October 25, 2006
To: Steve Ellis, David Boulware, Blayne Heckel
From: Oscar Vilches
Re: Changes to Curriculum

Dear Steve, David, Blayne:

Yesterday I chatted with Blayne about the proposed changes to the Physics Major's curriculum. I have been thinking about this for quite some time, but more intensely since the faculty meeting. I am not sure I'll be able to go to the next curriculum special faculty meeting since I have an experiment in France, leaving Nov. 29 and returning Dec. 10.

First, and as I said at the meeting, I am very happy to see a real effort to think about what a modern physics undergraduate major should look like. Second, I hope work done by all members of the committee does not go for naught. It is this second point that worries me.

Reading carefully all the syllabi proposed and through the course name changes, my impression is that 90% of the intention of the document could be done within the existing courses scheme, so no undue effort has to be done to redefine the major. We can ask for more courses, and on this there is a fair amount of wiggle room in our program. For example, one requirement is now "two courses of upper division physics or cognate subjects", which amounts to six credits minimum. Another possible target is the "nine credits of science electives not in physics or mathematics" which makes for a well rounded physicist but one who doesn't have much physics knowledge….

So here is a proposal that keeps the current "numbering" and order, but alters some of the contents. I also have a comment on the "tracks" issue being floated. I think that rather than a BA track and a BS track we should recognize and formalize the present division of interests and knowledge by instituting a BS degree in Physics and a BS degree in Applied Physics. I believe we have a "de facto" applied physics program with students who do all the electronics, computer interfacing, optics, and senior labs, plus Phys 315. This, of course, should be thought further, but it is in place.

Regarding keeping the current numbering but altering the contents, here is a possible blueprint.

a) First Year. Decide what to do with Phys 12X immediately. This will decide what is left for the rest. My rough idea is to follow the "standard texts" for calculus based physics (not Knight's book order!!!), with first quarter Mechanics through angular momentum (no special relativity), second quarter Classical Thermo and Electricity and Magnetism (do both DC and AC circuits in the lab using a well defined sequence of experiments, use the thermo labs from Phys 118, drop from Phys 12Z the quasi-tutorials done with computers, drop some of the Gauss' law and Ampere's law applications from lecture, do not include Statistical Physics in this course, not enough time), third quarter Waves with a shorter section on interference and diffraction, leave geometrical optics almost entirely for lab in favor of adding more modern physics, perhaps special relativity.

Credits: 15 in Physics, 15 in Math 12X or equivalent)

b) Second Year. The Math Phys series, with Mechanics at end, is already set. (6 credits without Phys 229, 9 credits if Phys 229 is made mandatory or prerequisite for advanced courses)

The major problems are Phys 224 and 225. I propose we keep both courses with the same number but alter their content.

Phys 224. With the elementary thermo (three chapters or so) done in Phys 122, Phys 224 can start with a very fast review of the first and second laws assuming students know (or can learn) about pressure, density and temperature. Then plunge into probability, Maxwell distribution, ensembles, etc… introducing entropy from the statistical point of view, free energy and very simple problems like the ideal gas, the classical solid, and problems with classical statistics. The Reif book from the Berkeley series still is an excellent book, which could be supplemented with some topics from thee introductory physics text which most students will have or can read in the library. I mentioned to Blayne that I will be willing to work alone or with others on making a new Phys 224 course, and teach it one time per year for the next few years. (3 credits)

Phys 225. This course can be redesigned along the lines of the "Quantum I" course proposed by the Curriculum Committee, perhaps not going so advanced, but to be discussed. I think that this can be sold to other Departments as a "need to get to more current topics faster than starting from the beginning". One has to keep in mind though that not all students taking these classes are physics majors, and one can not expect that students will have the benefit of taking Phys 227. Said in other words, this course and Phys 224 are still courses for a more general audience, but that should be useful to students in engineering, earth and space science, or other majors who will need some quantum concepts to do applied solid state physics. (3 credits)

Phys 334. Stays as is (except for updates). (3 credits)

Phys 231. Becomes mandatory for majors. It is mandatory for minors now, so the only problem is scheduling it often enough (twice a year, like Phys 334, seems sufficient). (3 credits)

Phys 232. Becomes mandatory for majors, and prerequisite for some other classes. Needs to be scheduled twice a year. (3 credits)

Students need to take Math 308 and 324 this year (6 credits). Phys 227, 228 should be offered twice a year for out of phase students.

TRACKS: I would offer two degrees from here on, 1) BS in Physics and 2) BS in Applied Physics (not a BA in Physics). See comment on (2) at end.

Third Year and Fourth Year BS. I would retain the current courses as they are, with two quarters of E and M mandatory and a third optional quarter (8 credits mandatory). I would make one quarter of Quantum mandatory for a BS in Physics (4 credits). With the updated Phys 225 one could upgrade or add to the content of Phys 324.

I would retain the current requirement of two optional labs in addition to Phys 334. I would retain the current course numbering and general theme, including E and M in its present location. Course contents can be updated, but more important is to define the requirements for the major. Of course some of the courses proposed by the Curriculum Committee are great, the issue is "what is mandatory and what is not". We should keep the possibility of the double major with Astronomy alive and well. Look at the Advising report from last year (that I wrote) to see what a large fraction of our majors are double majors with either Astronomy or with an aggregate of Math, Applied Math, Applied Math and Computational Science, Computer Science, and Statistics.

Solid State Physics in the third year, seemed "out of place to me", but I have not thought much about it. I think we should have some requirement like "two 400-level physics courses from the list below" added to our requirements.

The BS in Applied Physics. I think it should be possible to obtain a degree in applied physics from our department. We could include here requirements like:

1. First two years common with BS in Physics.

2. Make Phys 315 mandatory and increase its credits to 4 or 5, with one more lecture or tutorial, so it can be used for applications of quantum, see below.

3. In addition to Phys 334, mandatory 335 and 434 (updated) and two more labs out of Phys 331, 431, 432 and 433.

4. First Quarter of E and M, or better a new one quarter course on E and M (five credits), which addresses the conversion from integral to differential Maxwell equations (if not done in Phys 227/8), and applied electromagnetic waves. I taught a course like this out of Portis' book for the evening MS class, but it can be done with Griffith's book too. Some sophisticated detector physics and/or applied superconductivity could be included.

5. Special topics, applied research project completed (?).

6. Electives out of 300 and 400 level courses (so students with the Applied Physics degree "could" take some of the courses now taken by double majors, or even double major with Physics BS!)

A Reply from Larry Yaffe (11/4/06):

Oscar's email (of Oct. 25) offers quite a few thoughtful comments. Here's my take on some of his points:

· He says he hopes that all the work done by the committee doesn't go for naught, and worries that it may. So do I!

· He says that much of the proposed syllabus could be done within the existing course scheme, to minimize the effort of redefining the major. I think his estimate of 90% (of our proposal that could fit within the existing course scheme) is too high. But more importantly, I think that trying to shoehorn our proposed changes into the existing setup is simply a mistake. I believe it is in our department's self-interest to present (to students, and to the Dean) the envisioned changes as an overhaul of our curriculum, and not as incremental evolution. As noted above, I also think it is worth going through the hassle of renaming/renumbering, once, in order to end up with something which is logically coherent (and might at least encourage students to take things in the proper order).

· Oscar notes the "wiggle room" in our requirements of "two upper division physics or cognates" and "nine credits of related science", just as I did above. We are going to have to trim these requirements if we want to require more of our proposed core curriculum.

· Oscar envisions more modest changes in the 12X course content that we have. I really think we can use a Moore-style selection of material (trimming old stuff and adding new). Implementing structural changes that get students to come to class having read material in advance is a big part of this. However, it may be necessary to have four (big) class meetings per week, instead of three.

· Oscar notes that the current 224 and 225 are taken by both physics and non-physics majors. The envisioned replacement for 225, Quantum I, would have 227 as a pre-requisite, unlike the current 225. That means we will lose some non-physics students taking the current 225. So be it. I don't see this are a reason to keep a separate watered-down 200-level modern physics course (unless it is replacing some of the general physics offerings).

· I think Oscar's suggestion of a B.S. in Applied Physics (not a B.A. in Physics) is something we should consider seriously.