



**Louis Brown**

that developed as he wrote his magnum opus, *A Radar History of World War II: Technical and Military Imperatives* (IOP, 1999). The work was hailed for its encyclopedic breadth, its balance, and its international scope. As noted on the book's back cover, Pulitzer Prize winner Richard Rhodes called it "a great book, of permanent value: powerful, magisterial, full of surprises and freighted with deep insight into science and human affairs." Lou's expertise was sought by curators at the Smithsonian Institution in Washington, DC, and at the Historical Electronics Museum in Baltimore, Maryland. As unofficial historian of DTM, he was instrumental in preserving the department's archives and its historic field and laboratory photographs. Sadly, Lou did not live to see the culmination of that work in print, but the *Centennial History of the Carnegie Institution of Washington. Volume II: The Department of Terrestrial Magnetism* (Cambridge U. Press, 2005) is a lasting tribute to him.

A hallmark of Lou's style was his joyful zest and vigor, both physical and intellectual. He was remarkably generous professionally, an attribute that led to many successful team collaborations, and he contributed unselfishly to the success of his younger colleagues. Lou's plan was to retire at age 65 to make room for a younger scientist, and then keep working, which is exactly what he did. Many colleagues were inspired by his intellectual breadth and scientific enthusiasm, which never waned.

**Julie Morris**  
Washington University  
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## Leslie Charles Hale

**L**eslie Charles "Les" Hale was a distinguished researcher in ionospheric physics and atmospheric electricity and a professor of electrical engineering at the Pennsylvania State University in University Park for 30 years. He died in Las Cruces, New Mexico, on 26 December 2003 of heart failure following complications from hip replacement surgery.

Born in Alamogordo, New Mexico, on 26 June 1932, Hale was raised primarily by his mother and was completely on his own at age 19. Two events in his early years planted important seeds for his subsequent professional career in electromagnetics and rocketry: when, at age 12, he read a copy of *QST*, a publication about amateur radio, and shortly thereafter, when he witnessed the launch of a captured German V-2 rocket from White Sands Proving Ground. Hale enjoyed being an amateur radio operator for the rest of his life, and he was principal investigator on more than 100 sounding rockets for the upper atmosphere and ionosphere, a US record.

Hale earned his BS (1952), MS (1954), and PhD (1958) all in electrical engineering, at the Carnegie Institute of Technology (now Carnegie Mellon University) in Pittsburgh. His doctoral thesis, supervised by James B. Woodward Jr, was entitled "Initial Excitation and Amplitude Rise in Electronic Oscillators."

After joining Los Alamos Scientific (now National) Laboratory as a member of a group of "space cadets" in the post-Sputnik era, Hale began his rocket-based space investigations there when he helped initiate one of the first missions to Venus. In 1962, he was a senior research fellow in space research at University College London. There, he met Arthur Waynick, founder of Penn State's Ionosphere Research Laboratory, and subsequently joined Penn State's electrical engineering faculty. During his first year at the university, he met Roberta MacMillan, his future wife, who would later assist him with the editing and typing of all his scientific papers. He remained at Penn State as the A. Robert Noll Distinguished Professor of Electrical Engineering for the duration of his career.

Hale's pioneering efforts with rockets included the use of retarding potential analyzers for "deep space" ionization measurements, the development of continuum-flow probe techniques for middle atmosphere ionization measurements, early mea-



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surements of nitrogen oxide in the middle atmosphere, and interpretation of "blunt probe" electrical conductivity data to indicate the importance of aerosol particles in middle-atmosphere ionization processes. His investigations in the late 1950s to early 1990s involved the challenging tasks of measuring middle-atmosphere electric fields during thunderstorms and during geomagnetically disturbed and quiet periods.

Hale reveled in bucking the conventional wisdom. One good example is when he put forth his own theory about the physical origin of the extremely low-frequency "slow tail," an electromagnetic feature radiated from lightning discharges. Robert Wattson-Watt and, later, James Wait held the view that dispersion of white noise produced by the return stroke and propagating in the Earth-ionosphere waveguide explained the slow tail. Ted Pierce followed by Marx Brook proposed that continuing current in the lightning return stroke was necessary for slow tails. Hale, though, emphasized Lee Tepley's observations that slow tails were too common to be explained by continuing currents and rejected their primary role. As an alternative to the ideas of Wait, Hale advanced the idea that the slow tail waveforms were controlled by the round-trip propagation delay between Earth and ionosphere. The jury is still out on this issue.

The most important contribution Hale made to atmospheric electricity and the global circuit was his persistent insistence on the AC aspects and the role of capacitive coupling (in his customary electrical engineering perspective) between lightning and the

lower ionosphere. Hale's paper in *Nature* with student Mike Baginski in 1987, a decade prior to the heyday of research activity on red sprites, emphasized the transient energy dissipation by lightning in the mesosphere, where sprites were later identified by other researchers. His prescient ideas about coupling from lightning also extended to the magnetosphere, and his expectation of coupling into the opposite hemisphere along magnetic field lines led him, with interested collaborators, to search for conjugate field sites.

Hale's earlier use of rocket probes to explore the electrical properties of the nighttime magnetosphere also laid an important foundation for understanding sprite incidence in that region. The suppressed conductivity, which he interpreted as aerosol-scavenging of electrons, and the extended relaxation time enabled the short-duration stressing and ionization by lightning to produce the red sprite at high altitude.

In 1993, Hale formally retired and returned to New Mexico, but he remained active in research and communicated with colleagues until his death. In his later years, he focused on the newly discovered red sprites in the mesosphere over large thunderstorms.

Hale and his family enjoyed both playing and watching a competitive game of tennis. His athletic sons could not defeat him because of his powerful serve. At scientific conferences, he was renowned for his gracious chauffeuring of friends and colleagues to his favorite restaurants. His ideas and collegiality are sorely missed by the scientific community.

**Earle Williams**

*Massachusetts Institute of Technology  
Cambridge*

**John Mitchell**

**Charles Croskey**  
*Pennsylvania State University  
University Park*

## Bela Julesz

**B**ela Julesz understood that brain was physical, and that mind, which to some is a separate entity, was profoundly and utterly identical to brain. That vision of the mind-brain question was not the direct subject of his daily research endeavors, but completely informed his scientific work. For Bela, transformation of the physical world into the internal mental world was the key question.

He addressed this question, as he did everything in his life, uniquely. While the mid-20th century still had its share of philosophers and talkers

on such questions, Bela investigated the mental representations of external reality by fully implementing the experimental program first devised by Gestalt philosophers and—this is especially crucial—by informing it with the most current neuroscience.

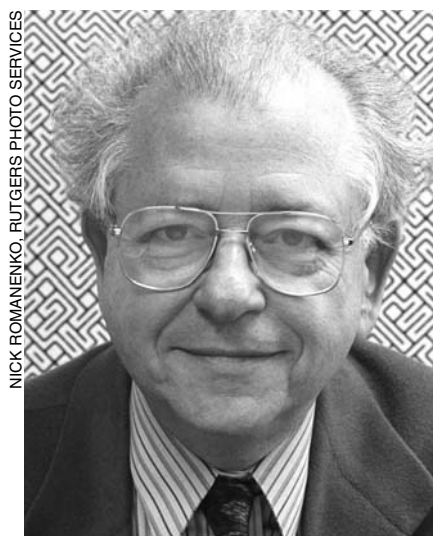
Bela Julesz died on 31 December 2003 in New Jersey—47 years to the day after he began at Bell Laboratories, 47 years of providing guidance and questions to the burgeoning field of neuroscience, 47 years as a physicist of the mind.

Bela was born in Budapest, Hungary, on 19 February 1928. It is not clear how his early years formed the foundation of an interdisciplinary scientist. From his doctorate at the Hungarian Academy of Sciences, he certainly understood physics and complex engineering. When the Soviet tanks rolled into Hungary in 1956, he and his wife Margit escaped, swimming the Danube to the West.

The first of the two positions he held in the US were at AT&T Bell Laboratories. Manfred Schroeder hired Bela to continue his doctoral studies on television signals. Yet Bela's unique approach to science rapidly became apparent. From studies by John W. Tukey, Harry Nyquist, and Claude Shannon on random number generators, Bela was given the task of assessing binary sequences for randomness. Rather than use numerical measures, he reached across domains and made images of the sequences using the unique pattern-recognizing ability of our visual system to evaluate randomness. One will never know how long that approach had incubated, or from whence it came. I prefer to think it was Bela's innate ability to rapidly assess problems from conventional viewpoints and then let his mind roam afield, bringing in his own experiences and unusual knowledge for resolution.

From that simple exploitation of the visual system to solve a mathematical problem, Bela addressed the question of mind and brain. He selected visual illusions in which the internal perceptions were not identical to the visual inputs on the retina. His first great success came with the invention of the random dot stereogram.

The random dot stereogram resolved a fundamental conflict between Charles Wheatstone and David Brewster from the mid-19th century. Bela computed two identical pairs of random dot images that lacked any identifiable cues; a square patch of dots in one image was displaced slightly. When viewed monocularly, each image lacked global structure. But viewed



NICK ROMANENKO, RUTGERS PHOTO SERVICES

**Bela Julesz**

through a stereoscope, so that each eye saw one image, a central square emerged in depth. Those displays—eventually known as Julesz random dot stereograms, or RDSs—and subsequent explorations described in his first monograph, *Foundations of Cyclopean Perception* (U. of Chicago Press, 1971), established the primacy of stereoscopic vision to shape and form vision. Bela saw stereoscopic fusion as analogous to alignment of magnetic dipoles—one of his many physical analogies for perception.

Importantly for the field of vision neuroscience, in its toddler stage at that time, RDS provided a paradigm to study higher cognitive function. A behavioral test is created for which the internal representation differs from the external world; the mental processes are then explored using physical approaches embedded in the brain's anatomy and physiology. Bela termed this approach “psychoanatomy.” Although the term never stuck, the approach is evident throughout contemporary neuroscience. In experiments ranging from single neuron recordings in monkeys to functional magnetic resonance imaging in humans, the *modus operandi* is to locate a physical neural correlate in response to an external physical event that is not a simulacrum. The “ghost in the machine,” the dualist nature of mind and brain, is finally excised from any scientific thinking about the mind. This is Bela's legacy.

In his later years, through his second book, *Dialogues on Perception* (MIT Press, 1995), one got a picture of how his particular mind worked. It was as if there were two people, constantly trying to best each other. Two opposing viewpoints could then be