

**Physics Program
University of La Verne**

**External Review Report
10/5/2002**

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1 Introduction

This report describes the outside reviewer's observations concerning the Physics Program at ULV. Section 2 contains an executive summary. Sections 3 contains a more detailed report, and section 4 contains some suggestions and general comments.

2 Executive Summary

The ULV Physics Program is a small but growing enterprise with excellent faculty and a small but devoted group of students. The Physics Program is housed in the Department of Mathematics, Physics and Computer Science, and shares space with these and other programs in a single building. During my visit on 9/25/2002 I met with students, faculty, and administrators and formed a favorable impression of the Physics Program. The first section of this report, the *Executive Summary*, summarizes in about one page the observations I made during the visit and from reading the Physics Program's self-study document prior to arriving on campus.

2.1 Goals and Objectives of the Physics Program

The goals and objectives of the Physics Program at the University of LaVerne, as described in the Physics Program's self-study, are consistent with those of physics programs at other high-quality undergraduate colleges. Overall most of the *five-year goals* seem to be attainable and the *specific objectives* seem to provide a road map to achieving the goals. The *resources needed* mostly involve faculty time, but some other resources such as space and funding are also mentioned.

2.2 Personnel

Student comments during my visit were unusually positive. Comments of colleagues were also very positive, and a strong sense of community among the faculty in the Department of Math, Physics, and Computer Science was apparent. The Physics Program is staffed by two faculty, unusual at small colleges which offer a physics major. There is currently no technical support staff associated with the Physics Program.

2.3 Students

The students in the Physics Program seem to have a positive attitude and are devoted to the Physics Program. There does not seem to be a sense of community among the students, and it is possible that the upper-division courses, often taught as independent studies, are below critical mass.

2.4 Facilities

The Physics Program is housed in space that is attractive and well maintained, but is also quite cramped. This may lead to inefficiencies if enrollments grow.

2.5 Equipment and equipment budgets

The Physics Program has enjoyed fairly dramatic increases in equipment expenditures during the past few years due to lab fees. The equipment budget appears to be adequate in the long term, but there is a backlog of equipment needs that will take some years to address at current spending levels. Insufficient quantities of certain lab equipment leads to inefficient use of faculty time.

2.6 Curriculum

The physics curriculum at ULV with mostly within the mainstream for small college physics programs, but there two courses that are usually part of the curriculum are missing: advanced laboratory and differential equations.

2.7 Faculty workload

The faculty in the Physics Program are clearly working very hard on teaching and on building up their program. Small enrollments leading to offering courses as independent studies and insufficient quantities of some equipment consumes faculty time. This will slow improvements in the Physics Program that can lead to growth.

2.8 Summary

The Physics Program is staffed by very dedicated and capable faculty who are working very hard to build their program. The physics curriculum overall is competitive with physics curricula at other high-quality undergraduate colleges, although a couple of adjustments already under consideration might improve the curriculum further. The Physics Program appears to be experiencing a renaissance, and the addition of modest resources might speed the improvements substantially.

3 More Detailed Report

This section of the report contains a more detailed analysis of the issues raised in the Executive Summary.

3.1 Goals and Objectives of the Physics Program

The goals and objectives of the Physics Program as described in the program's self-study document are well within the mainstream for small-college physics programs and seem directed at increasing the size of the program. Overall most of the *five-year goals* seem to

be attainable, although it is not clear that the addition of Astrophysics, Math Methods, and Special Topics courses would be possible without an increase in staffing. Overall the *specific objectives* seem to provide a road map to achieving most of the goals. The *resources needed* mostly involve faculty time, but also some other resources such as space and funding. Additional staffing is not mentioned in the list of necessary resources, but if the Physics Program achieves some of its five-year goals additional staffing may become a priority.

3.2 Faculty and Staffing

The ULV Physics Program has grown in recent years, first from one to one and a half faculty, and then from one and a half to two permanent faculty. In addition, adjuncts are hired to staff some introductory courses in physical science and astronomy. This is an unusually small staff. The majority of small college physics programs that offer a major have three or more permanent faculty members. Most but certainly not all small college physics programs have part-time technical support.

3.2.1 Quality of Teaching

I spoke to five students at some length during my visit. The students included two senior physics majors, two life science students, and a non-science student. These students had nothing but praise for both Dr. Johnson and Dr. Chappell. In fact, the students were in some cases effusive. Students commented that Dr. Johnson “extended herself” to help them in all kinds of ways that they felt were above and beyond the call of duty. Students reported that Dr. Chappell was “fun in lab,” not an easy thing to be.

It is difficult to know from a one-day visit whether the opinions of these students are representative, but if so student reaction to both Dr. Johnson and Dr. Chappell could be described as unusually positive. I was impressed with Dr. Johnson’s toy radio-controlled car collection for intro mechanics and I may buy a couple for use in my classes. I was impressed with Dr. Chappell’s efforts to incorporate an off-campus observatory into his teaching and will suggest consideration of this approach to our astronomer.

3.2.2 Quality of Research/professional development

Both faculty are well published in their fields. Dr. Chappell is beginning to interact with an observatory off campus and this could lead to student projects. Dr. Johnson is maintaining contacts with the particle physics community. It may be difficult in the long term for the faculty to continue participating in research if they have to continue teaching classes as independent studies. And yet it is important to undergraduate physics programs that at least some (but not necessarily all) of the faculty are well enough connected with current physics/astronomy research to offer students significant research projects. Ideally these projects can lead to publications and/or presentations at undergraduate conferences. Both faculty have been able to attract modest internal and external funding for their professional work while at ULV, but overall external funding is not thus far an area of strength for the Physics Program.

3.2.3 Distribution of expertise

It is difficult to have a wide range of expertise within a two-member program. Dr. Sarah Johnson is an experimental particle physicist and Dr. David Chappell is an astronomer. For a two-person program these would seem to be good choices: these two fields do a pretty good job of covering some of the most exciting areas of physics and particularly those which interest many students the most. In the event that a third faculty member could be hired, it would be very valuable to bring in someone who can do small-scale experiments on campus that involve students. This could be a biophysicist, solid state physicist, someone working in non-linear dynamics, etc. This would round out the program nicely.

3.2.4 Faculty Workloads

The faculty workloads are heavy. In addition to teaching, the physics faculty have to serve as their own technicians and are forced to teach some courses without compensation due to low enrollments. Additional inefficiencies result from limited equipment inventories. The addition of part-time technical support might make a large difference. At my institution the Physics Department was without technical support for some years. The arrival of our combination secretary and technician a few years ago has enabled the faculty to spend more time on teaching, research with students, and external grants. In general modern teaching equipment is too complex to fix on-site and is simply shipped off for repair. As a result, the technician need not be highly skilled. Many of the typical duties require only a high school education.

3.3 Facilities and Equipment

3.3.1 Facilities

The principle physics laboratory is a rather nice facility. It is attractive, well designed, and seems to be well computerized. The faculty offices are adequate and the student study room is rather nice.

While the facilities that the Physics Program has are good, the amount of space may prove to be inadequate as the program continues to grow. In particular, the lower-division courses may soon outgrow the lab. There are plans to convert the outer section of Dr. Johnson's office to a research space for student projects. This would be a very positive addition to the Physics Program. In general the Physics Program at LaVerne operates in fewer square feet of space than I have seen at other small undergraduate college physics departments or programs. All of the space the Physics Program now controls seems to be used efficiently.

3.3.2 Equipment

Lower division: The physics laboratories have modern equipment, but probably not enough of it. In particular the lab lacks complete classroom sets of a number of items. Unfortunately faculty now have to rotate students through lab exercises because of this, with different groups doing different experiments on the same day. I have had to do this myself a few times in the past, and it generally seems to reduce the quality of the course. In particular the need to rotate students through experiments makes it difficult to tie lecture and lab together, and students in this situation sometimes find the lab to be disconnected from the class. Moreover, it causes a lot of work for faculty who then have to explain multiple experiments and prepare multiple experiments each week. When possible, it is in my experience best to buy a classroom set of one piece of equipment then move on to another rather than gradually building up inventories of all items. This way the classroom sets contain identical equipment and this avoids complications in the lab (*e.g.*, each group using a slightly different oscilloscope).

Upper-division: As discussed in the curriculum section, the absence of a senior lab course is the most unusual aspect of the major. The Physics Program recently purchased an educational X-Ray apparatus (I hope your faculty have better luck than we've had with the same model). In addition, Dr. Chappell is resurrecting equipment from the now-defunct Optical Engineering program. If Dr. Chappell can add an astrophysics experiment, these three areas could provide a basis for a senior lab course.

Equipment Budgets: The equipment budget has increased due to laboratory fees paid by students, currently \$100. The budget for equipment over the past few years has fluctuated, but on average is comparable to other small departments that I am familiar with. The equipment budget seems adequate in the long-term. However, there is a backlog of equipment needs that will take some years to address at current spending rates.

3.4 Curriculum

3.4.1 Programs

The ULV Physics Department offers a B.A. and a B.S. These differ by only four credits of elective physics courses. With two exceptions (see below) the structure of the major and number of requirements is on the high side but well within the usual range, and the syllabi that I read suggest the breadth and level of the courses is appropriate. The textbooks for the intro courses and the upper division courses are at the appropriate level and are in fact widely used at high-quality undergraduate colleges.

3.4.2 Lower-division

The calculus and algebra based courses are currently taught together with an extra meeting for the students in the calculus-based course. This is not ideal since the approach to the material and problem solving is usually different in these courses. But in the absence of sufficient enrollments and staffing, this may be the necessary. The students I

spoke with did not object to this approach, but hopefully the addition of engineering physics as a requirement for the math major will increase enrollments enough to allow separation of the courses.

One student I spoke with had taken the MCAT and did well on the physical sciences portion. She felt the algebra-based physics courses had prepared her well. Of course this is only a small amount of anecdotal evidence, but it reinforces my belief that the physics courses offered at ULV are appropriate, well structured, and well taught.

3.4.3 Upper-Division and Majors Courses

The physics majors I spoke with identified the small class sizes as a positive aspect of their experience at ULV. Two students felt that the optimal class size was about 4-5. Unfortunately the faculty are forced by low enrollments to offer some upper-division courses as independent studies. The physics majors' opinion of independent studies was not as good. They felt that it is more difficult to learn without a study partner, and they have nowhere to turn other than the teacher when they get stuck on a problem. Students I have spoken to at my institution and elsewhere have expressed similar views.

3.4.4 Example Exams

I read exams from algebra-based general physics, analytical mechanics, EM, and quantum mechanics. These exams are similar in scope and difficulty to those given at other high-quality undergraduate colleges.

3.4.5 Senior Lab

The absence of a senior lab course is the most unusual aspect of the major. I know of no other physics BA/BS without some sort of senior lab experience. Dr. Johnson and Dr. Chappell are well aware of this problem and are on top of it. There are many models for senior lab courses, some project-based and may connect with faculty research, others rely more on traditional laboratory exercises. Some occupy as much as four semesters (usually at one credit per semester) while others are compressed into one semester (often three credits). Constructing a senior lab from scratch would probably be a fun and rewarding project for Dr. Johnson and Dr. Chappell.

Adding 3-4 credit senior lab to the physics requirements without removing any others would put the number of physics credits required for a B.A./B.S. somewhat higher than typical at small colleges, but still not outside of the mainstream. Perhaps the number of physics electives could be reduced to offset the increase.

3.4.6 Differential Equations

Most, but certainly not all, physics majors require differential equations. This is perhaps a bigger concern in the BS program than in the BA program. The faculty might wish to consider requiring DE for the BS in physics.

3.4.7 Minimum Major

In general the minimum physics major is in my opinion probably not adequate preparation for graduate study in physics, but that is usual at small colleges that are not science oriented. For example, the same can be said of the physics curriculum at my institution. Moreover, some very highly ranked and well-known undergraduate colleges have physics programs with fewer specific course requirements. Even so, it might be helpful to put a statement in the catalog noting that students wishing to continue with graduate study in physics should go beyond the minimum requirements.

4 General Comments and Suggestions

4.1 Enrollments

During the visit it was made clear by a number of people that small enrollments are a central issue in the Physics Program at ULV. It is clear that the faculty are working hard on this problem. The first *objective* in the Physics Program Review (self-study) is to increase the number of majors from 1-2 per year to 2-3 per year within five years. I will offer a few observations and suggestions, but each institution is unique and these suggestions may or may not work at ULV in particular.

4.1.1 Engineering 3-2 Program

A 3-2 engineering program can attract students to physics and mathematics in much the way that premed programs attract students to chemistry and biology. It seems to be a common situation at smaller colleges that students recruited to a 3-2 engineering program find that they like the physics and/or math programs, and most end up staying to complete a BA/BS at the small college.

4.1.2 Student Community

The senior physics majors could not tell me the names of any younger physics majors. In fact, they were not sure whether there were any younger physics majors! [There are at least two.] While the faculty are the most important role models in an academic institution, it is helpful if the younger majors get to know the more senior majors. This fosters a sense of community that can help with both recruitment and retention. An active physics club is perhaps the easiest and most enjoyable route to a community of students. Activities such as astronomy field trips overnight, picnics, etc can attract majors and potential majors as well as encouraging current majors to complete the program.

4.1.3 Visibility

I asked several students about the perception of the Physics Program on the campus. They said that most students are not aware that there is a Physics Program. Again, an active physics club that holds popular events can increase the visibility of the Physics Program on campus and even off campus. The Physics Program Review lists as a specific objective the improvement of the Physics Program web page. This would increase the visibility of the program.

4.1.4 Intro courses

If it is possible to build multiple entryways into the major (multiple courses without prerequisites) students may be able to give it a go without committing too much. Some may decide to major. This may or may not work at ULV.

4.1.5 Cooperation with other programs

Cross-listing of courses and allowing courses in physics to count toward a math or computer science major would invite some students to at least try out physics. In particular, if the electronics course in Computer Science and the electronics course in Physics can be combined and centered in Physics, it is possible that a few students would decide to either major in physics or at least take a few physics courses.

4.1.6 Minor

The physics web page has a link that has the title “Physics Courses offered for the Physics Major or Minor,” but I can find no other information about the minor. If the minor does exist or can be established this may help to boost enrollments. In particular, students training for secondary teaching careers can be advised that a major in chemistry or math with a minor in physics will make the more employable.

5 Concluding Remarks

The physics faculty at the University of LaVerne are excellent teachers, well-published scholars, and are clearly very devoted. The physics curriculum overall is competitive with physics curricula at other high-quality undergraduate colleges, but changes already under consideration might improve the Physics Program further. The faculty are accomplishing a great deal with limited resources and in a short time and they are clearly thinking about strategies for growing their program. I can see very little chance that the program will do anything but improve further and grow nicely in the coming years. The on-going renaissance in the Physics Program might be accelerated with modest additional funding.