Penn astrophysicist outlines a multi-pronged approach in the hunt for dark energy

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For the last few years evidence that we are living on a very "weird" universe has been growing: the expansion of the universe is accelerating, and one theory proposed to account for this acceleration is what has been termed "dark energy."
In order to find out what this mysterious energy really is, astronomers need to compare astrophysical observations that are at first sight completely unrelated. At a session on dark energy at the Annual Meeting of the American Association for the Advancement of Science today, University of Pennsylvania astrophysicist Licia Verde outlines how the hunt for dark energy will draw on the avalanche of recent and forthcoming data on surveys of objects throughout the universe.

"We were just coming to grips with 'dark matter' when, out of the blue, observations tells us that something is propelling the universe apart and that this something comprises about 73 percent of existence," said Verde, an assistant professor in Penn's Department of Physics and Astronomy. "Unlike dark matter, which, as mysterious as it may be, is still matter, dark energy is 'dark' only because astronomers simply do not know what it is. At the heart of the dilemma, however, hides the answer to just what all this universe stuff is made from anyway."

For example, some clues to the nature of dark energy have been obtained by comparing the state of the universe at its birth Ц as depicted in the Cosmic Microwave Background experiments Ц with how it exists today, using data taken from galaxy surveys. One of the first sources of data will come from the ongoing series of surveys that look at the state of galaxies today and other celestial objects which we see as they were few billion years ago.

These observations become even more powerful in combination with observations of the Cosmic Microwave Background, which provide a look at the young universe by measuring the residue of the Big Bang itself. If dark energy changes the way the universe expands, the distance between galaxies and the CMB and the time elapsed between the CMB and the era of galaxies must carry some clues about dark energy, left behind like fingerprints on space-time.

"If you think of the universe as a great sea, where space is water, over time gravity, like the wind, made ripples in that water that turned into waves. That's the universe today, a surfer's paradise," Verde said. "Of course, a surfer would end up in a different place if you changed the composition of water or if you let the wind blow longer. Likewise, the position and the properties of the galaxies today tell us something about how they surfed there and the composition of the universe that took them there.

"We're drawing on data compiled from astronomers across the globe in surveys of galaxies, supernovae, clusters of galaxies and other objects in space from as many different viewpoints as possible," Verde said. "Part of the difficulty studying dark energy is that we are still not sure what we are looking for, so we are looking to seemingly unrelated sources that might tell us something about the properties of dark energy.

According to Verde, if these approaches fail, it could mean that the current mode of thinking about the universe is wrong. If it turns out that dark energy does not exist after all, it would be the cause of a basic re-thinking of our understanding of astrophysics. "Finding out about the nature of dark energy will have consequences for both astronomy and fundamental physics," Verde said. "In other words, the question of dark energy cannot be answered without connecting the cosmological properties of the universe to the fundamental properties of matter on the subatomic level Ц from the infinitely small to the infinitely big."

Source: University of Pennsylvania