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.

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Massachusetts Institute of Technology
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John Mitchell
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Bela Julesz

Bela 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.

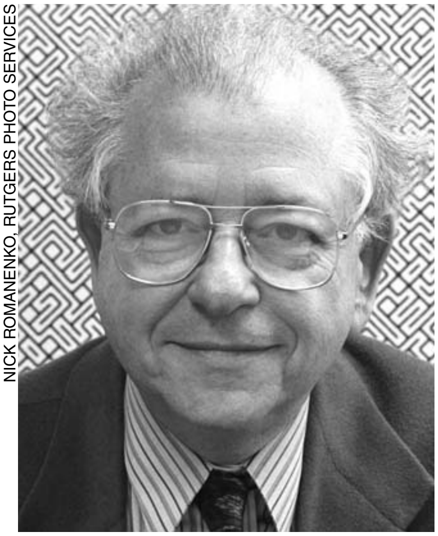
Bela Julesz died on 31 December 2003 in New Jersey—47 years to the day after he began at Bell Laboratories, 47 years of providing guidance and questions to the burgeoning field of neuroscience, 47 years as a physicist of the mind.

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 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.


NICK ROMANENKO, RUTGERS PHOTO SERVICES
Bela Julesz

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 held in his head and addressed. Bela's science, in which he appreciated a reductionist physical approach to the function of the most complex mechanisms of brain, also could endorse a synthetic model of brain with emergent behavior.

Through the 1980s at Bell, Bela developed a powerful research group and worked exclusively with postdoctoral trainees and faculty. Before retiring from Bell in 1989, he chose to move to Rutgers University, where he was awarded the highest academic position, the New Jersey State University Professorship, to establish the Laboratory of Vision Research. There, he constructed an international team to continue examining stereovision, texture, form, color, attention, and motion.

Bela received many awards, including a MacArthur fellowship from the John T. and Catherine D. MacArthur Foundation in 1983. He used the MacArthur money to travel and spent significant time at Caltech, where he lectured to students and faculty.

An approachable man, Bela had an inexhaustible collection of anecdotes. In his last years, his health deteriorated. He would rally for visitors, and his wit and questing intelligence continued to be evident. In 2003, he had begun a second edition of *Cyclopean Perception*. Knowing Bela, that text certainly would have raised more questions about the physical nature of brain and mind than it answered.

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Rudolf Zinovievich Levitin

Rudolf Zinovievich Levitin, a distinguished scientist in the field of magnetism and a professor of physics at Moscow State University, died on 26 February 2004 in Moscow of a heart attack.

Levitin was born in Kharkov in the Soviet Union on 5 May 1928. In 1951, he graduated from Moscow State University with a degree in physics; he remained closely connected to the university until his death. Under the supervision of Konstantin Petrovich Belov, he received his PhD there in 1962 for his research on magnetoelastic properties of some antiferromagnets and rare-earth metals.

Immediately after earning his doctorate, Levitin was elected a junior researcher of the chair of general physics for the natural sciences department. Two years later, he was named a senior researcher, and he held that post until he was appointed a leading researcher in 1987.

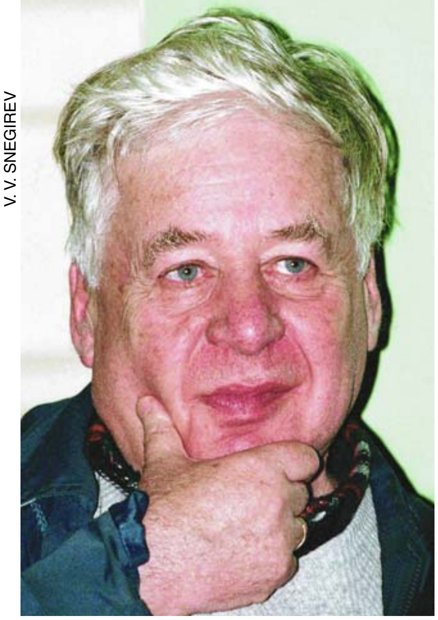
Levitin and Belov were among the founders, in 1964, of the physics department's Problem Laboratory for Magnetism, now one of the main centers in Russia for studies of solid-state magnetism. In 1972, Levitin completed his second dissertation, entitled "Investigation of Magnetic and Magnetoelastic Properties of Some Ferro-, Ferri- and Antiferromagnets in High Magnetic Fields."

A talented and bright man, Levitin carried out research that covered a wide range of problems involving magnetism of lanthanide and actinide compounds. He could deeply penetrate into the physics of phenomena and was able to clearly formulate the aim of an experiment and relate the results plainly. His work, which elucidated the nature of magnetism and of spontaneous and field-induced magnetic phase transitions in rare-earth compounds, created a basis for the theory of magnetic phase transitions,

Levitin wrote what are now classic papers on the weak ferromagnetism in hematite and on the spin-reorientation phase transitions in rare-earth iron garnets in strong pulsed magnetic fields. In 1959, he found and later systematically studied magnetostriction and other magnetoelastic effects in $3d$ and $4f$ antiferromagnets. Together with his colleagues in 1961, he discovered giant magnetostriction in lanthanide and actinide compounds, explained the nature of giant magnetostriction and its connection to the electronic structure of the given $4f$ or $5f$ ion, and suggested possible technical applications of that new phenomenon. Levitin found a number of new effects in $3d$–$4f$ intermetallic compounds that resulted from magnetic instability created because of peculiar densities of states near the Fermi level. Those effects included itinerant metamagnetism, thermally induced metamagnetism, and a large increase in the Curie temperature under a nonmagnetic dilution of the $3d$ sublattice.

Research topics that caught Levitin's attention in the late 1990s and early 2000s were the properties of low-dimensional magnetic systems, particularly quasi-one-dimensional Haldane-gap compounds, which he investigated in collaboration with optical spectroscopists, and spin-Peierls and other magnetostructural transitions, systems with different magnetic instabilities, magnets that exhibit memory of shape, and complex multisublattice magnets. He established vast and

V. V. SNEGIREV



Rudolf Zinovievich Levitin

fruitful scientific contacts with colleagues from other institutions in Russia and from leading scientific centers in the Czech Republic, Poland, France, the Netherlands, and Japan.

Levitin summarized his research in three books, *Rare-Earth Ferromagnets and Antiferromagnets* (Nauka, 1965), *Physics of Magnetic Materials and New Rare-Earth Magnets* (Znanie, 1976), and *Spin-Orientation Transitions in Rare-Earth Magnets* (Nauka, 1979), and in a series of fundamental review papers.

A brilliant lecturer, Levitin also supervised numerous PhD students and established a school of well-known magnetophysicists. He was approachable, ready to discuss any scientific problem in a friendly manner. One of the main organizers of the Moscow Seminar on Magnetism, Levitin remained an active participant until his last days. He participated on the program committees of all the conferences on magnetism in the Soviet Union and Russia, and had been a member of the Bureau of the Academic Council on Magnetism since 1988.

In 1984, Levitin was awarded the USSR State Prize for his work on magnetism of $4f$ and $5f$ compounds. He shared that honor with his colleagues in the Problem Laboratory for Magnetism and in several research institutes of the Academy of Sciences of the USSR.

Levitin's understanding of solid-state physics was deep and broad. He possessed a youthful spirit and was always open to new ideas. The day before he died, he enthusiastically discussed the paper he was writing on magnetic properties of new ferroborate crystals. Levitin was widely respected and loved in the physics community for his professionalism, his