

THE  KAVLI PRIZE
KAVLI PRIZE IN
ASTROPHYSICS 2010

*The Norwegian Academy of Science and Letters has decided to award
the Kavli Prize in Astrophysics for 2010 to*

JERRY E. NELSON

Professor of Astronomy, University of California, Santa Cruz and Lick Observatory, US

RAYMOND N. WILSON

Senior Physicist, European Southern Observatory, Garching, Germany

JAMES ROGER PRIOR ANGEL

Regents Professor, Steward Observatory, University of Arizona, US

*“for their contributions to the development
of giant telescopes”*

New telescopes and their instrumentation are at the heart of progress in astronomy. The size of the telescope primary mirror determines the light-gathering power and ability to detect and resolve the faintest and most distant objects in the Universe. Jerry Nelson, Ray Wilson and Roger Angel have pioneered the development of a new generation of large optical telescopes. The basic challenge for building a large telescope is to create a precise reflecting surface that focuses the light and is at the same time able to withstand the forces due to gravity, wind and thermal changes. Until the work of Nelson, Wilson and Angel, these requirements limited the primary mirrors of ground-based optical telescopes to a diameter of less than 6 meters for over four decades. With conventional technology, larger mirrors would have been too heavy, too costly and not sufficiently stiff.

In the 1970s and 1980s, Nelson, Wilson and Angel independently proposed and demonstrated truly innovative solutions that could overcome these hurdles. Remarkably, these advances enabled not only the construction of larger mirrors but also more sophisticated shaping of the mirror surfaces, leading to lighter telescopes and more compact telescope enclosures. All three telescope concepts have had outstanding successes, leading to a wide range of fundamental discoveries.

Jerry Nelson pioneered the use of segmentation in telescope primary mirrors, transforming the problem of mirror stiffness from the scale of the primary to the scale of the segment, and thereby reducing the required weight per unit area twentyfold. This approach requires segments with individual complex surfaces, which are aligned and controlled precisely so as to act as a single coherent reflector. Nelson and his co-workers

introduced several revolutionary technologies to accomplish these goals, including polishing optical surfaces under stress and aligning segments to an overall common shape with edge sensors and harnesses. The twin 10-m diameter Keck telescopes on Mauna Kea (Hawaii), in operation since 1992, were based on this pioneering technology. Nelson was the intellectual and technical leader of this audacious enterprise. The principles developed by Nelson have been applied in the 10.4-m Gran Telescopio Canarias and the 6.5-m James Webb Space Telescope, and form the basis for still larger telescopes planned for the future.

Ray Wilson pioneered the closed-loop computer-controlled telescope, a method known as active optics. This process, first implemented by Wilson and his colleagues in the 3.5-m New Technology Telescope, is a pre-requisite for telescopes based on thin, flexible, “meniscus” mir-

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rors. The key concepts of active optics involve continuous wavefront sensing, active collimation and real-time reshaping of the primary mirror surface by actuators in the backup structure, permitting the entire telescope to be significantly lighter. Thin-meniscus active optics technology is the basis of the four 8.2-m telescopes of the European Southern Observatory's VLT, in operation on Paranal (Chile) since 1998, as well as the two Gemini 8.1-m telescopes and the Subaru 8.3-m telescope.

Roger Angel pioneered the development of lightweight mirrors with short focal ratios. These mirrors have a thin reflector surface stiffened by a honeycomb backing, a technology which Angel extended to mirrors of large diameter by casting in a spinning furnace, warping the polishing tool, and other innovations. The 6.5-m MMT, in operation since 2003 on Mount Hopkins (Arizona), the two Magellan telescopes, and the 2x8.4-m LBT all contain Angel mirrors. This technology also enables the construction of large-aperture telescopes with a very wide field of view.

The expansion in the capabilities of observational astronomy led by Nelson, Wilson, and Angel will continue in the future through even larger and more powerful telescopes based on the concepts that they developed.

