

THE  KAVLI PRIZE  
B I O G R A P H I E S  
A S T R O P H Y S I C S

*Jerry E. Nelson, Raymond N. Wilson and James Roger Prior Angel*

## Jerry E. Nelson

Jerry Nelson started out studying physics at the California Institute of Technology before moving to the University of California at Berkeley to complete a Ph.D. in elementary particle physics. A natural tinkerer with things, Nelson grew interested in astronomical instruments and in 1977 made a proposal to the University of California to build a telescope with a mirror 10 metres across, twice the size of the biggest telescope in the United States at the time.

The size of telescopes had been stalled for decades because they were made of single slabs of glass. Anything larger than around 6 metres was impractically heavy and not rigid enough to hold its shape under gravity. Nelson's novel solution was to piece together a large mirror from a number of smaller tiles which would be much lighter. He devised a way to grind the tiles into the unusual asymmetric shapes needed and a system of sensors, actuators and computer control to make the tiles act as a single reflecting surface. It was a risky proposal and university authorities were initially sceptical, but Nelson's design eventually led to the twin Keck Telescopes on the summit of Mauna Kea, Hawaii, each with a 10 metre mirror made from 36 segments.

Moving to University of California, Santa Cruz, in 1994, Nelson has won awards from the French Academy of Sciences, the Optical Society of America, the American Astronomical Society and the optics society SPIE. He has been elected a member of the National Academy of Sciences

and SPIE. Now, Nelson is planning to put his scheme to a much stiffer test in the proposed Thirty Meter Telescope, whose mirror will be made up of 492 segments.

## Raymond N. Wilson

Ray Wilson studied physics at Birmingham University in the United Kingdom and then specialised in optical engineering at Imperial College London. After finishing national service in 1952, he spent 20 years shuttling between academic institutions, such as Imperial College and the National Physical Laboratory, and optics firms, particularly Karl Zeiss in Oberkochen, Germany, finally specialising in astronomical instruments. A former colleague reports him as saying: "If you love optics but want nothing to do with its military applications, working on telescopes is the fulfilment of a dream."

In 1972 Wilson joined the European Southern Observatory (ESO) first in Geneva and then Garching, Germany, and would remain there for more than 20 years. He faced the same problems encountered by all telescope designers of the time, how do you keep your mirror in its ideal shape as it moves to different inclinations while also dealing with wind and temperature variations. His solution was to abandon the idea of a rigid mirror entirely and build a thin flexible one supported by computer-controlled actuators on a rigid frame. Wilson developed a closed-loop computer system that sensed any problems of the telescope's vision from distortion of the mirror and adjusted the mirror's shape to correct them on a minute-by-minute basis.

Wilson's idea was first tested on ESO's successful New Technology Telescope, completed in 1989, and then was applied in all four main mirrors of the Very Large Telescope, which began operations in 1998. He has been awarded prizes by Geneva University, the German Astronomical Society and the French Academy of Sciences. He was also made a Chevalier of the French Legion of Honour. Wilson retired from ESO in 1993 to write a two-volume book distilling his knowledge of telescope optics. Since then, he has pursued studies in other areas, including history, economics, cosmology and biology. Ray Wilson received the Tycho Brahe Prize in 2010.

## James Roger Prior Angel

Roger Angel trained as a physicist at Oxford University and the California Institute of Technology in the 1960s and, while working at Columbia University in New York, flitted between astrophysics and high-energy physics. He settled on mirror design at the University of Arizona in Tucson and was soon melting down Pyrex dishes in a makeshift backyard kiln to test his ideas on mirror casting.

With telescope mirrors stuck below 6 metres diameter because they were sagging under their own weight, Angel wanted to make them lighter and stronger. His solution was to cast mirrors in a mold filled with hexagonal columns to give the finished mirror a honeycomb of holes in the back, reducing weight by

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*See also:*

*The Kavli Prize*

[www.kavliprize.no](http://www.kavliprize.no)

*The Kavli Foundation*

[www.kavlifoundation.org](http://www.kavlifoundation.org)

four-fifths and increasing rigidity. In addition, Angel would spin the mold as the glass cooled to give it a curved surface. He also developed a computer controlled polishing machine with a tool that could change shape as it moved over the surface. Angel has cast 6.5-metre mirrors for the Multi-Mirror Telescope and the two Magellan Telescopes, plus two 8.4-metre mirrors in the Large Binocular Telescope. They will also be used in the Large Synoptic Survey Telescope and the Giant Magellan Telescope.

Angel created the Steward Observatory Mirror Laboratory and is director of the Center for Astronomical Adaptive Optics. He has won numerous prizes and fellowships, including membership of the U.S. National Academy of Sciences and the U.K. Royal Society.

