Querying the Cosmos

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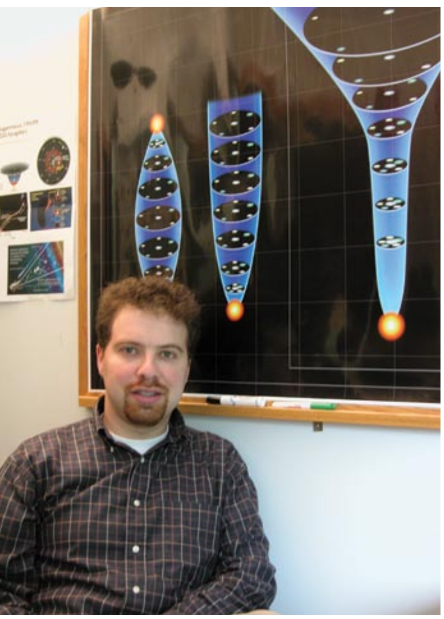

Ten years ago, when Dr. Adam Riess led a study for the High-z Team of the most distant supernovae studied to date, little did he know that he would be proving Einstein's prediction (discounted by most—including Einstein himself) that there was a mysterious anti-gravity force that not only allows the universe to expand but accelerates that expansion. For this amazing discovery, Dr. Riess and his colleagues have been awarded a number of prestigious prizes, including the Shaw Prize and Gruber Cosmology Prize. In September, Dr. Riess was named a MacArthur Fellow.

The Seed of My Career

My fascination with the cosmos started with the things my father told me when I was kid: how far away the stars were, how long it would take to get there, how everything we're seeing was actually the way the stars were in the past, and that now they might not even be there anymore. Those ideas blew my mind: I was awed by the cosmos. But I really didn't think about being an astronomer. Like most kids, I thought dinosaurs were cool and wanted to be a paleontologist.

My Path

In high school, I gravitated to physics class, which I liked very much. I went on for my undergraduate degree in physics at MIT but didn't take any astronomy courses. It wasn't until I went to graduate school at Harvard that I reconnected with astronomy. Physics is the basis of the astronomy field, but the actual work is that same awe-inspiring stuff that interested me when I was a kid. I knew right away that as an astronomer, I wanted to focus on the subfield of cosmology, the study of the universe as the whole.

My doctoral thesis was on the subject of using a certain class of exploding stars called supernovae as cosmic mile markers. Because they are so far away, they're really pictures of the universe in the past, and so they allow us to map not just space, but time as well. Because they allow us to measure changes in the size of the universe over time, we can measure the expansion rate of the universe with these exploding stars.

Cosmic Growth Charting

We've know since the days of Edwin Hubble back in 1929 that the universe is expanding. Here's an analogy. When we mark kids' heights on the door frame, we can see that they're getting bigger. We can see not only that they were at this line on this date, but also if they were having growth spurts—times when they grew quickly—or were growing more slowly. We wanted to measure that aspect: not just whether the cosmos is growing, but if it's growing faster or slower.

After grad school, I was fortunate enough to lead a study for the international High-z supernova team, making the same kind of measurements as I made for my thesis, but using the Hubble Space Telescope. With the Hubble, we were able to measure supernovae even further away, further back in time. So this data set was the first set large enough to really powerfully investigate the expansion rate of the universe.

There was a very strong expectation that the universe would not have a growth spurt. In fact, we expected that its rate of expansion would be slowing down because of the force of gravity of all the objects in the universe. We thought by measuring how much it was slowing down, we might be able to determine how much mass was in the universe and what the fate of the universe would be—if it would expand forever, or if it was slowing down so much it might actually stop expanding and re-collapse, the inverse of a Big Bang. What we found was the really shocking discovery that the universe *is* having a growth spurt. It is speeding up.

Einstein had discarded the idea of what now is called "dark energy." He called the cosmological constant the biggest blunder of his career after Hubble had shown him that the universe is expanding. But now it's most likely that we've discovered that the universe does have this phenomenon, even though we've never before witnessed it.

What's Next

I am broadly studying this whole class of possible phenomena called dark energy.

NASA, ESA, and The Hubble Heritage Team (STScI/AURA)

Supernova Remnant N 63A Menagerie. A violent and chaotic-looking mass of gas and dust is seen in this Hubble Space Telescope image of a nearby supernova remnant. Denoted N 63A, the object is the remains of a massive star that exploded, spewing its gaseous layers out into an already turbulent region.

Although its nature is not well understood, it comprises the bulk (about 70 percent) of the mass-energy of the universe. Many others are studying it, too, and NASA and the U.S. Department of Energy are planning a billion-dollar mission called the Joint Dark Energy Mission (JDEM). Most of our most powerful telescopes spend a lot of their time studying dark energy. Hubble spends a lot of time studying dark energy, and I use that a lot.

My Typical Day

I have two graduate students and a post-doctoral fellow who work with me, and I frequently spend time discussing their projects with them. One semester each year, I teach a large undergrad class called Stars and the Universe, a general introduction to astronomy and astrophysics.

I also maintain a position on the faculty of the Space Telescope Science Institute. So during the semester I'm not teaching, I work there. Right now I'm working on calibrating wide field camera 3, which is one of the instruments that astronauts will take up to put on the Hubble in 2009.

I could be at a conference where I'm presenting my results, speaking in front of other colleagues, talking with them about various possibilities, and going to other talks. I also sometimes go and make observing runs on ground-based telescopes.

If it's a really good day, I'm working on my research. I'm an observer, not a theorist. Theorists are in the predictions game; I'm in the testing predictions game. So if I'm really lucky, I'm analyzing some data I've recently collected from the Hubble and trying to test a theory or explanation of what dark energy could be.

My Advice to Students

Take any science and math course you can, and don't get discouraged if you're not the very best in those courses. Being a scientist involves many skills. Of course it requires a certain amount of science and math ability, but like a lot of things in life, it requires a balance of skills.

I can't tell you how often I hear students who say, "I love this stuff, but I'm not really a science and math person. I'm just not quite good enough" or "science and math are too hard." I think some of these people have the wrong impression—that they have to be the very smartest, get the very highest scores. I want to encourage kids to pursue what they love. Being pretty good at the science part is enough if you also have some other skills like patience, creativity, and diligence. **i**

For more about dark energy, visit the Hubble site at http://hubblesite.org/hubble_discoveries/dark_energy/

NASA, ESA, and The Hubble Heritage Team (STScI/AURA)

Gazing deep into the universe, the Hubble Space Telescope has spied a menagerie of galaxies. In taking this picture, Hubble is looking down a long corridor of galaxies stretching billions of light-years distant in space, corresponding to looking billions of years back in time.