

1.3

INTRODUCTION TO ASTROPHYSICS

0:13–1:00

FUNDAMENTAL LAWS

I'm Janna Levin and I'm a Professor of Physics and Astronomy at Barnard College and Columbia University and I primarily study astrophysics. And astrophysics is really very much rooted in physics, the study of physical laws and how mathematics actually describes natural phenomena and laws. But it's applied to the universe as a whole, not just the things in it-- stars, galaxies, the things that we observe at very great distances-- but also space itself, space and time and how space time evolved and even how the universe began and was created.

So, astrophysics has this very beautiful setting in which to study physics, from which to study the fundamental natural laws.

In physics, there's kind of a distinction in people who work in physics between experimentalists, observers, and theorists.

1:00–2:23

PHYSICS DISCIPLINES

Experimentalists build things to try to make detections, to confirm and gather evidence. Observers will often use things like telescopes to look out into the sky and hopefully receive something from the cosmos that's new and never been seen before. And then there's theorists, such as myself, who often sit quietly with a pen and paper, maybe a computer, and use the mathematics to try to make discoveries, to talk to the observers, and maybe make suggestions for what they could look for. And then there are people who do all three and can combine all those skills.

But there's a real conversation between doing the math, making a prediction, going to the observers to make an actual observation, or building an experiment and vice versa. Sometimes there are discoveries made with telescopes that we just didn't foresee and then we have to go back to our pen and paper, back to the drawing board and figure out what did we miss and how could we not have predicted this phenomenon? And then often, it goes that way that we're trying to understand something we've seen in the world but don't yet understand.

So, astrophysics draws from a lot of different kinds of study and I actually came to realize that this was this beautiful field kind of late. I was not interested in physics when I was a student. I was not one of those kids in the basement with a chemistry lab and I didn't understand or appreciate how elegant and beautiful

2:23–3:15

MATHEMATICS

science was until much later. I wouldn't say I had a fear of mathematics but I didn't recognize how rich and beautiful it was. And it wasn't until later when I understood that mathematics gives us this kind of... it's a gift that connects us to the natural world that somehow, through mathematics, we're able to understand natural phenomena and then that's just remarkable and that it's the same wherever you are in the world and it's the same with the other side of the universe, you know, one plus one is still two.

3:15–4:35

BIG QUESTIONS

So, there's something that connects all of us there that seems really important. And when I discovered that in college, I became completely enamored of physics and math and astronomy and I started to study astrophysics. And now, I work on questions like, "How did the universe begin?" and, "How is it evolving?" and, "How many dimensions are there? Are there more than three dimensions in the universe?" and, "What's the universe made of?" because the most important questions right now seem to be bound to an attempt to understand what the universe is made of because we've realized that most of the universe is in a form of matter and energy that we've never seen before because it's literally dark. We cannot see it with our telescopes. But we know it's out there because we can see the effect it has on galaxies and on the expansion of the universe.

And so we deduced that this energy is out there and this matter is out there but, amazingly, it is nothing like any kind of matter energy we've ever seen before.

And so, it's a very big question that says, by studying

astrophysics, we're learning about the deepest underlying principles in nature that are fundamental to how the universe began and evolved.