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455th Convocation Address: "The Universe Is Speeding Up,"

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"The Universe Is Speeding Up"
by Michael S. Turner

In January of 1998 astronomers made a truly remarkable announcement: Contrary to what had been thought, the universe is speeding up and not slowing down.

To many here today, the discovery that the universe is speeding up probably comes as no surprise. Life itself is speeding up. It started with fast food, and then it was fast news. Today one consulting firm has condensed the M.B.A. into a twenty-day course for its new associates. E-mail makes communication across the planet instantaneous and irrevocable; no going down to the mailroom to retrieve an ill-advised letter. The Internet provides information about anything right now and with the full force and subtlety of a fire hose. I even have a friend who now reads musical scores rather than listening to the music to speed up the process.

For cosmologists, however, the discovery that the universe is speeding up was a little more surprising. Seventy years ago, Edwin P. Hubble, a graduate of this University, discovered that other galaxies are moving away from us and that the universe is expanding. Since then, cosmologists have been trying to measure the slowing of the expansion due to gravity.

The answer delivered to us by Saul Perlmutter and his team was both a surprise and a relief, and both an end and a beginning. I was there in Washington, D.C., and I heard Saul with my very own ears. I will never forget the experience. I was simultaneously elated, amazed, and humbled. In the most concrete way, this cosmic revelation illustrates the joy that we all have experienced here and the process that is the essence of a University of Chicago education: the great intellectual adventure of formulating a question and wrestling it into submission, and the satisfaction of finding the answer with its insights leading to the next, more profound question. I think this is what my more literate colleagues call our "dedication to the interrogative."

What Perlmutter and his team found is that with time the speed with which a galaxy moves away from us increases. It should have been the other way around; the attractive force of gravity should be slowing galaxies and thereby slowing down the expansion of the universe. By trying to measure this slowing, cosmologists since Hubble had hoped to determine the amount of matter and energy in the universe. Because Einstein's theory of general relativity relates the amount of matter and energy to the curvature and fate of the universe, they had hoped to answer even deeper questions about space, time, and eternity.

Cosmologists at Chicago had even more at stake. Graduate students, postdocs, and faculty helped to shape and develop a new theory that links the inner space of the quantum world with outer space. It is known as cosmic inflation. Many have called it the most important idea since the big-bang theory itself. Inflation makes a clear prediction: The universe has just the right amount of matter and energy to make its geometry like that discussed by Euclid, flat and simple. Space should neither curve back on itself like the surface of a ball, nor away from itself like the seat of a saddle.

There was a strange twist on the way to the discovery that Science magazine called the "Scientific Breakthrough of the Year." Chicago scientists working at the South Pole measured the tiny variations in the intensity of the microwave echo of the big bang between different points on the sky. Their results and those of others indicated that the universe was flat, just like inflation predicted. However, other scientists at Chicago and elsewhere determined that matter could only account for 40 percent of the amount needed to make the universe flat. Where is the other 60 percent needed to balance the books? Or could someone at Chicago be wrong? Not likely!

This is where theorists like me came into the picture. Following the advice of Sherlock Holmes-when you have eliminated the impossible, whatever remains, no matter how improbable, must be the truth-we came up with the following: The missing 60 percent is in a weird form of energy called vacuum energy. It is the energy associated with the mysterious quantum vacuum. Nature's quantum vacuum is not empty, but filled with a simmering sea of particles living on borrowed time and energy. Because vacuum energy does not associate itself with matter, it would not have shown up in the matter inventory. It does, however, have a striking signature: Its gravity is repulsive. If it is truly there, it will cause the universe to speed up rather than slow down.

The discovery that the universe is speeding up brought it all together. The universe is flat; both groups of Chicago scientists are right; and a wild idea turns out to be just crazy enough to be correct. And better yet, I can now tell my friends with a straight face that the universe is filled with nothing that weighs something.

A simple question, a seventy-year pursuit, a last-minute twist, an answer, and a crazy idea that turns out to be right. What could be better? That's simple. It's the new, deeper question we now have to ponder. What exactly is this weird energy and why does it weigh what it does? I should tell you vacuum energy has a checkered history. It started with Einstein who called it the cosmological constant; he invented it and then discarded it. Physicists have failed spectacularly in their attempts to calculate how much the vacuum weighs. The next adventure has already begun, and a new generation of graduate students, postdocs, and faculty have signed on. I am confident that we won't be disappointed.

Cosmologists do not have a monopoly on this adventure of the mind; we just happen to think that ours is the grandest game in town. You too have sought answers to important questions. How do living cells regulate their own deaths? What is the role of the narrative in American political theology? How does regionalism in Russia affect the national economy? What were the origins of the Chinese erotic novel (my favorite)?

All of us at Chicago share a passion for asking questions and seeking answers. It is our common bond, and it will stay with us even after we leave this University. Because the universe and our world are accelerating, certain things will change-areas of interest and study, the curriculum, and even the degrees that we offer. They change in order to keep the essence of an education at this University unchanged. You, like your predecessors for the past hundred-plus years, take with you the ability to formulate rich and meaningful questions, a love of the intellectual pursuit of them, and the certain knowledge that the answers will lead to insights that permit even deeper questions.

I wish you well. May your life outside of this University be filled with more questions, wonderful adventures pursuing them, many interesting answers, and one or two mysteries that elude you!

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