GUIDE TO THE PHYSICS MAJOR AT NYU

BY FELIX FEIST

I. Join the Community!

- SPS (Society of Physics Students) meetings happen every week on Thursdays at 7pm in room 1067, 726 Broadway. There is free food (not just pizza, we get the real stuff), everyone just hangs out, and sometimes there's a talk.

- Join the "NYU Physics and All Things Similar" group, it is our Physics Facebook group!

- You are *ALWAYS* free to come to room 1014, the Physics Majors Office, to hang out. We have couches, books, a microwave, a fridge, super smash bros, and lots of people. Please do respect us and clean up after you eat, though. We are here to make events and help the community, not clean up your trash.

- Our undergrad lecture series: **NOTE**: Times are TBA. Check with the Society of Physics Students for meeting times at beginning of each semester.

We try to also find professors who can work with undergraduates so that you can find research opportunities directly from these lectures.

You should be getting emails from the SPS co-presidents about events, job opportunities, SPS meetings, and more. If you're not, email Bill LePage (wlp1@nyu.edu) asking to be on the email list.

II. Resources offered by the department for majors

First, **Declare your physics major**, to get all of the benefits. It's not a permanent thing. It's literally just a field in some database that can be done and undone at a whim. You can also have more than 1 major at once. Talk first to Frank Moscatelli, the Physics Adviser, in Room 838. Then declare with *Bill LePage*, our awesome physics advisor, in room 1005C. Expect to stay for 30 minutes having had the most random and interesting conversation of your day.

Printing and **Scanning** can be done for free on the 10th floor, 726 Broadway, in the Physics Office, 1005. Use the office computers to print (there's a color printer). The scanner can ingest a whole packet of pages in one go. Don't print more than 25 pages at once unless it's off hours.

24/7 Building Access – Talk to *Jacqueline Downing*, in room 1005 – or email her at downing@nyu.edu .

Email List / Opportunities - People get jobs, internships, research opportunities, and info about community events

Advising. Prof. Frank Moscatelli is the Undergraduate Physics Adviser. Prof. Daniel Zwanziger is the Director of Undergraduate Studies. Bill LePage is the Undergraduate Coordinator. Bill tends to do schedule-related things, Prof. Zwanziger is also a physics professor so he tackles content-related questions.

This is in general an offering by NYU, not the department, but **you can see NYU's course evaluations online** at http://www.nyu.edu/cas/ceg/ . Use them to choose your classes wisely.

III. How to get started with Physics Research / Programming

Do you want to make a contribution to science? If you are interested, you can get started with research as early as freshman year or as late as junior/senior year, but don't wait until senior year because you'll need a year to actually *do* the research. You will not have the credentials for every project – many will require knowledge of computer programming or more advanced physics. Let the professor decide whether you have the right credentials, don't just give up. It can be fun to work in a lab or run physics simulations. And for better or worse, research is important for getting into physics grad school.

I was pretty afraid before I started research, thinking that I wasn't good enough. It ended up being a nice experience and a good way to get to know & work with a professor on a 1-on-1 basis. People are very friendly here, and I was able to make a (small) contribution to a question that I found interesting. Don't be afraid to shop around a bit until you find a project that you're interested in. You can also switch research projects. Just be courteous about it.

You can do research at NYU all year, and you can do it at other universities over the summer. Summer research projects at other universities are called "REUs" – research opportunities for undergraduates. These are hard to get into, while NYU research is just about asking a professor. You might want to apply to REUs if you 1. Want to study in another state / country, or 2. Are interested in a physics subject which is not researched at NYU. They also look slightly better on a resume, but it is not a big difference. The rest of this guide does not talk about REUs.

How to prepare for research:

Ask the research professor what is needed; different projects require different skills. However, many projects require computer programming. While I didn't go into research with much programming experience myself, it would have sped things up a *lot*, so I recommend having familiarity with at least one programming language first. If you can solve project Euler (PE) problems 1, 3, 5, 7, 9, 11, then I think you are ready for a research project – the rest you can learn

on the go (more on PE below). If you don't already know how to program, a good language to start with is Python, for which I can recommend a few resources:

- codecademy.com : This site starts off simple. Sometimes too simple. But they go through *almost* all of the material you might need for research, and it can be fun to earn points on the site. Try doing the exercises without looking much at the guidelines.

- Pine's Python primer : Professor David Pine wrote a Python guide for students at NYU. I think it's quite good, and could be used on its own or in addition to "codecademy," because it has important things which codecademy is missing: 1. installing python on your own computer, and 2. the scientific libraries (numpy, scipy, and matplotlib). Try this if you already have programming experience & want to shape up. If you don't, you can try this or start with codecademy. You can download it here: http://www.physics.nyu.edu/pine/Teaching.html

- projecteuler.net/archives: Project Euler has a series of mathematical questions in computer science which can be done in any logical programming language. These are fun to do and you can test your ability with them. If you can do problems 1, 3, 5, 7, 9, 11, then I think you're ready for undergraduate research – the rest you can learn on the go. If you can't, I'd recommend going through the resources above. They are overkill for PE, but they will leave you with important skills.

How to get started with research:

- Ask your past physics professors. They are usually very receptive, and even if they don't have a project you can assist with, they will be happy to encounter someone so motivated! Email them & then stop by their office, or ask after class.

- Ask Prof. Zwanziger. He can coordinate undergraduate research.

- Look up a professor on the NYU physics website to see what they work on, and email the people who are doing something interesting to you. Then email them again. Then go to their office a few times. If they tell you not to pursue them, then stop – but if you just haven't been able to really reach them yet, don't give up.

- Go to research-related events, most of which are listed on http://physics.nyu.edu/events.php . They are a good way to see what is actually happening in the department and to get a feel for what research actually *is* – although for this you might be better off just asking an undergraduate. Warning: They often use lots of prerequisite physics terminology. But you can get used to them if you go home and read about the things you didn't understand until you get it. I recommend having completed at least Physics I and II before trying to understand the material - potentially more, depending on the subject. But to each their own.

- Go to the undergraduate talks at SPS meeting. Ask Bill to get you in touch with the current SPS presidents if you have questions.

The events are divided into different research groups / topics. You may want to focus on one topic to attend regularly.

IV. Where to Study as a Physics Major

At 726 Broadway:

1014 is always open to study or hang out.

1067, when not in use for classes or meetings, is usually free.

9th floor couches / tables, in the center of the 9th floor

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In Bobst:

Group study rooms are available and usually free on the 9th floor throughout the entire East, West, and South sides. There are also rooms in LL1/2 but it's hard to get one without reserving in advance.

V. Study in another country for a semester

Wah, I'm a physics major so I have no time to study abroad – FALSE! I did it twice, once in Berlin and once in Florence (this is Felix talking). And now there are even more opportunities out there. Here's what you can do:

1. Study at one of NYU's "side campuses", which do not offer full majors: Accra, Berlin, Buenos Aires, Florence, London, Madrid, Paris, Prague, Sydney, Tel Aviv, or Washington DC

Q: They don't have lots of classes! I only see two here that I could take!

A1: Yep. I was in this situation, and I asked my physics III professor for next semester if I could take the class abroad. I turned in the homework by email, took the tests at the same time, and it didn't affect my grade at all. If you don't learn well on your own, though, this may not be for you.

A2: If you get a few students to study abroad from the same class, the department may make special accommodations. We had 3 students abroad and the department offered us someone to help take HD videos of each lecture. Talk to bill and your professor to coordinate this. It may be a lot of work.

2. Study at one of NYU's "main campuses", which have students staying for all four years: Abu Dhabi, Shanghai. Abu Dhabi is a very prestigious program that only accepts the strongest NYU candidates, but you can study abroad there without the same requirements. They have plenty of research opportunities and physics classes, which you can find at http://nyuad.nyu.edu/en/academics/undergraduate-programs/courses.html#keywords= (the classes at least)

3. Do an exchange at another school. Many other schools have study abroad programs and are happy to take students from other schools. Even NYU abroad was around 25% other university students from my experience. This will take a lot of research but you also have the most options. You can even study at a foreign school if they are in English or you speak the language.

Start deciding what you want to do at LEAST two semesters in advance and know the deadlines. Study Abroad programs have an application process.

VI. Applying to grad school

Dramatic gopher: https://www.youtube.com/watch?v=8lXdyD2Yzls

This could be a whole article on its own, but I'll just give a few tips to complement your other knowledge.

- Get to know your professors. They are willing (and usually happy) to answer your questions one-on-one and give you advice. You'll benefit a lot from it, and they will get to know you. This will help with recommendations, but I would do it even if recommendations didn't exist. You paid up to $70,000/year to study here so take advantage of it! But don't ask them questions which you can answer yourself or easily google, as you should respect their time too.

- Take the April physics GRE in your junior year. You don't have to report your scores at all, and it will let you know where you stand. Register for it in February or earlier. All (?) schools in the US require this test. Almost no schools outside the US require it.

- To study, use "Conquering the Physics GRE" and take practice tests, then review your wrong answers. It can be fun to reread past textbooks, and it helped me understand the theory at another level, but it didn't help much with this multiple choice test.

- I compiled grad school resources, including a PDF of the book I recommended on my google drive: https://drive.google.com/open?id=0B4p3AXTsrXbwYVF5T3NNdWY0bzA

It contains other multiple choice physics tests, and Griffiths textbooks as he wrote much of the Physics GRE & asks similar questions in his books. There's a lot in here, I didn't use most of it.

- I am going to Germany for grad school so I'll talk about that. The programs there are in English (same with many EU countries) and the tuition is free, as it is in the US. You don't get paid to cover your food/rent, but you also don't have to work as a TA or grader. I especially recommend the Bonn-Cologne Graduate School of Physics and Astronomy (BCGS) and the programs at LMU Munich. BCGS has an honors program with an early deadline (January 15) that offers a scholarship to support cost of living. LMU Munich is an excellent research university. There are other good programs too; you can search here:
https://www.daad.de/deutschland/studienangebote/international-programs/en/

- Ask professors in fields you are interested in which schools are good in that field. They will probably also end up giving you more advice that you didn't know you didn't know.

VII. Studying Advice

As a physics major you will have to constantly question things and think for yourself, so most of this is your own journey. Understand yourself and find out what works for you. Be patient with yourself. But I'll say a few words:

- Don't hesitate to work hard. If you feel bad for having studied a lot because other people get good grades without studying, you're defeating yourself. Maybe they can do that, but physicists who made a great contribution to science worked hard. Do what works for you, and if other people do it differently, fine. I would not have made it into my first choice school if I hadn't really tried & cared.

- Pursue your intrinsic interests. I met an inspirational professor who commented on this:

"If you're in physics, you probably have some math skills. They are in demand, and you could earn a lot of money by going into finance or big data. The reason you chose physics is because you are interested in the subject. If you let yourself be guided too much by other people's opinion of you – and by grades and prestige – you are not doing physics for the love of it anymore. Then you could go into another field and do better. So let yourself enjoy physics and don't worry about the consequences too much."

Join the community. It can help a lot to make friends who are doing what you are doing. It can make you happier.

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A PERSONAL STORY BY FELIX FEIST (the writer):

In freshman year, I did terribly. I came into college thinking I wanted to make a brilliant discovery, and I got a C and C+ in Physics I and II, and was totally disappointed with myself. I was frustrated but I didn't know how to make myself do better. I knew I cared a lot about physics and about truth, and this was the right thing for me – there wasn't anything else I would want to study, except maybe music composition, but not really. I wanted to study the fundamental laws of nature.

I was in a bad mental state for a year or two, because the things I valued about myself were seemingly gone – the ability to think and learn. I went to therapy & even took some medication for mental health issues. I kept pursuing physics, doing it my way and learning for myself. I thought I might get bad grades, but at least I was learning the laws of the universe (or something close to them). I was very honest with myself and critical with myself. I did problem sets, even though I was mostly interested in the conceptual parts – but if I can't make conclusions with the knowledge I have, what am I worth? The whole time I thought I had potential but also thought I was somehow very shitty or worthless.

My mental health got pretty bad, so I left for a year and came back. I decided to try to work with the school structure a bit more, and it was my goal to do all of the homework and do well on the tests. But when I studied, I still studied for myself: I convinced myself that I didn't have any deadlines and just read the books – at the time it was Griffiths' Electricity & Magnetism book for the most part. This worked very well. Since I was *honestly* doing it for myself to improve and learn physics, I would know very well where my understanding was lacking. I wasn't as self-conscious about being stupid or not understanding things. I read the chapters for myself, and then I did the homework for school.

Studying took a LOT of time. I read slowly and I like to understand the intricacies of the physics. I don't like to believe things are true unless I understand them so well that I could explain them to another person convincingly. I also took tangents when I got interested and I tried to derive or guess things myself because it's fun and makes you feel smart. It is hard or impossible to get through the material fast enough with this approach, and I had to compromise some of the reading. I didn't go to class at the time because I couldn't satisfactorily understand things just by listening. Maybe it was too fast but I was also intimidated by the other students and didn't think clearly.

This approach didn't work at first – I got a B- in Classical & Quantum Waves and Mathematical Physics just before taking the year off. But I continued – and also tried to promise myself that I would turn in homework – and starting with E&M and QM I got an A or A- in all of the rest of my physics classes. I think it took me a very long time to transition into the physics major, to learn how I studied well, and to make and follow goals which I set for myself, but it was definitely a life-changing experience and now I get to go to graduate school in a field which I really love.

The last thing I want to say is about "loving what you do". There's a lot of hype on the internet about finding what you love. I wasn't sure for some time, but now I *know* that I really care about physics. Still, the pursuit of what I honestly care about isn't what the world depicted it as. I'm not in bliss at every moment, and a lot of the time I still honestly think I am not good enough. Sometimes I get very frustrated and sometimes I really have to stubbornly *force* myself to do work. Once I get into it, I really like it though. Mostly, the way that I knew I really liked physics is how enthusiastic I noticed myself being whenever I talk about it or explain it to other people. Other people noticed it too, and when I wasn't sure for some time if I wanted to continue in physics it was this that made me change my mind.