THE SHAW PRIZE 邵逸夫獎

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Autobiography of Professor Saul Perlmutter

My grandparents immigrated to the United States from Eastern Europe, part of a generation of poor but optimistic intellectuals, who expected that education and rationalism would build a better world. Unsurprisingly, their children became professors, my mother in social work, and my father in chemical engineering. On weekends our home was full of their friends, discussing politics and movies, books and arts. In this atmosphere I grew up wanting to know about all the universal "languages" -- music, literature, math, science, architecture, psychology. When I headed off to college, I thought I would pursue my fascination with the biggest mysteries: How does the world work? How does the mind work?

I majored in physics at Harvard, and when I arrived at graduate school at Berkeley in 1981, my goal was to find a research project with real data -- not just theory -- that would address a deep philosophical question. I found an unusual, dynamic, eclectic research group led by Professor Richard Muller, with projects ranging from fundamental gravity measurements to atmospheric

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carbon-cycle measurements to a table-top cyclotron.

I focused on a robotic-telescope supernova project, since it offered the possibility of a fundamental measurement, the Hubble constant. I developed the software and some hardware that made it possible to identify automatically and reliably the supernovae in the images. By 1986, when I graduated, the automated supernova search was successfully running, and I was asked to stay on as a postdoc.

By this time, there was evidence (particularly from Gustav Tammann and Bruno Leibundgut) that the new sub-classification of Type “Ia” supernovae could be used as a distance indicator, perhaps better than the originally targeted Type II's. This news prompted group-member Carl Pennypacker and me to think about new projects. Since the 1930's there had been the hope that supernovae could someday be used to measure the deceleration of the universe's expansion. The Type Ia's uniformity re-opened this possibility, and we also now had built up experience with novel tools to study them: the first generation of ultra-sensitive CCD imagers and the corresponding image-analysis software.

In 1987 Carl and I proposed a new project: we would build a wide-field camera, the widest ever with a CCD on a 4-meter telescope, and develop the software to search through ~10,000 galaxies in one night (the previous nearby searches had studied just one galaxy in each image). In several years we could discover sufficient numbers of much more distant, high-redshift (z~0.3) supernovae to measure the deceleration parameter. The project started in 1988, a founding project of Berkeley's new Center for Particle Astrophysics, but began slowly with several years of bad weather at the telescope. Still, by early 1992, when I was asked to take over from Rich as leader of the supernova research group, we had found a Type Ia supernova at z=0.45 -- doubling the world's high-redshift sample.

Two key problems stood in our way: relating brightnesses of high- and low-redshift supernovae (measured in different filters); and guaranteeing distant supernova discoveries in advance -- and in time to measure their peak brightness. Without such a guarantee, one could not obtain time on the large telescopes needed to study them. By 1994, we had solved these problems and we were able to guarantee entire “batches” of multiple high-redshift supernovae, all still brightening, and all found on a pre-selected date, perfect for scheduling the measurements of brightness and spectrum. Such “guarantees” led us to propose a novel use of the Hubble Space Telescope: precision measurements of distant supernovae, particularly important for the ultra-far z~1 supernovae that Ariel Goobar and I had shown could be used to distinguish among cosmological theories.

Meanwhile, between 1990 and 1993, supernova researchers, including David Branch, Mark Phillips, Mario Hamuy, and Nick Suntzeff, had developed empirical techniques and beautiful nearby supernova datasets to further calibrate the Type Ia standard candle. So, by late 1994, with our batch discovery and multi-band follow-up of high-redshift supernovae, our now-international team of scientists was working together round-the-clock, collecting new batches of high-redshift supernova data using the best telescopes in the world. And so was a new team, organized by Shaw co-winner Brian Schmidt.

Finally, in 1997, we were analyzing our haul of 42 Type Ia supernovae at redshifts about z~0.5 and finding an odd result: the universe's expansion was actually speeding up -- this didn't fit with known models of physics! We announced these results at the American Astronomical Society January 1998 meeting. Because both our team and Brian's team --including Shaw co-winner Adam Riess -- independently announced matching results at conferences in the beginning of the year, by the end of the year most of the scientific community had accepted the startling findings.

When we started the project we thought that whatever answer we found would be exciting: if the universe were decelerating enough then it would be finite and coming to an end; if not then the universe is likely infinite in space and time. We could not have imagined the actual outcome, a surprise that presents a major puzzle for fundamental physics. Since 1998 we and others have begun the exciting, painstaking effort to collect new data to explore this puzzle. We have even begun developing a new space telescope. Perhaps when my three-year-old daughter, Noa, enters high school, humankind will have the next answers -- or, better yet, new surprising questions about our world.