Princeton University

Honors Faculty Members
Receiving Emeritus Status

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The biographical sketches were written by
colleagues in the departments of those honored.

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Faculty Members Receiving Emeritus Status

James Edward Gunn

James (Jim) Gunn was born in Livingstone, Texas, in 1938. He was a star student at Rice University where for many years the expression "to gunn an exam" was part of student slang. He joined the Princeton faculty as an assistant professor in 1968, then taught at the California Institute of Technology from 1970 until returning to Princeton in 1980 as the Eugene Higgins Professor of Astronomy.

In the broadest terms, there are three main areas of astronomy research: theory, observation, and instrumentation. Most researchers specialize in one of these areas, and a few have made substantial contributions to two. Jim has had an outstanding scientific impact in all three. His scientific interests are equally broad, and in his career he has made groundbreaking contributions in fields ranging from the cosmic distance scale to the physical nature of pulsars, from the nature of dark matter to the physical state of the universe when the first stars formed.

Theory: In 1965, while still a graduate student, Jim (with fellow student Bruce Peterson) described what became known as the Gunn-Peterson limit to provide the first evidence that the universe was reionized by the formation of the first stars and quasars.

With Jerry Ostriker, Jim wrote a series of fundamental papers describing the magnetic dipole model for pulsar emission, which explicitly shows how pulsars derive their luminosity from the rotational energy of a neutron star.

In 1967 Gunn was among the first to investigate gravitational lensing in cosmology, and in particular provided much of the formal mathematical structure for studying the propagation of light in inhomogeneous cosmologies; in 1973, with his student Bill Press, he was the first to discuss lensing as a means of detecting dense dark objects at cosmological distances.

Modern observations favor a "concordance" universe with a non-zero cosmological constant and a matter density substantially less than the critical value. The first serious discussion of observational evidence for a cosmological constant was by Jim and Beatrice Tinsley in 1975. In 1974, he and Tinsley, along with J. Richard Gott and David Schramm, were among the first to break publicly with the shared but unstated prejudice among cosmologists that the mean density of the universe was equal to the critical value, by energetically advocating a sub-critical universe with matter density not far from the value favored today.

Observation: One of the major observational thrusts in cosmology in the 1960s and 1970s was to use bright cluster galaxies as "standard candles" to measure the geometry of the universe. Jim and Bev Oke's 1975 paper revolutionized research in this area, not only through new observational techniques and careful analysis of selection biases but also by deriving an estimate for the curvature of the universe that was quite different—and certainly more accurate—than earlier investigators had found. Despite this success, Jim was also one of the first to recognize that evolution of bright galaxies seriously compromised their use as standard candles, and thus to stress other methods of determining the cosmological parameters.

The photometric filter system designed by Jim and his postdoc Trinh Thuan, developed to avoid prominent night-sky spectral lines, defines one of the half-dozen most popular and important color systems in optical astronomy—and two of the others, the Hubble Space Telescope filter system and the Sloan filter system, were also largely designed by Jim.

Jim's 1978 work on the galactic rotation curve (with Jill Knapp and Scott Tremaine) was the first modern paper to argue that the solar orbital speed in the Galaxy was 220 km/s, a value adopted by the International Astronomical Union a decade later as its standard.

Jim and his students played a central role in exploring the dynamics and properties of galaxies in rich clusters; their contributions include detailed photometry of large samples of galaxies, searching successfully for distant clusters, and mapping the velocities of large numbers of galaxies in given clusters to construct dynamical models.

Instrumentation: Jim played a central role (deputy principal investigator) in the design and construction of the Wide Field/Planetary Camera (WF/PC) on the Hubble Space Telescope. The design for the

WF/PC was based on CCD detectors, which at the time was a bold innovation; CCDs have now superseded almost all other detectors for astronomical observations in the optical, and Jim is probably more responsible than any other single researcher for introducing them to the astronomy community.

During the 1970s and 1980s, Jim designed a number of major instruments for the Palomar 5-meter telescope. These include the Double Spectrograph, the Four-Shooter, the Prime Focus Universal Extragalactic Instrument, and the Palomar Observatory CCD Camera.

Jim's greatest achievement, however, has been the conception, building, and scientific leadership of the Sloan Digital Sky Survey (SDSS), a bold and revolutionary effort to construct a detailed digital imaging and spectroscopic catalog of one-quarter of the entire celestial sphere. This project saw first light in 1998, has obtained the images of more than 300 million objects, and obtained over 1.3 million spectra—by far the largest redshift survey in the history of astronomy. The data have been made public and are being used extensively by astronomers all over the world. Among the project's discoveries:

- Most of the 30 most distant quasars are known, which among other things have led to the determination of the epoch of reionization predicted 40 years ago by Gunn and Peterson;
- The first free-floating brown dwarfs are known;
- The detection of acoustic oscillations in the galaxy power spectrum, an important confirmation of the concordance model of cosmology and an important tool for determining the nature of the dark energy;
- The direct measurement of galaxy masses, including dark matter, via gravitational lensing;
- The discovery and mapping of tidal streams in the distant Galactic halo, directly supporting modern models of the formation of our Milky Way by accretion of dwarf companions;
- The discovery of almost a dozen previously unknown companion galaxies to the Milky Way.

The survey has produced catalogs of unprecedented size and uniformity of galaxies, active galactic nuclei, many types of stars and even asteroids, allowing detailed statistical studies of the properties of these objects. There are well over 1,500 refereed scientific papers based on SDSS data, including close to 100 Ph.D. theses. The SDSS has been rated number one or two in terms of scientific impact (as measured by the number of highly cited papers) in each of the past four years, beating out the Keck Telescope and the Hubble Space Telescope, among others.

The Sloan Digital Sky Survey has not only provided deep insights into astronomy, but has also changed the way that we do astronomy. Astronomers traditionally went to a large telescope to take images of a small portion of the sky. They worked as individuals or as small teams on "special cases." After the SDSS, many astronomers now carry out statistical studies on well-calibrated and characterized large data sets. A measure of the change is that the National Academy of Sciences has just made the Large Synoptic Survey Telescope (LSST) its top ground-based priority for the coming decade. The LSST is designed as the successor to the SDSS.

Jim's contributions have been recognized by numerous awards and fellowships, including the Gruber Prize in Cosmology, the Swedish Academy of Science's Crafoord Prize, the Gold Medal of the Royal Astronomical Society, MacArthur Fellowship, and the American Astronomical Society's highest honor, the Henry Norris Russell Lectureship.

While Jim is retiring from his teaching responsibilities, he remains intellectually very active. He is playing the leading role in the design of the Prime Focus Spectrograph (PFS) for the Subaru Telescope. PFS will be able to simultaneously take 2400 spectra, enabling an even larger and deeper spectroscopic survey than the SDSS.