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FGSA Survey on Physics Graduate Education

Our survey consisted of 13 questions which were mainly inspired by the mission statement of the Task Force. The survey was sent to the members of FGSA (~1000 people, mostly graduate students, some postdocs, and others). We received about 50 responses, all from current graduate students, a few of whom are in applied math programs but work closely with physics departments. We might have had a larger response rate if we had given a multiple choice survey or asked fewer questions, but we felt that the way we wrote the survey would elicit more in-depth responses, since the participants did not have any word limitations, and we would hear from the people who feel most strongly about these issues, since they would have to make an effort to answer the questions. Since there were so many questions, we asked the participants to answer whichever questions they felt most strongly about, and many people did not answer every question. However, each question did have at least ~20 responses.

In this report, I summarize the responses we received, each number corresponding to a numbered question in the survey. I am also attaching a document with more raw data—quotes from each participant answering each question, omitting students' names and institutions. I also have the original emails of the surveys from all of the participants, but it is probably not necessary to provide them to the Task Force. We hope this report is helpful in guiding the improvement of physics graduate education and thank you for consulting us, the physics graduate students.

1. We asked the students which undergraduate courses they think should have been required as part of their physics major. The most common answers were more physics courses, math courses, laboratory courses, and computer courses.

Specifically mentioned courses include:

physics: optics, theory of lasers, electronics lab, solid state, Lagrangian and Hamiltonian mechanics, special relativity, analog and digital electronics, 2 semesters quantum mechanics, condensed matter, introductory astrophysics

math: complex variables, fourier analysis, linear algebra, ODE's, PDE's, probability, group theory, differential geometry, mathematical methods for physicists

computers: computational physics, numerical techniques, C++ programming

other: technical writing, philosophy, history of physics, data/error analysis

Some specific suggestions were:

- Offer a survey course to introduce physics majors to different areas of research, such as visiting laboratories and having professors tell the students about their research.
- Early undergraduate education should teach physics majors to think like physicists, not just regurgitate equations the way engineers and pre-meds are

taught. From the beginning, material should be taught in an advanced way, teaching the math first, if necessary. Students shouldn't learn equations that they will learn to derive in seconds a few months later.

- There should be more levels of physics courses to make them more accessible to non-physics majors so that there would be better general physics understanding in society.
 - Fundamentals of physics should be taught conceptually first, so that students are not just crunching numbers.
 - Every student, regardless of major, should learn a little bit about practicing physicists, what they do, their political activities, their influence on history, and the relationship of their work with research, political, and industrial communities.
2. We asked which undergraduate courses in other disciplines would have been helpful to their careers. Here, many students mentioned math, computer programming, chemistry, and writing courses.

Specifically mentioned were:

Math: statistics, differential equations, modern algebra (group theory), linear algebra, vector analysis, complex analysis.

Computer: programming in C/C++, fortran, matlab, and mathematica, LabVIEW training, linux, computer math and modeling

Other sciences: general, organic, and physical chemistry, chemistry laboratories, biology, geology (geophysics), solid state device and electronics engineering, cybernetics

Other: machine shop, a business course on how to write grants, philosophy of science, survey course of new interdisciplinary physics courses (such as biophysics, nanoscience, semiconductors), a one semester course on how to find a job in your chosen field, science writing, public speaking

3. We asked about the distributional courses required in graduate school. Many schools require students in condensed matter specialties to take 2 courses in high energy or computational physics, and vice versa. Most students found these useful, as long as they were kept general and didn't add too many hours to their workloads. Some students were interested in taking the distributional requirements outside of the physics department, for example, in engineering or math departments. Some students said the breadth courses made colloquia more understandable and helped in their research. Other students said the professors taught at too specialized a level to make the course of general interest or take too much time away from research. One student suggested including a policy or writing class in the distributional requirements. Another student expressed interest in being able to simultaneously get a degree in another department, such as biology for a biophysicist or materials science for a condensed matter physicist.
4. We asked if the students had taken any "distance learning" graduate courses by internet or videoconference. The majority said no, and they weren't interested

- because they value the student teacher interaction, which they felt would be missing. Some students thought it could be a good option for a specialized course that is not taught often. Another advantage mentioned is that it allows one to be more flexible with time. One student said they might try it if it cost less than a regular course, since they would get less out of it. Another said just reading a book is better. In general, it did not seem to be an extremely desirable option.
5. We asked the students the typical number of years it takes to get a Ph.D. in physics and whether they thought this was reasonable or not. The students gave a very consistent answer of typically 5-6 years, with a lowest value of 4 and an upper limit of 8-9. Most students found 5-6 years reasonable, but not 8-9, especially considering the low salary, the lack of retirement investments, the need to pay off student loans, and the difficulty of having children in graduate school. In order to keep students on track to a reasonable graduation time, students suggested meeting on a regular basis with their advisor and getting honest advice from advisors and committee members. They also suggested that professors should encourage their colleagues not to hold on to grad students for too long and that the department should have short-term deadlines to help keep students on track.
 6. We asked the students how and where they learn professional ethics and how effective this method is. The majority of responses were that ethics are learned at home, at a young age, and they can't be taught in a formal course. Most students said they learn ethics from their advisor and other scientists they work with, mostly by example. Other ways students learn ethics are by the news media, at conferences, in high school / undergrad, at home, by the university honor code. A few students had a seminar or workshop on ethics in graduate school. Some students mentioned the APS (a session at the 2003 March Meeting, the ethics column in APS news), seminars at REU programs, reading Nature and Science (they mention the role of authorship and other ethical issues). Some students thought an occasional meeting to discuss ethics issues could be helpful. One student mentioned a useful seminar system in which once or twice a year one of the faculty leads a discussion about ethics in science based on case studies or examples taken from current events. One student suggested establishing an ethics committee to handle situations as they arise.
 7. We asked what are basic rights of graduate students and how could they be protected. We listed examples such as salary, healthcare, leave of absence, ability to retake exams, freedom from harassment, and intellectual property rights (IPR). Almost all students agreed that all those listed are very important. A few students suggested graduate student unions as a means to securing and protecting rights, as well as establishing national standards with regard to salaries and benefits. One student thought that lobbying of departments/universities by APS, as opposed to unions, could be helpful. Many students expressed concern about their low salaries and meager and expensive healthcare, especially with regard to having children. Students wanted less expensive healthcare (especially family plans),

and vision and dental plans included. Many students said the salaries were abysmal, especially considering that they work 14 hour days and don't get much vacation. Some students suggested that graduate students should get similar benefits that staff members get, including vacation and the ability to invest in an IRA through the university. A few students were very concerned with IPR, saying that some physicists falsely attribute some students' work as their own. One student suggested that these rights should be set forth by the university, but if not, the department should ensure them. A few students mentioned access to affordable housing, a guarantee of when paychecks will arrive, parking availability, and general respect for graduate students. As a way to enforce rights of research assistants, one student suggested specifically requiring these rights in research grants. Travel grants are also an issue, many students are not able to attend conferences due to lack of funding.

8. We asked about the teaching training that graduate students receive and what should be expected of them. Most students are Teaching Assistants (TA's) for at least one year, and received training in one class or a series of classes/workshops on teaching. Most students agreed that teaching experience and training is important. A few students thought their teaching assignments were too many hours or teaching loads were unequal. One successful training method mentioned was that a video tape is made of the student's lecture, and then a professor and a teaching expert review it with the student. This is repeated halfway through the semester. A program that was specifically mentioned is the DELTA program, part of an NSF-funded CIRTTL program whose mission is to improve teaching across the science, engineering, and math disciplines, bringing together grad students, faculty, and staff to discuss issues in teaching at the college level (including curriculum development, teaching methods, assessment methods, diversity in the classroom, and creating effective learning communities). One student suggested that physics grad students should get some teaching experience by teaching part-time in local schools and helping the community at the same time. Many students expressed interest in getting more training as teachers. One student suggested that TA's should be trained to recognize good and bad communication strategies, in a classroom or during a presentation.
9. We asked how many conferences they go to and which ones. The most popular answers were 0 or 1-2, with a few individuals going to more (up to 5). A few students mentioned lack of funding as a reason they don't go to any/more conferences. Other than major conferences, some students go to conferences at local universities and program/grant review meetings and also attend summer schools. A few students mentioned conferences in Europe.

Conferences specifically mentioned include:

- **APS:** March and April meetings, APS Division of Laser Science, DAMOP, DPP, DFD, CAM (this is a conference organized by FGSA), Pacific Coast Gravitational Meeting

- **Non APS:** IEEE Applied Superconductivity Conference, Optical Society of America, CLEO, BNL, AIAA student conference, Biophysical Society Meeting, ACS, Society on Industrial and Applied Mathematics Dynamical Systems, Dynamics Days, AVS symposium, Physical Electronics Conference, Gordon Conference, AAS, AGU, Texas Symposium on Relativistic Astrophysics, Guillermo Haro Conference, QCMC, SPIE, HUGS2000 summer school, Penn State NSF center, UTB Center for Gravitational Wave Astronomy, MRS, AAPM, Quantum information and quantum control conference, SIAM, Sherwood Fusion Theory meeting

10. We asked the students if building a community in the physics department is important to them and how their department succeeds or fails at this. The vast majority said that a sense of community is important. Some students said that the lack of a grad-student lounge and the de-centralized locations of offices or buildings made it difficult to build a community. One student complained that there is an unhealthy competition among graduate students and between students and advisors. One student cited difficulty in getting along among faculty as a detriment to the community. Students who were not as interested in the department building a community said they create their own by studying with others. Aside from the department, at some schools a grad student senate or undergraduate group (AIAA student chapter) is a source of community-building activities. Some students complained that there is not enough interaction between students and professors. One student mentioned that their department is good at building a social community but not an academic one, citing quality of speakers, lack of a regular group of audience members, and lack of encouragement of talks by students as detriments. One student said that a sense of community in the department provides a professional and personal support system and allows everyone to communicate and work through problems. Other suggestions included allocating more money for grad student activities, holding events just for women, holding events for both astronomy and physics together, encouraging more communication with foreign students.

Specifically mentioned ways in which the departments build a community:

- Annual department-wide social events (labor day picnic, holiday party, Halloween decorating party)
- Department-sponsored student-only events (free pizza and beer, ski trip, dept. facilitates by allowing students to buy tickets from grad coordinator, softball team, barbeque's, bar nights)
- Weekly / Daily tea and cookies for faculty and students
- Weekly departmental colloquia, informal seminars
- Informal gatherings to celebrate department members' successes
- Providing resources (grad-student lounge, department library, student machine shop, grad-student association)
- Having staff and faculty who care about the students
- Professors hold parties at their houses for students

11. We asked the students where they get career advice and for what career tracks and how this could be improved. Many cited their advisors and other scientists, especially for academic career track advice. Many cited the internet, where they searched for alternative science careers. Some students also looked to their peers who were graduating. Many students felt pressure to stay in academia.

Sources mentioned:

- People: department head, advisors, professors, post-docs, graduating students, peers
- Internet
- Preparing Future Faculty (for teaching at small liberal arts college)
- School of engineering holds panel discussions about being an engineering faculty member
- University holds periodic workshops on careers in academia and industry (not specific to science)
- Cornell has a new program to facilitate career development for all scientists
- Publications/statistics from AIP/APS
- APS March meeting (2004) panel discussion on Alternative Careers in Science
- Department invites people from industry and national labs to talk about their research and what their jobs are like

Ways to improve:

- Create a contact database of physicists doing alternative careers
- Provide research experience to undergrad physics majors
- Department brings in speakers from outside of academia, forum/panel discussion about careers
- Admit that some grad-students go into industry and let them be open about it
- Teach how to write grants
- APS should give more advice on CV's and resumes aimed at different employers (academic, government, industry) and how to sell the same skills in different ways.
- A seminar course where invited speakers talk about their jobs

12. We asked about special issues foreign students face and how the transition to American universities can be eased. Many non-foreigners cited difficulties of foreign students speaking English as a major barrier to communication and integration into the community. Some foreign students said the department should be more flexible with course requirements, since they often have already taken advanced courses as undergrads. It was suggested to make all the University/Departmental rules clearly spelled out for the foreign students, since they are often unfamiliar with rules that Americans already know about (ex. rules about grades, graduation, how to apply for health insurance, etc.). This could be

done by the grad program director holding special office hours for foreign students or having a detailed introductory briefing about “the rules”. Many students mentioned visa difficulties and Homeland Security as major issues that the APS / Universities / Physics departments need to find some way to deal with. One student wrote their congressperson about the difficulties with visas and security issues that foreign students face.

Other issues mentioned:

- Knowing how to recognize and troubleshoot credit card fraud
- Getting stuck in one’s home country for months trying to renew a visa
- Finding a job in the U.S. after grad school
- Financial support
- Writing skills, presentation skills
- Respect / equality with American grad students
- 9/11 security craze—students have to pay a fee to the university to cover surveillance of themselves
- Loneliness

13. We asked the students why they chose their departments or programs.

Reasons mentioned were:

- Quality of resources, facilities, students
- Collegial atmosphere, faculty care about students’ well-being and success, attention to individual students, satisfaction of grad students who helped in recruitment, professors and office staff seemed warm and easy to work with, department chair was encouraging, diversity, many women seemed satisfied
- Salary/fellowship value, offered research assistanceship from very beginning, cost of living
- Location (close to BNL, close to job, in preferable city, dual career issues with wife)
- Stayed at undergrad institution because of advisor, helpful to already know faculty members, ease of transition
- Size of department (large, small)
- Variety of research available, rotation system between different groups
- Interdisciplinary program (nonlinear science; projects span physics, chemistry, biology, engineering)
- Interested in research topics
- Offered Preparing Future Faculty program
- Excellence in field of study, reputation
- No subject GRE required
- Recommended by advisor at undergrad institution
- APS bulletin listed top departments and top names in field
- Access to people in industry