

Graduation Ceremony – May 13, 2021  
Department of Astronomy & Steward Observatory  
The University of Arizona

**Presentation by Professor Andrea Ghez (13:18)**

Alright, Don! I forgot about *“Terry the Tarantula.”*

Congratulations. Class of 2021.

It was just delightful to hear of each of you speak about what you've accomplished. Your passion for the topic, and your sense of community, really come through loud and clear.

It's there that that community is part of what has allowed you to work hard, persevere, and earn a degree in a field that expands our understanding of our place in the Universe.

At this moment, as you stand ready to begin your next chapter, you have a tremendous opportunity to reflect on your place in your more immediate universe.

The older I become, the more these moments in life when we can reflect on our purpose, our opportunities, and our responsibility, become much more meaningful to me. And it turns out, as I get older, I also realized that most organizations do some sort of self-reflection to lay out their strategic vision for the next five years. Every five years or so. And, early in life, we have very obvious, and common opportunities, to do the same as we graduate from high school, as we graduate from college, as we graduate from graduate school perhaps, or move on to our next job. And I'd like to suggest to you to find those opportunities for self-reflections and that that might be a useful way to think about moving forward.

We rarely understand what life holds in store for us too far in the future, but we can assess ourselves, and our contacts, along the way to understand better which roads, we want to take.

I've come to think that it's useful to ask three very specific questions on this cadence of every five years or so. And they are as follows. One, at this point in my life, what do I truly enjoy doing what are my authentic passions, what are the pursuits that I am passionate enough about to overcome the bumps in the road that are inevitable along the way? So, that's number one.

Number two: What is it that I'd like to explore that is new, that might require me to take some risks in my level of comfort, that might expand my understanding of what I enjoy in life?

And three, how can I give back? In particular, how can I help others in their journey in life. So many people help us along the way, as so many of you so wonderfully articulated just a moment ago. And so, as we become more secure in our own journey, how can we help those along their paths?

So, I thought I'd take this opportunity to share a bit about my own journey - a journey as Don noted now includes a Nobel Prize. But, I think it's useful to share that I didn't start knowing, or having any vision, that this path in astrophysics really was what I wanted to do in life.

I was very fortunate to grow up in a family that valued education. So, I never questioned that I would go to college and was strongly encouraged to pursue my passions. But, I had parents who had very different backgrounds. One was a European Jew who escaped persecution from World War II through immigration and who is highly educated and spent most of his youth in big cities, particularly Geneva. The other grew up in a tiny blue-collar town in Massachusetts, was Catholic, didn't go to college, and yet achieved much through hard work.

Their differences meant that home was a very lively place, full of passion around the things that they loved in common, and friction from differences in their background. And today, I'm quite grateful for having grown up in that household that shared that commitment to education for their children, the arts and creativity, but was really full of disagreement, as it taught me an important early lesson about being comfortable with disagreement - being comfortable with discomfort.

I was not one of those kids who knew exactly what they wanted to do but, but I can find the seeds of what led to where I am today. And for me, I would find them in three early places and again this is where you know telling the story, we can all create the story.

So, I was four years old, when the Moon landings first happened and according to family legend, I announced I wanted to be the first woman on the Moon and evidently the job is still open. But, these events led me to be very curious about the Universe, and in particular I became quite interested, or you might say obsessed, with the questions of boundaries: What are the beginning and end of time, what is the edge of the Universe? These are the questions that actually kept me up at night.

But at the same time, I also wanted to become a ballerina. I had great plans to drop out of school when I was 16. But I soon learned that I didn't have the talent for the latter and got interested in choreography but, and today I really understand that to be connected to a fundamental love that I've had all along, which is the love of a good puzzle, the love of a good mystery. Putting together the pieces is what scientists do; it's what choreographers do, and science has become my profession while dance has become my hobby.

As I headed to college, it seemed to me that solving the mysteries of the Universe was a math problem, so I began as a math major but soon learned that the language of math was far more esoteric than I liked, and it was the language of physics that resonated with me.

Today, that sounds like an easy switch but, like so many of you, there was a semester or so of complete angst about what to major in. And while that was painful and confusing, it also gave

me a tremendous opportunity to explore topics and classes, I hadn't considered before. Organic Chemistry and Philosophy are two that stick in my mind.

At the juncture that you are today, I knew that I wanted to become a scientist, but I also knew that one of my greatest fears was that of public speaking. I couldn't introduce myself without my voice shaking. So, when choosing a graduate school, I thought about the schools that would give me access to the best telescopes in the world, like The University of Arizona, but I also thought about places that would not force me to be a Teaching Assistant. I mean that's how deeply I wanted to avoid public speaking.

Caltech offered me that chance - the chance to enter graduate school as a Research Assistant, which is what I thought I wanted, and I spent the first year enjoying the rigor of classes and the excitement of a new research group. But in my second year, I was asked to give a lunchtime talk on my research project, and I shook from my head to my toes throughout the whole presentation. I mean, it was awful!

And my Ph.D. advisor insisted at that point that it would be a good idea for me to teach. So, this is exactly what I wanted to avoid, but I had gotten to the point in understanding how science is done. It really required me to learn how to speak in front of a public audience and that it wasn't just about whether or not I wanted to be a researcher versus a teacher, but that, as a scientist, this was really an important thing to do.

And actually in thinking back about the story, this is actually the interesting to me part of the story. At Caltech, the only professors at that time taught discussion sections, but I had decided that if I was going to have to teach, that I really wanted to teach freshman Physics.

At the time, I believe there were no female Physics professors there and I found that I could overcome my fears of teaching by bringing my passion or desire to encourage young women into the sciences to this activity. I had gotten to the point in my career, where there far fewer women, and I could see the importance of having teachers who look like you in the classroom. I succeeded in both convincing the powers that be to allow me to do this, but in doing so, also discovered my own passion for teaching, one that I quite frankly had not anticipated and is a lesson that I am so grateful for.

Scientifically, what brought me to graduate school was an interest in black holes and an interest in developing new techs for observing the Universe, and I joined a group that was working on new techniques for using big telescopes to overcome the blurring effects of the Earth's atmosphere. And the promise was to be able to study supermassive black holes at the centers of galaxies - active galactic galaxies in particular. But, at the time, this was the late '80s, the technology actually turned out not to be ready. It was not ready for the discovery of black holes.

So, there was an interesting moment of having to choose, again - a juncture of having to choose whether or not it was my interest in black holes that was going to determine my path or my

interest in the technical challenges. And at that juncture, I decided that it was the technology that was giving us new and different ways of understanding the Universe, and that that was a really powerful tool for making scientific discoveries. So, I stuck with the technique and looked for a new problem, and so, in fact, that's how I came to work with Don - was looking at the question of the formation of young stars and whether, or not, they formed in binary stars.

But all along, I was keeping my eye on the technology and I'm looking for the moment when it would be possible to return to this question of black holes. So, by the time I reached UCLA, the technology had just gotten to that point, and I could put in my very first proposal to look for black holes. And here, while this is the project that has been recognized this year, but I wanted to share with you that in fact the first proposal that I wrote to get time on the Keck telescope was turned down.

It was turned down because the Keck telescope was a new architecture, was segmented; people didn't believe that it could get to the diffraction limit. So, not only was there skepticism about the technology, but there was also skepticism about whether or not one would see stars at the center of the galaxy, or actually see them move, which was foundational in terms of how we were going to discover the presence of a supermassive black hole - that movie that Don referred to, and showed, was watching, but I mean you have to see the stars. Without these techniques, you can't see them, and you have to see how they move. And what's been so delightful about new technology is that not only have we been able to answer the question, and increase the evidence for the existence of a supermassive black hole by a factor of 10 million, which is a huge advance forward, we've actually found more questions than answers, and I have to say, in doing research that is one of the most gratifying parts of doing research.

I want to say that today I find doing research in the university context, particularly gratifying because it gives you the opportunity to do cutting edge research that creates new knowledge about the Universe. And at the same time, you get to create new knowledge in a completely different way through the training of the next generation of scientists.

I have to say I love my job, and while I've been a Professor for 26 years, my job is constantly evolving as I've moved from being a junior faculty to a more senior faculty.

And while my science has been very focused over this period of time on a single spot at the center of our galaxy, and what I learned from today is that we should call this, what was it, the Silver River - the Center of the Silver River. I've been looking at a point that's no wider than the width of a hair at arm's length. Our ability to see that has changed radically over the last three decades.

And, I've had to learn to go from doing my own coding to managing a large international group. I've come to love and embrace the expression that every challenge is an opportunity, and I hope many more lie ahead.

You are at the beginning of your professional lives, and you're doing so in an incredibly unusual time. I hope that this is giving you strength - a particular advantage or perspective that recent graduates before you have not had.

Take advantage of the opportunities that lie ahead, learn from the challenges that you will face, and take the time to self-reflect on where you are going along the road that lies ahead of you.

Congratulations Class of 2021 - thanks.