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The Universe, Dark Energy and Us

By ROBERT P. KIRSHNER

Friendship, Me.

ALMOST every scientific talk or seminar in astronomy today starts from the idea that we live in a universe in which a mysterious force known as dark energy makes up about 70 percent of the total cosmic amount of everything. A mysterious substance known as dark matter makes up about 25 percent. And ordinary matter — the stuff of the periodic table, including interesting assemblies of matter like galaxies, stars, planets and people — is a paltry 5 percent.

If this is right, the things we observe in the universe are not the important things. Think of it this way: when you look at a snow-covered mountain, what you see is the snow, but the snow is not the mountain. In the cosmic setting, the fate of the universe depends on a tug of war between dark matter, which is trying to slow down the expansion of the universe, and dark energy, which is trying to speed things up. We see the motion of galaxies as the space between them stretches out and the light from exploding stars to judge their distances, but they are just tracers of the underlying reality.

Some people are upset by the idea that we are made up of material — atoms — that is a minor part of the cosmic scheme. Personally, it makes me feel special.

This week, the Nobel Prize in Physics was awarded for the discovery, by two separate teams of astronomers, that the expansion of the universe is speeding up as a result of the force of dark energy. Saul Perlmutter of the Supernova Cosmology Project shared the prize with Brian P. Schmidt and Adam G. Riess of the High-Z Supernova team. Mr. Schmidt and Mr. Riess were graduate students of mine at Harvard, and I participated in this scientific adventure.

Both teams found, while they were taking measurements of distant exploding stars in 1997, that the expansion of the universe seemed to be speeding up, but at first neither team believed it. The energy needed to drive this acceleration seemed too crazy. It smelled of the notorious “cosmological constant,” a kind of energy associated with empty space, which Einstein proposed in 1917 to guarantee a static universe and then later banished from polite company when the universe was observed to be not static, but expanding. “Away with the cosmological constant,” Einstein said. As my mother said to me (more than once), “Do you think you are smarter than Einstein?"

Yet just a decade after the first inklings, this is the standard picture, secure enough for cautious Swedish academicians to select for this year's prize.

How did this happen? Not by persuasive argument, but by evidence. If the expansion of the universe is the result of a battle between dark energy speeding things up and dark matter slowing things down, then the history of cosmic expansion will have a record of which entity was winning at various points. Because light takes time to get to us, we can see into the past by observing distant objects. In the recent past (say, the last five billion years) we see acceleration. But if we could look far enough into the past, then the balance should tip — the dark matter should be denser when the universe was a smaller place, while the dark energy, if it resembles the cosmological constant, should hold steady. This would make the universe slow down. Mr. Riess led a group that carried out these observations with the Hubble Space Telescope. In 2004 and in 2007, his team showed that the change from deceleration to acceleration really happened: the predictions for a dark energy/dark matter universe match the observations.

Where do we go from here? We know we live in an accelerating universe that is about 13.7 billion years old, but we do not understand the nature of dark energy. What we really need is a better theoretical idea, but while we are waiting for inspiration, a prudent path is to devise more stringent tests to pin it down. After all, the "it" is 70 percent of the universe, discovered only a decade ago.

To help tackle the matter over the next decade, the scientific community has selected the James Webb Space Telescope, big telescopes on the ground like the Giant Magellan Telescope, the Large Synoptic Survey Telescope and a dedicated satellite — like the Wide-Field Infrared Survey Telescope or the Euclid telescope — to make dark energy measurements.

The case for investment in science often rests on the connection between technology and economic development, or national defense, or relief from suffering and disease. These are good arguments. Everybody wants to be rich and safe and immortal. But even in stringent times, it seems like a good idea to do some science to find out what the world is made of and how it works.

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