The Science Education System in Oxford and the UK

David Andrews
Outline of this talk

• High school education (brief)
• Undergraduate education
  – Oxford Physics
  – Other sciences at Oxford
  – Other universities
• Postgraduate education
  – Masters
  – PhD
I shall mostly talk about England + Wales + Northern Ireland.

Scotland has a slightly different education system.
Brief outline of school education in UK

• Age ~5: start formal education
• Age ~ 15-16: major **national examinations**: General Certificate of Secondary Education (**GCSE**)  
  - Core subjects: English, Mathematics, Science (may be split into 1-3 sciences)  
  - Languages (e.g. French, German)  
  - Technology  
  - Computing  
  - Humanities (History, Geography, Religious Studies…)  
  - Many other possibilities
• GCSE: The best students may take 10-12 subjects.
• Some students leave school after GCSEs.
• Academically-able ones stay on to study for 2 more years.
• Age ~ 16-17: major national examinations: **AS Levels**. Students may take 3-5 specialist subjects.
• Age ~ 17-18: major national examinations: **A Levels**. Student typically focus on 3-4 of their AS subjects, in greater depth.
• [Alternative: vocational qualifications.]
University requirements for Undergraduate study

• Most universities require passes in **3 subjects** at A Level.

• If the student wishes to study a **science** subject at University, they will usually need to have A Levels in **relevant science subjects**:
  
  – e.g. for a University *Physics* course, A Levels in *Physics* and *Mathematics* + *one other* science or other subject.
University Terms

• Most UK Universities have 3 terms, 8-10 weeks long:
  – Autumn Term (in October-December)
  – Spring Term (in January-March)
  – Summer Term (in April-June)

• There is a ‘Long Vacation’ between July and September.
Oxford University Requirements

• Usually, 3 top ("A") grades at A Level. (Other major universities, e.g. Cambridge, London, have similar requirements.)

Oxford University Terms are only 8 weeks long, so are highly intensive. Students are expected to do revision and preparation during the vacations.
Oxford Physics Department

About 180-190 Physics undergraduates each year
Physics Undergraduate Degree Courses at Oxford University

• There are two undergraduate degrees:
  – **4-year MPhys** (Master of Physics): mainly for those who wish to continue in Physics, technology, science teaching, etc, after graduating.
  – **3-year BA** (Bachelors degree): mainly for those who wish to move into a different area after graduating.

• The courses are identical for the first 2½ years.
The main structure of the Oxford Physics course

Four main teaching elements:

1. Lectures: ~ 10-12 per week.

For presenting the basic subject material to all 180 students in the year group.
2. Laboratory Practicals: 6 hours per week. Students work in pairs and in each of the labs:
- General Physics (Mechanics)
- Optics
- Electronics
- Computing

- In later years, more specialised labs as well:
  • Condensed Matter, Astrophysics, Nuclear Physics, Atmospheric Physics, etc.
3. Tutorials (in small groups: 2-3 students taught by a senior academic, or postdoctoral researcher): 2 per week. Students do assignments each week, which are marked by, and discussed with, the tutor. (This system is unique to Oxford and Cambridge.)

4. Classes: 6-8 students with a tutor, mainly for revision of material learned earlier, or for specialist instruction in advanced subjects.
# A typical First-Year student’s week

<table>
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<tr>
<th>Monday</th>
<th>9 a.m.</th>
<th>10 a.m.</th>
<th>11 a.m.</th>
<th>12 noon</th>
<th>Afternoon</th>
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<td>Electromagnetism</td>
<td>Vectors and Matrices</td>
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<td>Tutorials</td>
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<td>Electromagnetism</td>
<td>Waves</td>
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<td>Wednesday</td>
<td>Waves</td>
<td>Vector Calculus</td>
<td>Computing</td>
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<td>Thursday</td>
<td>Vector Calculus</td>
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<td>Practical laboratory work</td>
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<td>Friday</td>
<td>Classical Mechanics</td>
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Year-by-year progression

Year 1: Foundation

- Basic Physics and Mathematics principles:
  - Classical Mechanics, Special Relativity, Electromagnetism, Optics, Waves, Calculus, Vectors, Differential Equations, etc.

- 4 examination papers at the end of the year.
Year 2: Core material

• Topics common to many areas of Physics:
  – More advanced Mathematics, Quantum Mechanics, Thermal Physics, Further Optics, Further Electromagnetism, etc.

• A choice of short options in a variety of specialist subjects

• 3 examination papers
Year 3: More advanced topics

- Atomic, Nuclear and Particle Physics
- Condensed Matter Physics
- Astrophysics and **Atmospheric Physics**
  [includes Climate Physics and Fluid Dynamics]

- Short options
- 3 examination papers
- For 3-year students: a short research project or essay instead of 1 paper.
Year 4: Advanced options

- Students choose two **advanced subjects** (e.g. Particle Physics, Atmospheric/Oceanic Physics, Astrophysics, ...) and attend lectures and classes.
- 2 examination papers.
- Students spend about 8-10 weeks working on a **research project** with one of the Department’s research groups, and writing a report on it.
MPhys and BA Degree Classifications

- **First Class**: obtained by top ~ 35% of students
- **Upper Second Class**: obtained by ~ 50% of students
- **Lower Second Class**: obtained by ~ 12% of students
- **Third Class**: obtained by ~ 3% of students

(The examinations are partly assessed by an external examiner from another university.)
Other Science Subjects at Oxford

- Laboratory-based subjects (e.g. Chemistry, Engineering, Biochemistry) are similar to Physics in structure, with small variations:
  - E.g. the 4th year in Chemistry is entirely devoted to a research project.

- Some subjects (e.g. Earth Sciences, Biological Sciences) may also have a substantial Fieldwork element.

- Mathematics has no laboratory work....
Joint Subjects

• A few students take a combination of subjects, e.g.
  – Physics and Philosophy
  – Mathematics and Philosophy
  – Engineering, Economics and Management.

• These are usually very difficult!
Other UK Universities

Cambridge
[I was a student there]

Reading
[Has a famous Meteorology Department]

Others with Atmospheric, Oceanic or Planetary Sciences:

- Imperial College London
- East Anglia
- Leeds
- Edinburgh
- Open University
- Southampton
- Exeter
- ...

About 100 universities in total
Other UK Universities

• Science courses are broadly similar in structure to those at Oxford, but
  – No (or very few) small-group tutorials, except at Cambridge
  – Courses are often more varied, with a larger choice of options and less ‘core’ material.
  – Often the courses have a more ‘applied’ emphasis

• The 3-year/4-year Physics degree structure is similar at most other universities.

• Scotland: some courses are 1 year longer.
Post-Graduate degrees

Some standard UK models:

- Taught 1-year Masters degree
- Or 2-year Masters, partly taught and partly research
- 3-4 year PhD degree, mostly research

There is a wide variety, according to subject and university.
Post-graduate degrees in Oxford Physics

• Currently has only a DPhil (= PhD) degree, mostly devoted to research (but with some taught material in the first year).

• UK funding agencies currently provide student grants (for UK students only) for 3, 3½ or 4 years (confusing!)

• But probably moving towards 4 years.
Supervision of PhD students

• Every student has a main supervisor, based in Oxford: a senior academic Faculty member.

• May also have a second supervisor from outside Oxford, if working on a joint project.

• Will also have a postdoctoral ‘advisor’ from within the research group.

• Will usually have a lot of informal support from other students and postdocs in the research group.
A typical time line for a PhD student

- Year 1: probationary status
  - Takes some taught courses, and does examinations
  - Starts on research project, e.g. writes literature review, project outline, maybe obtains some preliminary results
  - Writes a 20 to 30 page report
  - Has a review with 2 academic staff at the end of the year.
  - If all is going well, is allowed to continue to second year.
• Year 2:
  – Mostly spent on full-time research.
  – Probably attends some national conferences/workshops, to present results.
  – May start writing papers with supervisor.
  – Writes a 30-50 page report.
  – Again is reviewed by 2 academic staff at the end of the year.
• Years 3 - 4:
  – Heavily engaged in research
  – May write papers
  – Writes thesis
  – Attends conferences

• Most students submit their theses after about 3 – 3½ years.
• Maximum thesis length: 250 pages.
PhD examination

• This is an *oral* exam: two examiners (1 from the department, 1 from another university) read the thesis, and then have a *private discussion* with the student to discuss the thesis work.

• This discussion usually lasts 2-3 hours.

• The examiners write a report, and make a recommendation.

• Possible outcomes:
  - Only minor revisions to thesis (⇒ pass)
  - Major revisions (⇒ new exam)
  - Award of lower degree (MSc)
  - Failure (very rare)
Application process for Oxford DPhil (= PhD)

• See
  www.ox.ac.uk/admissions/postgraduate_courses/apply/index.html

• For Atmospheric, Oceanic and Planetary Physics:
  www.atm.ox.ac.uk/main/Graduates/index.html
  (or ask me!)

• But there are very few Oxford funding sources for overseas students – usually have to find their own funding.

• AOPP has about 25 DPhil students at any time, of which about 8 are from overseas.
Other Subjects and other UK Universities

• Until recently the PhD system has been very similar in most subjects and at most universities

• But...
A new concept:  
**Doctoral Training Centres**

- The funding agencies have recently started setting these up in different universities, in areas of particular scientific interest and importance, e.g.
  - Physical Sciences students moving into Life Sciences
  - Energy Science
  - Complexity Science
  - Neuroscience
  - Chemical Biology

- Funding is provided for perhaps 12-20 students and for additional teaching faculty.

- Students do 1 year of intensive course work and projects.

- They then do a 3-year PhD.
Master’s Courses

• There is a huge variety in the UK.
• Many are for training students to move into a specialised area:
  – E.g. training Physics and Mathematics students in Atmospheric Sciences (Reading University has MSc courses of this type.)
• These equip students for moving on to a PhD, or for working in Government laboratories, etc.
The Bologna Process

• There are plans to coordinate undergraduate and graduate education across Europe:
  – To allow easier comparison of qualifications.
  – To make it easier for students and staff to transfer between countries.

• Proposed progression:
  3 years for BA/BSc
  ⇒ 2 years Masters degree
  ⇒ 3 years PhD

The UK system in most sciences does not currently fit this model.
The End