics and Astronomy National Student Survey results

It is clear from Table 2 that the overall NSS performance of Physics and Astronomy continues to be strong – with the School exceeding the institution benchmark of 80% on 17 of the first 21 questions and narrowly missing the 80% target on two of the other four questions. This was one of the most consistent performances across the entire University and continues a pattern of strong achievement in the NSS over the past four years. Figure 3 presents a comparison between the 2011 NSS results for Physics and Astronomy and the Glasgow University average. We can see from this comparison that the School sits ahead of the University average on all but five questions, and is less than 4% behind the GU average on those five questions. Again, this comparison confirms and consolidates the pattern that has been seen in recent years.

Specific features of our NSS results are discussed elsewhere in this report. In the context of this section, it is particularly encouraging to see our very strong performance on “Staff are good at explaining things”, “The course is intellectually stimulating” – as well as our overall satisfaction rating of 93% for Question 22. We believe that these results, and their antecedents in previous years, provide valuable evidence in support of the high quality learning opportunities which our programmes offer.

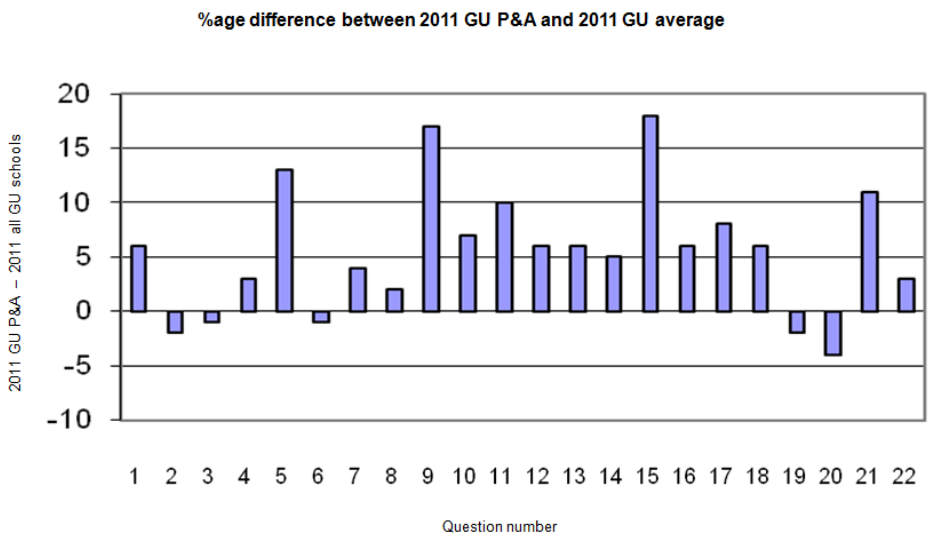

Figure 3: comparison of P&A 2011 NSS results with the 2011 GU average

A major strength of the School of Physics and Astronomy is the effectiveness of our research-teaching linkages. As discussed in Section 1.2, we are highly research-active School (one of the most successful in the University in the most recent Research Assessment Exercise, for example) but despite this (or perhaps more accurately *because* of this) our entire academic staff complement are involved in teaching and contribute very effectively to enhancing the quality of our teaching and learning environment. We comprehensively engage our students in research-led teaching in a number of ways:

- Our "Frontiers of Physics" lectures in Physics 1, that set the Level 1 curriculum in the context of the very latest cutting-edge research in which our staff are internationally leading, such as research at the Large Hadron Collider, the emergent field of Gravitational Wave Astrophysics, and advances in optics, nanotechnology and soft materials;
- Our open-ended approach to laboratory work in the junior classes, particularly in the "Experimental Tutorials" in Physics 1;
- Our Astronomy Level 2 field trip that provides students with hands-on experience using professional-level software and telescopic equipment in a dark sky observing location, supplementing and enhancing the observational experience they gain at the University Observatory as part of the mainstream Astronomy laboratory teaching;
- Our wide range of courses that feature extended project work: experimental, computational and theoretical, involving group work, research literature review and written and oral presentations and generally featuring opportunities for students to carry out original research embedded within one of our School's internationally-leading research groups;
- Our extensive programme of Astrosoc and Physoc lectures that expose our students to the latest international research presented at an accessible level;
- Our provision and promotion of opportunities for our students to carry out vacation research projects within our School, or at overseas facilities working directly with Glasgow staff and/or our research collaborators.

In session 2010-11 we re-launched a system of Peer Observation of Teaching (POT), led by Dr Peter Sneddon (one of our University Teachers) in collaboration with the Learning and Teaching Centre. Although we have thus far only adopted POT for a small subset of our lecturers – focussing in the first instance on new and less experienced teaching staff and postdocs – we intend to develop this

scheme further in session 2011-12 and beyond, as a useful adjunct to our existing teaching quality assurance mechanisms.

We believe that our School fosters a supportive environment for inducting and nurturing new staff and developing their learning and teaching, in cooperation with the University's central support structures. All new teaching staff also undertake the New Lecturer and Teacher Programme (NLTP) run by the University's Teaching and Learning Service, and in addition recently several of our early career postdocs who have a strong interest and involvement in teaching have voluntarily enrolled on the NLTP. It comprises a 2 year part-time programme leading to the award of a Postgraduate Certificate in Academic Practice. Successful completion of the programme also leads to eligibility of full membership of the Higher Education Academy (HEA). Postgraduate students who are involved with teaching in the laboratories and small group tutorials attend courses from Teaching and Learning Service at the start of the academic year. Furthermore, laboratory heads arrange induction sessions for new demonstrators for their laboratory.

3.8 Resources for Learning and Teaching

3.8.1 Staffing: description of our approach and practices

A full list of the staff associated with teaching in the School of Physics and Astronomy is provided in the accompanying documentation. The list contains academics, researchers and postgraduates. Lecturing is carried out mainly by academics, although as part of their career development some postdoctoral researchers also deliver lecture courses. Lecture course components at Levels 1 and 2 are normally given by a single lecturer. At Level 3 and above lecture courses generally comprise 18 lectures and tutorials for 10-credit courses (in Physics) and 25 lectures and tutorials or timetabled supervision sessions for 15-credit courses (in Astronomy). Some 10-credit courses are delivered by a single lecturer, although the majority are delivered as two distinct halves by two lecturers; this is also the approach adopted for the 15-credit Astronomy lecture courses.

As we noted in Section 3.7.2, new lecturing staff and University teachers undertake the New Lecturer and Teacher Programme (NLTP). Postgraduate students who are involved with teaching in the laboratories and small group tutorials attend courses from Teaching and Learning Service at the start of the academic year. Furthermore, laboratory heads arrange induction sessions for new demonstrators for their laboratory. Experienced postgraduate demonstrators often raise points about their laboratories with the Laboratory Heads.

3.8.2 Evaluative statement

As we discussed in Section 3.7.2, Physics and Astronomy is a highly research intensive School but one in which there is a clear commitment among all staff, at all levels of seniority, to the effective delivery of our curriculum. Our staff-student ratios are consistent with those of other Physics and Astronomy departments across the country. Similarly the student contact hours for our courses and programmes, which have been established and agreed by Teaching Committee after careful comparison with other UK Physics and Astronomy departments, are commensurate with their programmes – an observation which is supported by comments from our external examiners over many years.

The School operates a rotating policy so that lecturers do not, in general, lecture a course for more than 5 sessions. This is intended to encourage a fresh approach to the material from time to time. As outlined in Section 1.2.4, academic teaching duties are allocated by the School Registrar

(Personnel) in consultation with the Convenor of Learning and Teaching and the Head of School, taking into account the School workload model. The workload model is described in the supporting documentation and covers staff commitments in teaching, research and administration.

Technical staff support teaching mainly through laboratory and IT work. There is a technician associated with each laboratory in Physics for Levels 1 to 3. At the University observatory one technician has overall responsibility for the Astronomy teaching laboratory, with further assistance provided at Levels 2 and above as required. Research group technicians assist with project work in Levels 4 and 5.

As we already noted in Section 3.7.2, we believe that the School of Physics and Astronomy fosters a supportive environment for the induction and nurturing of new staff and development of their learning and teaching, in cooperation with the University's central support structures. New lecturing staff and University teachers are assigned a mentor, from among the senior professors in the School, who meets regularly with the new staff member to discuss their progress and assist with planning their early career development. A major focus of these meetings is a review of teaching goals. Mentors will generally seek to support wherever possible innovative ideas and approaches developed by new staff (in liaison with the Convenor of Learning and Teaching as required).

3.8.3 Teaching and learning resources: description of our approach and practices

As described in Section 1.2.6, Lectures for most classes in Physics and Astronomy are held in the Kelvin Building, based on allocations made by Central Room Bookings. Small group teaching and supervisions generally take place in staff offices, although some small teaching rooms and conference rooms, as well some 'break out' flexible space in the refurbished Physics labs, are also available.

Currently the School has around 150 desktop PCs in three computer clusters in the Kelvin Building and one cluster at the Observatory, whilst further PCs are located in the Physics honours laboratory. The School also maintains a library within the Kelvin Building that includes a wide range of textbooks and monographs, as well as journals spanning many fields of physics and astronomy. An extensive library of astronomical textbooks, bequeathed to the School by a former graduate student, is also housed at the Observatory. The School makes extensive use of technology in support of student learning. Some specific recent examples are listed in the next section.

Financial resources for teaching and learning are allocated by the Head of School, in the light of discussions with the School Management Team. Each year teaching funds within the School are allocated to laboratory heads at the start of the session for maintenance and/or equipment purchase.

3.8.4 Evaluative statement

The School generally has access to appropriate teaching accommodation although the substantial growth in our class sizes over the past 5 years has placed considerable pressure on the lecture space available. However we have been able to alleviate these issues somewhat through making innovative use of our refurbished laboratory space in the Kelvin Building for some smaller classes.

As noted previously, the laboratories have been completely refurbished since our last PSR and now provide a flexible, modern and well-equipped workspace which we believe has significantly enhanced the student experience in the Kelvin Building. Booking of this refurbished space for other teaching functions is administered by one of our research and teaching support secretarial staff, in

conjunction with the chief laboratory technician. Despite these additional spaces having become available, the general shortage of suitable rooms for small group teaching, and for offering study space to our students, remains a matter that is raised regularly in the annual course monitoring reports completed by class heads.

Our most urgent current priority is the refurbishment of the Honours teaching wing of the University Observatory, which is no longer fit for purpose. This issue has been raised as a matter of urgency with the College Dean of Learning and Teaching and we are hopeful that progress towards the completion of the Observatory refurbishment will be made before the start of next session.

We believe that the School provides excellent IT facilities to students, although maintaining the hardware at an appropriately modern specification presents an ongoing logistical and financial challenge – particularly in view of the significant recent increase in the numbers of B.Sc., M.Sci. and M.Sc. students undertaking extended projects work. To alleviate the pressure on our desktop machines, and in recognition of the flexible working practices which are often appropriate for project work, our recent practice has been to make a laptop available to our M.Sci. students, and now also to the M.Sc. cohort. Wireless access is also provided throughout the Kelvin Building and access codes are made available via moodle to students at all Levels. Our students also particularly appreciate the free printing facilities which we make available to them via the cluster computers.

As noted in the previous section, in recent years the School has made increasing use of technology in the support of student learning, with specific examples that include:

- The use of PSR handsets for “pop quiz” formative assessment in lectures;
- The use of moodle for the management of teaching material, and as a discussion forum for e.g. supervision groups and group projects;
- The introduction of a film project strand to the Honours Physics group project course;
- Piloting the use of the “peerwise” software environment to stimulate peer-to-peer learning and formative feedback;
- Piloting the use of “Turnitin” software as a formative tool for educating students on the issue of plagiarism in report writing;
- Audio podcasting of lectures at all levels, combined with a “tagging” scheme to assist students with post-lecture review and revision.

4. Maintaining the Standards of Awards

The maintenance of the standards of awards and the assurance and enhancement of quality are closely linked and these issues are collectively discussed in Sections 4 and 5. A diagram showing the interlinking of all the participants in these processes is effectively a summary of the quality assurance in the School of Physics and Astronomy and this is presented in Appendix 3. This diagram is relevant to the issues discussed in both Sections.

As was discussed in Section 3, responsibility for the design, approval, monitoring and review of our programmes resides with the School of Physics and Astronomy Teaching Committee, chaired by the Convenor of Learning and Teaching. The benchmarking of our programmes against the appropriate SCQF descriptors is an important part of the internal University processes for approving our programmes, via the STPC (and now College) Board of Studies.

The IoP Accreditation process, most recently undertaken by Physics and Astronomy in 2008, also provides a crucial external validation of the maintenance of standards within our programmes. As well as assessing the content of our programmes and their calibration against subject benchmark statements, a key element of the IoP Accreditation process is an evaluation of the robustness and

quality of our assessment procedures – as evidenced by historical data on the grade profiles of our courses and the degree classifications of our graduating students. As is the case with every other subject in the University, a crucial component in the maintenance of high standards in these procedures is the input which the School receives from its external examiners.
In the School of Physics and Astronomy there are four external examiners responsible for monitoring our assessment processes and the maintenance and enhancement of the standards of our awards. For Session 2011-12 these examiners are:

- *Non-Honours Physics (i.e. Levels 1 and 2):*
  Dr Norval Strachan (University of Aberdeen)
- *Honours Physics*
  Professor Steve Lloyd (Queen Mary College, University of London)
- *Undergraduate Astronomy*
  Professor Derek Ward-Thompson (University of Cardiff)
- *PGT Programmes*
  Professor Douglas Heggie (University of Edinburgh)[20]

In addition the School of Physics and Astronomy adopts stringent internal procedures for control of assessment, as detailed below.

In ensuring that standards are maintained in the Junior classes the School has a member of staff who acts as internal checker for the examination papers. The job of the checker is to vet the papers prior to their dispatch to the external examiners. Once the comments are received from the external examiners, Class Heads liaise with the question setters to finalise the papers. Meetings with the examiner are held after the December, April/May and August diets of examinations. The same procedure is followed for Astronomy degree examinations at all Levels.

The honours examination checking in Physics has even more quality assurance steps. The first step involves setters and checkers for each lecture course being assigned from among the academic staff. Once this checking procedure has been completed, a moderator for each examination paper then assesses the overall level and standard of the paper and feeds back any proposed changes to the setters and the Honours Physics Examination Committee. Drafts of the papers, in the correct format, are then prepared by the moderators and sent to the external examiner. A meeting of the Honours Physics Examination Committee with the external examiner is held in the School around the middle of February. This meeting involves, in addition to the external examiner, the committee chair and secretary together with the paper moderators. Each paper is scrutinised at this meeting and modifications agreed for moderators to discuss with the setters. After these changes have been made the final versions of the papers are prepared for the April/May examination diet.

After the examination, marking is carried out based on a rigorously prescribed procedure, or marking scheme. From Session 2010-11, and following discussion with the external examiners, all markers are now required to complete a short pro forma providing commentary on the question(s) they have marked. This commentary should include an assessment of any perceived anomalies in the distribution of marks, and any gross imbalance in the number of attempts at each question in cases where a choice of questions was available. The commentary should also indicate any remedial action which the marker intends to take when teaching the course the next time. Marked papers are then checked by the Class Heads (moderators for Honours Physics exams) and rechecked by another member of staff. Combination of exam and continuous assessment marks is then carried out by Class Heads (Honours Physics Exam Committee secretary) and random checks are carried out by an independent member of staff. In all cases the University's Code of Assessment is adhered to

[20] Prof Heggie has indicated that he wishes to end his appointment as external examiner and the search for a replacement examiner for our PGT programmes is currently underway.

strictly for the conversion of numerical marks into 22-pt scale grades, the weighted combination of 22-pt scale grades for different assessment components within a given course, and the aggregation of grades – based on a credit weighted average – to determine final degree classifications.

As previously discussed in Section 3.3, the meetings with the external examiners at which grades and awards for courses and degree programmes are finalised, are extremely important. At the external examiners meetings the current year's grade profiles are studied, and compared to previous year's results. Any issues with particular lecture courses or assessments are discussed and investigated if discrepancies are noted. For final year students, the honours external examiners consider students at grade boundaries and also a small, random subset of students may be invited to attend a short oral examination for calibration purposes. Additionally representatives from other Subjects/Schools attend the honours exam meeting to finalise awards for joint degrees. In the following session the Exam Committees report back to the Teaching Committee, which considers any remedial actions (e.g. possible changes to the teaching staff, syllabus or assessment components of courses) that may be appropriate.

5. Assuring and Enhancing Quality

A diagrammatic summary of the quality assurance processes involving the School of Physics and Astronomy is given in Appendix 3. It is clear from this diagram that the maintenance and assurance of quality is multi-faceted and provides many opportunities for feedback and input from all participants involved in teaching and learning.

Once the examination procedures described in Section 4 have been completed, external examiners' reports are returned to Senate and passed on to the School for consideration by the Teaching Committee and the relevant Exam Boards and Class Heads. This provides one level of input for the Annual Course Monitoring Reports (ACMRs) that are completed for all undergraduate courses taught within the University. Class heads are responsible for preparing these reports, with emphasis on providing feedback at all Levels and undertaking a comparison of the most recent cohort of students with those from previous years. Explanations for any anomalies in grade profiles are required.

In the School of Physics and Astronomy, it is policy for the ACMRs to be returned to the Convenor of Learning and Teaching who scrutinises all the reports and then works with the School Quality Assurance Officer to produce a summary report for the School. This is made available to all staff within the School and is fed back to the College Learning and Teaching Committee and the College Committee of School Quality Assurance Officers. Any major issues or recommendations arising from these reports are discussed at Teaching Committee and may also be discussed at subsequent Student-Staff Liaison Committees, and if necessary the Academic Staff Committee. Copies of these recent summary ACMRs from the last few years are included in the supporting documentation.

The School's mechanisms for gathering and acting upon student feedback have been considered in section 3. Mainly these comprise the SSLCs and course questionnaire returns, although the NSS and other national barometers are now providing other significant channels for feedback. The School has introduced a range of mechanisms for responding to our NSS results – from formal discussion at the following Teaching Committee and SSLC meetings, to informal focus groups with recent graduates. These have been very instructive in probing more deeply the views expressed in the NSS responses and identifying possible actions that will address concerns raised.

Whilst informal feedback – gathered throughout the semesters via interactions between lecturers and tutors and their students – is extremely important, we find that the SSLC meetings provide the more effective means for identifying significant actions. The minutes of the SSLCs show that actions

by class and lab heads to address student concerns are required and therefore the procedures are transparent to the students and feedback loops are seen to be closed. Minutes of the SSLCs are published on the SSLC moodle sites soon after the relevant meetings and are then available to all students.

In the case of student questionnaires there is evidence that students are less than discerning in these returns; as shown in the accompanying documentation, questionnaire results do not discriminate well between different course components. When one considers how many of these questionnaires students are asked to complete in a session it is perhaps not surprising that students appear to suffer some “fatigue” in answering the questions. However these returns can be useful in that written comments may highlight a problem not brought up by other means.

Enhancement of the student learning experience within the School of Physics and Astronomy is evident from a number of standpoints that have been discussed earlier in this report. Here we briefly emphasise the strong research activity of the School, enhancing graduate attributes and our innovative approaches to interactive learning.

The P1 class is supported by an on-line tutorial system developed by Addison Wesley publishers known as "Mastering Physics". 1.5 hours of weekly tutorial problems are selected by the lecturers and the students responses are automatically marked by the system, providing immediate formative feedback. The sophisticated parser interprets full algebraic answers and assists the weaker students by providing optional hints. Prizes are awarded to the top performing students in the year.

Students entering degree programmes in Physics and Astronomy do so in a School that was one of the most successful in the University in the 2008 Research Assessment Exercise. The fact that the teaching and learning experience of students takes place in a strong research environment becomes very apparent to the students, especially those in honours courses. While this enhances undergraduate teaching it also provides students with an indication of the future research opportunities in their subject as they encounter it as a science that is continually developing and evolving. The School has an excellent record of attracting its students into postgraduate research. This is partly attributable to its strong encouragement of summer placement work and the strong research flavour of the projects undertaken in the final years of the undergraduate degrees. An annual undergraduate and PGT research fair is held in the School each year which is principally intended to attract final year students to consider the possibilities of a postgraduate research degree. Honours students not in their final year are also encouraged to attend this research fair to discuss summer research work with the various research groups; such summer placements may be supported by the School itself, or by various external bodies such as the Carnegie Trust, the Royal Society of Edinburgh or the Nuffield Foundation.

In recent years the University has identified employability training as a significant priority, in accordance with the recent enhancement theme that seeks to better develop and embed graduate attributes within our undergraduate and PGT programmes. In the School of Physics and Astronomy we continue to provide a number of components within our Honours courses that deal explicitly with this enhancement theme. For level 3 students, in collaboration with representatives from local industry, we run a three-day “Skills Revolution” workshop as part of the Honours Physics laboratory course. The aims of this workshop are:

- To apply logical analysis to problem solving
- To learn the key to successful teamwork
- To gain exposure to business type problems
- To interact informatively with industrialists
- To think seriously about employment prospects upon graduation

These aims are achieved though problem-solving sessions and team exercises together with presentations from external speakers. The workshop concludes with a "Question Time" style question and answer session with a panel of experts.

Final year students in our degree programmes are asked to prepare CVs within the supervision sessions. A representative from the Careers Service gives a presentation to the class to raise awareness of the resources available to students in the University in preparation for job applications; these activities are coordinated by one of our academic staff (currently Dr Giles Hammond) who is responsible for Careers Liaison. The Careers Service also acts as a conduit for summer placement advertising for industry.

6. Summary of Perceived Strengths and Areas for Improvement

To be completed.