

- **Brief biography (where you're from, what you're studying, etc):**

The “where I’m from” question is slightly complicated. I was born in Saudi Arabia, where much of my early childhood took place. My father is an American physician and my mother is Armenian-Lebanese. I’ve spent most of my life in northeast Pennsylvania, where my family lives currently, in a rural area close to Scranton. Every year we travel to Beirut, Lebanon (my mother’s home city) and live there for a month. My experiences living in other countries have been invaluable; they have shown me how different life is for most people outside of the USA.

I’m currently a junior majoring in physics, mathematics, and astronomy. I will have essentially finished the physics and math degrees by the end of this semester.

- **Why did you decide to come to Penn State?**

When I was applying to college, I carefully investigated the course offerings, faculty interests, and research opportunities available at each school. It rapidly became clear that Penn State’s science and engineering departments offered at least as much breadth and depth in these areas as any of the Ivy League schools to which I was applying. Indeed, since coming to Penn State I have become more impressed every year by the strength and diversity of Penn State’s faculty across the board in physics, astronomy, mathematics, and every other field of science and engineering. I was, and am, especially attracted to Penn State’s Institute for Gravitation and the Cosmos—it focuses on all of my favorite topics in physics.

I knew that I would receive a first-rate education at Penn State, but I also preferred the academic atmosphere at Penn State over that of other top schools. MIT likes to say that getting an education there is ‘like drinking from a firehose’, and by word of mouth I learned that the same is true of most Ivy League schools. They foster a hypercompetitive atmosphere in which many students are overwhelmed with the volume of coursework they must complete. This didn’t appeal to me – I wanted to go to a school where I would have the freedom to spend extra time thinking, reading, and consulting professors about specific topics that interested me. In short, I wanted to have more personal control over what I learned, instead of being limited to what was on my homework. I think that this was an accurate evaluation on my part, although I must add that Penn State has never made me feel like I’m not being worked hard enough!

Of course, a major reason why I chose Penn State in the end was that I was offered the prestigious Braddock scholarship as an incoming freshman. The deal was sealed when I and the other potential Braddock scholars were invited to tour Penn State, and I simply fell in love with the campus (and the weekly physics colloquia, complete with cookies). Penn State has met or exceeded all of my expectations, and to this day, I count coming here as one of the best decisions I have ever made.

- **I understand that you had a lot of college credits completed while in high school - can you tell me about that?**

Yes – I am “unschooled” (explained further in the following question). Instead of going to high school, I started taking college courses at a local community college (Keystone College) when I was almost 15. I

began with biology and basic algebra. I was immediately successful – in fact, I was the top student in every class I took, despite having never taken a class or done homework before in my life. After a few semesters I started taking courses in chemistry, physics, calculus, history and philosophy at the University of Scranton. Finally, before enrolling at Penn State I spent a semester at the Penn State Wilkes-Barre campus. It was very interesting to take courses from so many different schools; it allowed me to take advantage of each school's unique strengths.

Since I was of high school age, I got to take all of these college courses at a discount. By the time I was admitted to Penn State, I had almost 80 college credits under my belt. I think that most ambitious students would be better off doing the same thing – namely, skipping high school and taking college courses instead. Despite not having attended high school, I never found myself underprepared for college in any way.

Because I had completed so many courses before coming to Penn State, I've always been a few semesters ahead in terms of my course schedule. I am currently in my junior year, but I'm taking senior level electives and graduate courses.

- **What do you think your parents did differently to help you prepare so well for such a successful tenure in high school and at Penn State?**

The best thing that my parents did for me was to allow me to stay out of school and be a completely self-directed learner. Prior to enrolling in college courses at age 14, I had no formal education whatsoever. Not only had I not attended any educational institution, but I also wasn't homeschooled – that is, my parents did not set a curriculum for me or assign me homework of any sort. As far as I was aware, I wasn't expected to study anything. The choice of whether and what to learn was wholly mine. The only thing my parents did was give me unlimited access to a computer, the internet, educational video games, and books (and they happily answered any questions I had, of course).

I was always a voracious learner, and I was especially fascinated with science (starting with dinosaurs, of course). I taught myself how to read with no trouble at all. I knew, from the start, that I was responsible for what I learned and who I would become. Since learning was something that I chose to do rather than something that was pushed on me, I developed a passion for knowledge and learning that I always had trouble finding in other kids my age.

One of the most unusual things about my upbringing is that, since I live in a rather isolated area of the countryside, I essentially grew up on the Internet. And I did so at a time when it was making libraries of knowledge freely accessible to any curious person. I spent hours every day reading about science and art and communicating with artists and writers on the Internet.

Growing up on the Internet has interesting psychological effects. First of all, it makes the gender, race, and age of the user almost totally irrelevant. As a female, I think this prevented me from internalizing any gender-specific stereotypes or expectations – I assumed that I should be just as intelligent, knowledgeable, and skillful as any male my age. Secondly, being on the Internet makes you set very high standards for yourself. Instead of comparing your skills and knowledge with those of other kids in your school, you end up comparing yourself with the greatest scientists and artists in the world, or even the greatest who have ever lived. As a result, from an early age I became extremely ambitious about everything I did.

Interestingly, I had almost no experience with mathematics when I enrolled in my first college course in algebra, and yet I immediately found math to be very straightforward and easy—it's just logic after all. I've been very comfortable with mathematics ever since. I think that my experience indicates that it is unnecessary to force children to learn mathematics at an early age; if a child is interested in mathematics, she'll pick it up easily whenever she chooses to do so. If she isn't, then forcing it upon her will only make her dislike and fear it.

- **Explain the area of research you're working on, who you're working with, and your role in the research (try to explain so the general public can understand).**

My research interests lie principally in theoretical physics – especially in relativity, quantum mechanics, and quantum gravity. I am particularly interested in the role of space in general relativity (GR) and cosmology. There are several phenomena in general relativity which can be mathematically formulated in terms of the motion of space itself, and this often results in intuitively satisfying explanations for the physical effects predicted by GR. For instance, due to the expansion of the cosmos, some galaxies are moving away from us faster than light. Cosmologists say that this is compatible with the luminal speed limit of relativity because each galaxy's local space is moving with it, so the galaxy is traveling slower than light in its own space. Similarly, several physicists have established that the general-relativistic model of the gravitational field of a spherical mass – such as the Earth or a black hole – is mathematically equivalent to a model in which space is flowing and accelerating radially into the mass. In this picture, we experience gravity because space is accelerating downwards through us towards the center of the Earth, and we are prevented from accelerating with it by the Earth's surface. This is a direct physical interpretation of Einstein's principle of equivalence of gravitational and inertial acceleration.

I have seen some papers claiming that in fact, all of general relativity can be expressed in terms of the velocity and acceleration of space. If this alternative formulation of GR is indeed possible, it may give us additional insights into gravity and other relativistic effects, and could lead to a new way of incorporating GR into a theory of quantum gravity – that is, a theory of what gravity is, how it acts at the atomic and subatomic scales, and how elementary particles are structurally related to the fabric of space.

Since my interests are theoretical in nature, I have so far pursued them independently – it's not necessary for me to work with a professor until I have sufficient knowledge to express my ideas completely and with full mathematical rigor. But I do often consult professors about the issues I run into. I maintain a long list of questions and unsolved problems in physics that interest me; these are my research topics. Every summer I dedicate much of my free time to studying these problems through books and published papers.

- **What is the best/most rewarding part of studying at Penn State?**

My discussions with professors have definitely been the most rewarding part. I have had so many wonderful professors at Penn State, and every year I enjoy talking to them about their experiences in research and academia. I frequently stumble upon questions in physics or astronomy that I cannot find answers to in any textbook or paper, and very often I can get a satisfying answer – or at least learn a lot and get a nudge in the right direction – from a faculty member at Penn State. No matter what topic or

question I'm interested in, I can always find somebody (usually multiple people!) at Penn State who is very knowledgeable about it, which is one of the main reasons why I came here.

Another great thing about being a student at Penn State is the huge variety of courses. Every semester I look forward to seeing what's offered in the physics, math, and astronomy departments. And each time, there are inevitably more interesting courses than I have room for in my schedule.

- **What are your career goals/future plans?**

I want to enroll in a physics graduate school as a PhD student, and I already have a very good idea about what my thesis topic will be (as well as some alternatives if that one doesn't work out). I will probably pursue a career in academia after that. Even if I do something else, like go into industry, it will only be under the condition that I can pursue my theoretical research interests in my free time.

- **What awards have you won for academics or research? What major papers have been accepted and published by journals or science magazines? Have you traveled to do research at other universities?**

I am a recipient of the Braddock Scholarship, which is awarded to outstanding incoming freshmen in the Eberly College of Science at Penn State. I have also received the Bert Elsbach honors scholarship in physics and the Evan Pugh Scholar award. Last spring I was invited, along with a handful of other distinguished mathematics students, to attend a conference on Geometric Mechanics in Sanya, China. Additionally, when I was a high school scholar at the University of Scranton, I won first place in the university's annual Integration Bee, a calculus-based math competition.

I did some research early on with Penn State professors, but nothing in my specific field yet. I'm a coauthor on one published paper in Astrobiology, titled "Can Increased Atmospheric CO₂ Levels Trigger a Runaway Greenhouse?" by Ramirez et al.

- **What's your life like outside of the lab? What activities/interests do you participate in?**

I am an avid graphic artist and science fiction writer – in fact, these are the things that got me interested in physics in the first place. I try to draw creatures, scenes, and so forth realistically without using photographic references, and to do so I had to become an expert in things like optics, linear perspective, and anatomy. I mainly draw sci-fi and fantasy-themed subjects. For years I've also been writing a story about aliens – about how fundamentally different they could be from us in cognition, physical composition and structure, and means of evolution. I try to make the story as scientifically plausible as possible, and in order to do so I've had to learn a lot about physics, chemistry, geology, engineering, and just about everything in the natural world. In summary, my interests in art, science fiction, and science mutually inspire one another.