

ACCELERATING UNIVERSE? NOT SO FAST

Astronomers have found that the type of supernovae commonly used to measure distances in the universe fall into distinct populations not recognized before. **The findings have implications for our understanding of how fast the universe has been expanding since the Big Bang.**

Certain types of supernovae, or exploding stars, are more diverse than previously thought, a University of Arizona-led team of astronomers has discovered.

The results, reported in two papers published in the *Astrophysical Journal*, have implications for big cosmological questions, such as how fast the universe has been expanding since the Big Bang.

Most importantly, the findings hint at the possibility that the acceleration of the expansion of the universe might not be quite as fast as textbooks say.

The team, led by UA astronomer Peter A. Milne, discovered that type Ia supernovae, which have been considered so uniform that cosmologists have used them as cosmic "beacons" to plumb the depths of the universe, actually fall into different populations. The findings are analogous to sampling a selection of 100-watt light bulbs at the hardware store and discovering that they vary in brightness.

The differences lead to separating Ia supernovae into two groups, where the group that is in the minority near us are in the majority at large distances -- and thus when the universe was younger -- there are different populations out there, and these have not been recognized. The big assumption has been that as you go from near to far, type Ia supernovae are the same. That doesn't appear to be the case.

The discovery casts new light on the currently accepted view of the universe expanding at a faster and faster rate, pulled apart by a poorly understood force called dark energy. **This view is based on observations that resulted in the 2011 Nobel Prize for Physics awarded to three scientists, including UA alumnus Brian P. Schmidt.**

The Nobel laureates discovered independently that many supernovae appeared fainter than predicted because they had moved farther away from Earth than they should have done if the universe expanded at the same rate. This indicated that the rate at which stars and galaxies move away from each other is increasing; in other words, something has been pushing the universe apart faster and faster. The idea behind this reasoning is that type Ia supernovae happen to be the same brightness -- they all end up pretty similar when they explode. Once people knew why, they started using them as mileposts for the far side of the universe.

The faraway supernovae should be like the ones nearby because they look like them, but because they're fainter than expected, it led people to conclude they're farther away than expected, and this in turn has led to the conclusion that the universe is expanding faster than it did in the past.

Milne and his co-authors -- Ryan J. Foley of the University of Illinois at Urbana-Champaign, Peter J. Brown at Texas A&M University and Gautham Narayan of the National Optical Astronomy Observatory, or NOAO, in Tucson -- observed a large sample of type Ia supernovae in ultraviolet and visible light. For their study, they combined observations made by the Hubble Space Telescope with those made by NASA's Swift satellite. The data collected with Swift were crucial because the differences between the populations -- slight shifts toward the red or the blue spectrum -- are subtle in visible light, which had been used to detect type Ia supernovae previously, but became obvious only through Swift's dedicated follow-up observations in the ultraviolet.

These are great results the Swift data has provided and is completely independent of the satellite's primary mission. **It demonstrates the flexibility of satellite research to respond to new phenomena swiftly. While the realization started with Swift data, the trend seems to be present in all the other datasets when you look at it in ultraviolet light.** More data have to be collected before scientists can understand the impact on current measures of dark energy. These include projects led by NOAO; the Large Synoptic Survey Telescope, or LSST, and a camera built by the UA's Imaging Technology Lab for the Super-LOTIS telescope on Kitt Peak southwest of Tucson. Super-LOTIS will use the new camera to follow up on gamma-ray bursts -- the "muzzle flash" of a supernova -- detected by Swift.



galaxy M82 before the explosion and combines data acquired between 2007 and 2013. Mid-ultraviolet light is shown in blue, near-UV light in green and visible light in red. The image is 17 arcminutes across, or slightly more than half the apparent diameter of a full moon.