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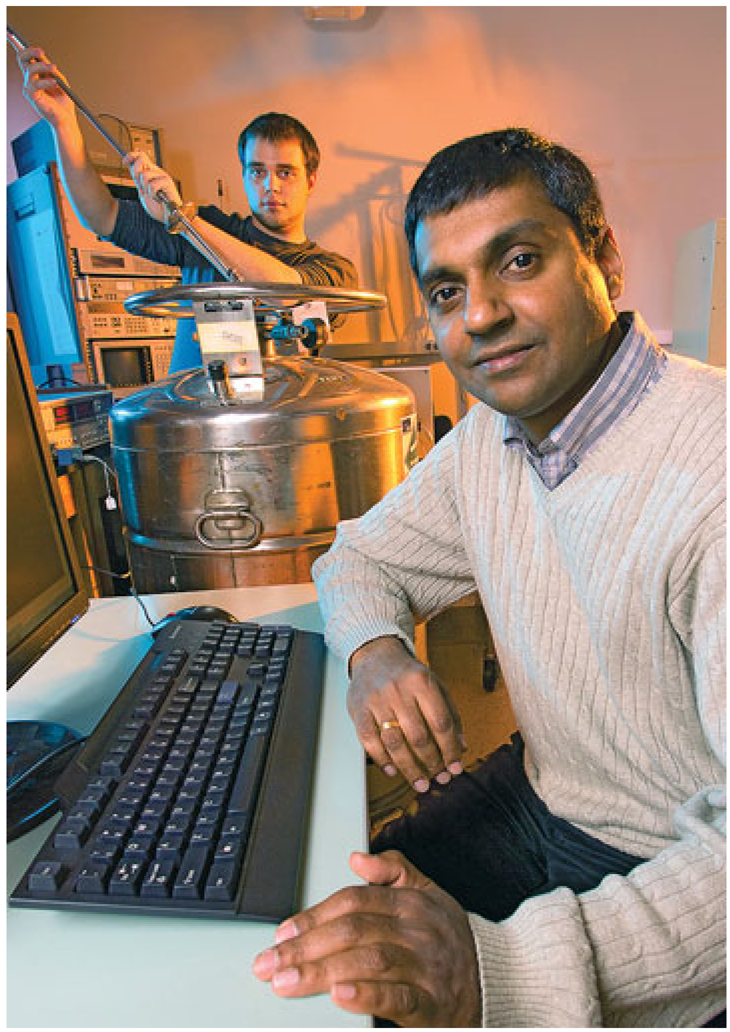
Story by TIM OBERMILLER

“Dark energy” may sound like a phrase from a *Star Wars* film. But for cosmologists such as Assistant Professor of Physics Thushara Perera, the search to verify and understand this bizarre form of energy may be key in grasping the fundamental nature and destiny of our universe.

“Everything we know about the universe is probably 5 percent of what is really out there,” Perera says. “My research has been completely based on finding the missing elements of the universe. Dark energy is one of those elements.”



Perera develops technologies to trace how the universe formed. Behind him, junior physics major Jesse Schaar prepares a liquid-helium container used to cool devices that detect light from early galaxies.
(Photo by Marc Featherly)

Perera’s quest to understand the true nature of the universe began as a teenager growing up in Sri Lanka. His parents were doctors, “and my father was always interested in learning more about different topics in astronomy, such as black holes. But without the necessary background in mathematics, he felt his understanding would always be superficial. I think it was my father’s drive to have a deeper understanding of the universe that also inspired me.”

As a college student at Ohio Wesleyan University, Perera majored in math and physics. “If you want to have a deeper understanding of the universe, you always go to physics,” he says, describing his chosen field of cosmology as “a sub-branch of physics.”

“Just as in any branch of physics, there are two kinds of cosmologists,” he continues. “There are theoretical cosmologists, who use mathematical models to create theories about the evolution and composition of the universe. And there are experimentalists who devise ways to gather data that confirm or falsify these theorists’ predictions and occasionally find something totally unexpected. I am an experimentalist."

Among the biggest questions cosmologists are now attempting to answer is: "Will the universe go on forever or not?"

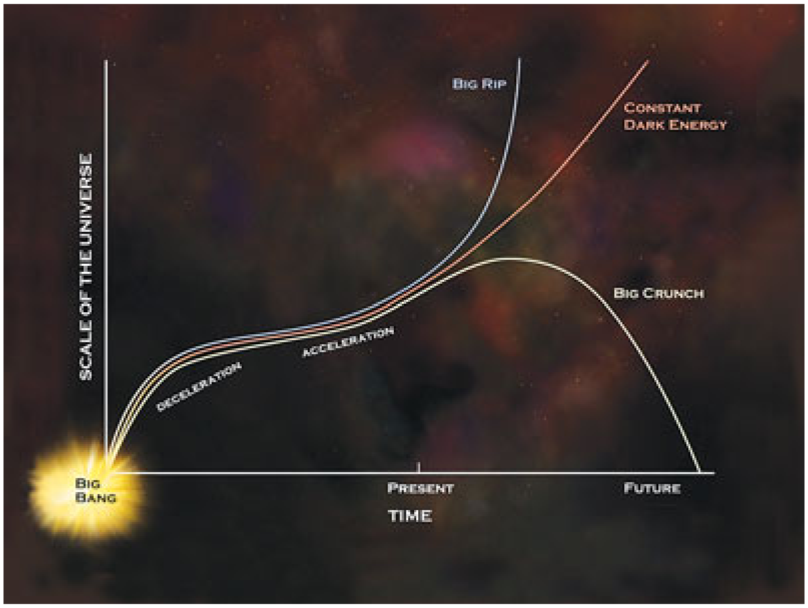
According the Big Bang model, the universe began about 13.7 billion years ago when all the energy and matter of space was condensed into one extremely hot, dense point. It has since been expanding and changing into the vast cosmos we live in today. While cosmologists generally accept this model, theories differ about what the eventual fate of the universe will be.

Recent theories have suggested that the universe will simply stop expanding at some point and reach a plateau of equilibrium that holds it in a steady state. Another theory supports the idea of a "big crunch" that will occur as the expanding universe slows down enough that it will begin to collapse under gravitational forces.

But what if something is making the expansion speed up instead of slow down? That was the startling conclusion based on measurements of supernovae published by two international teams of astronomers in 1998, which called into doubt the established expectation of a universe that was expanding at ever-slower rates.

Because gravity pulls things together and never pushes them apart, gravity exerted by the known matter in the universe should create a drag that slows down the universe as it expands. However, the supernovae study — later verified by many other cosmological observations — suggested that some mysterious, repulsive force, a "dark energy," must exist to explain the model of an accelerating universe.

It is now believed that dark energy currently accounts for about 70 percent of the total mass-energy of the universe, says Perera — the rest being dark matter (about 25 percent) and ordinary matter (5 percent). That's a radical shift in thinking from just decades ago, when scientists thought that the universe was comprised almost entirely of ordinary matter — the protons, neutrons and electrons that make up everything from distant stars to human beings.



The chart above depicts three possible futures for the universe, depending on the behavior of dark energy. First verified by astronomical measurements in 1998, dark energy is believed to account for 70 percent of the total mass-energy of the universe. (NASA/CXC/M.Weiss)

Scientists first postulated the existence of a non-visible form of matter, called "dark matter," in the 1930s to explain certain gravitational effects observed in the motion of galaxies. Experiments are continuing to directly detect dark matter, but physicists suspect it is composed of sub-atomic particles, called WIMPS, that interact very weakly with ordinary matter, making them extremely difficult to detect.

Perera participated in dark-matter detection experiments as a graduate student at Case Western Reserve University. Using an array of semiconductor detectors cooled to extremely low temperatures, Perera and his collaborators hoped to detect any rare WIMP-scattering events among a vast number of more common particle interactions.

"Dark matter has still not been detected directly," Perera says, "but we must be getting closer because recent experiments have become exquisitely sensitive."

While dark matter's existence may soon be confirmed, the search to understand dark energy is just beginning. When Perera became a postdoctoral research fellow at the University of Chicago's Enrico Fermi Institute in 2002, he couldn't resist the challenge of joining that search.

"They gave me the freedom to just roam around, sit in at various group meetings and decide which group I wanted to join," Perera recalls. "The group I chose was working on an experiment that would have potential for revealing the nature of dark energy. And the detectors they were developing had technology similar to those used in dark-matter experiments. So it was a good match."

In 2005, as a research associate at the University of Massachusetts, Amherst, Perera continued to develop superconducting detectors and semiconducting technologies for use in the Astronomical Thermal Emission Camera (AzTEC). Mounted on telescopes in extremely high and dry places, the camera is sensitive enough to examine light wavelengths from early in the universe, all the way back to 300,000 years after the Big Bang.

"The aging process of the universe stretches ancient light, and you have to go through a lot of trouble to see it," says Perera. "But that light is critical to answering fundamental questions about early galaxies and how they formed." With this and other experimental data, cosmologists hope to determine the expansion history of the universe — and what role dark energy may play in that expansion.

Joining Illinois Wesleyan's faculty in 2008, Perera continues his work with AzTEC by analyzing data the camera collects, and by building and designing hardware for future cameras. This coming fall, he plans to have IWU physics students help him in these efforts.

Dark-energy investigations are currently centered at big research universities. "If my students and I are able to make a piece of hardware that is useful for instruments being built at several large institutions, that would be an example of a small university making an important contribution to this field," says Perera. It would also help keep alive his goal of helping answer some of the most intriguing questions posed by careful observations of our universe.