Mauna Kea, IfA Played Key Roles in Nobel Research

by Louise Good

One of the most dramatic scientific discoveries of the last thirty years was the finding that the Universe is expanding at an ever-increasing rate and will therefore last forever. This discovery, announced in 1998, has led to the 2011 Nobel Prize in physics, awarded on Tuesday to the leaders of two large groups of astronomers. And it would not have happened without the observatories on Mauna Kea, a camera designed and built at the IfA, and the pioneering work of IfA astronomer John Tonry, a member of one of those teams.

The objective of the search was to compare how fast the Universe is expanding now compared with its expansion billions of years ago. Astronomers expected to find that the Universe's expansion was slowing down, suggesting the possibility that the Universe would eventually stop expanding and would then collapse in a "big crunch."

To study this problem, astronomers searched for exploding stars called type 1a supernovae in very distant galaxies. In the early 1990s, astronomer Mark Phillips discovered that this type of supernova could be used to measure how far away other galaxies are. In 1996, when the project began, the most sensitive system for doing this kind of research was a giant digital camera designed and built at the IfA and mounted on the Canada-France-Hawaii Telescope, a telescope with superb optics located on Mauna Kea, where the skies are uniquely clear and dark. Earlier, scientists had begun this work at an observatory in Chile, but the camera was not as good and the skies were not as clear.

Tonry spent his nights observing on the telescope and his days analyzing the data. There was no time to waste because supernovae explode brightly but fade fast. Other members of his team needed to receive the locations of these explosions quickly so that they could observe them with a spectrometer mounted on one of the two 10-meter-diameter telescopes of the W. M. Keck Observatory, also on Mauna Kea. Their job was to measure the speed at which the galaxies were moving away from us as well as to confirm the nature of the exploding stars.

The reason they chose to study these faint, distant galaxies was that they are so far away that their light must travel for billions of years to reach Earth. Astronomers are therefore able to glimpse our Universe at a time when it was much younger than it is now.

What they discovered was considered surprising, even shocking. They found that the distant galaxies—the ones they were observing as they were in the distant past—were moving apart from each other more slowly than were the nearby galaxies. In other words, the Universe must be expanding faster now than it did in the past. Team members were amazed. "It couldn't be. We had better recheck our calculations." But it was, and it has since been confirmed by other observations.

What could cause the Universe's expansion to speed up? It couldn't be gravity because gravity always pulls things together. It had to be a new kind of pressure, which has now been named "dark energy."

Interestingly, when Albert Einstein formulated his theory of general relativity in 1915, one of his equations hinted at the existence of such a pressure, but it took nearly 100 years for its significance to be realized.

What is dark energy? No one knows. And we don't know whether the answer will be found by particle physicists at a giant laboratory such as the Large Hadron Collider in Geneva, Switzerland, or by astronomers at large telescopes such as those on Mauna Kea.

Caption: Gerard Luppino and the UH 8k Mosaic Camera he designed. When used on the CFHT, it enabled John Tonry to image distant supernovae.

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