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Tullio Eugenio Regge

Distinguished Italian theoretical physicist Tullio Eugenio Regge passed away on 24 October 2014 in Orbassano, Italy, after an acute attack of pneumonia.

Tullio was born on 11 July 1931 in Turin, Italy. After graduating from the University of Turin in 1952 with his *laurea* in physics, he studied with Robert Marshak at the University of Rochester. From 1958 to 1959, he visited the Max Planck Institute for Physics, directed by Werner Heisenberg, in Munich. In 1961 the University of Turin appointed Tullio as a full professor. He went to Princeton University in 1963, and two years later was made a member of the Institute for Advanced Study (IAS), at the time guided by J. Robert Oppenheimer. In 1979 Tullio was back in Turin as a professor, first at the University of Turin and then at the Polytechnic University.

In 1983 Tullio and I founded the Institute for Scientific Interchange (ISI), today a top research organization in complex systems and data science. We based the institute on the IAS mission to cultivate a legacy of living on the edge of science, with a small, elite group of visionary scientists pursuing their ideas without constraints. Tullio was president of ISI for 20 years, and then honorary president until his death.

Tullio greatly enjoyed popularizing science. From 1989 to 1994, he served as a member of the European Parliament. Among his numerous recognitions were the 1964 Dannie Heineman Prize for Mathematical Physics from the American Physical Society, the 1996 Dirac Medal from the Abdus Salam International Centre for Theoretical Physics, and the 2001 Pomeranchuk Prize from the Institute for Theoretical and Experimental Physics.

The name Regge is part of the lexicon of modern physics—Regge poles, reggeons, Regge calculus, Regge symmetries of 3- j symbols—and the community of physicists resounds with it, something that amused Tullio and about which he enjoyed making practical jokes and puns. His contributions cover most of the theoretical physics: general relativity, quantum mechanics and field theory,



Tullio Eugenio Regge

astrophysics, statistical mechanics, low-temperature physics. Regge poles and Regge calculus exemplify the depth and width of his influence.

The notion of Regge poles, which Tullio proposed in 1957, came out of his bold idea of studying the potential scattering amplitude as a function of angular momentum and analytically continuing the angular momentum to complex values. The amplitude grows as a power of the cosine of the scattering angle, with the energy-dependent exponent equal to the angular momentum that a would-be bound state with that energy would have. Such an exponent, a function of the energy squared, defines a Regge trajectory. Tullio's ideas inspired the formulation of a theory in which hadrons are bound states lying on Regge trajectories. Within that framework, Gabriele Veneziano formulated his self-consistent scattering amplitude, the precursor of string theory. Regge poles also help us understand glory, that ephemeral optical phenomenon similar to a rainbow.

In 1961 Tullio introduced his piecewise-linear reformulation of general relativity, now universally known as Regge calculus, in an article titled "General relativity without coordinates" in *Il Nuovo Cimento*. He loved the classics of mathematics and was fascinated by Carl Friedrich Gauss's "theorem egregium" (remarkable theorem), which proves that any surface's Gaussian cur-

vature is intrinsic: Although defined as a product of the principal curvatures, which depend on how the surface is immersed in ambient space, it is independent of that space. But in general relativity, as encapsulated by John Wheeler, "Matter tells spacetime how to curve; spacetime tells matter how to move."

Regge calculus circumvents the difficult formalism of differential geometry through discrete objects that characterize the intrinsic metric structure of curved spacetime, and it reduces Einstein's equations to a set of expressions that depend only on their value. Such combinatorial objects are simplicial complexes, structures whose constraints are twofold: They have a flat metric in their simplices, and their n -simplices are attached to each other only along pairs of $(n - 1)$ -simplices.

The space metrics thus generated are fully characterized by edge lengths. Local coordinates, indispensable in differential geometry, are no longer there, yet the equivalence principle of relativity holds naturally, as the simplex metrics can be chosen to be Minkowskian, and triangulations with vanishing edge lengths let us recover the physical, continuous Lorentz spacetime. Tullio's winning intuition, inspired by Gauss's theorem, was to define curvature in that discrete representation in terms of angle deficit and to express the Einstein-Hilbert action only through edge lengths, with no need to resort to the Riemann curvature tensor. Many models of quantum gravity are rooted in Regge calculus.

I have fond memories of Tullio. The first time I met him was at CERN in 1972. His first words to me were, "Did you read Gauss's original work?" When, embarrassed, I confessed that I had not, he said, "You should. In Latin, of course." And I did. Later, I asked him how he had conceived the beautiful conceptual scheme of Regge calculus. His answer: "I was sitting at the barber's shop and I had mirrors both in front and at the back. Looking at my image in the mirror, I saw infinitely many images and images of images, both of my face and of the nape of my neck. I thought how nice it would be to imagine this in four dimensions."

Besides being a great scientist, Tullio was a cultivated man with a deep love for Mozart's music, and a warm and gentle human being. His exceptional intellectual vigor and unyielding ethical principles earned him respect as a teacher, mentor, and colleague. With his incredible comprehension of science, deep knowledge, sense of humor, and curiosity, he left an indelible imprint on

those who had the fortune of interacting with him. We shall dearly miss him.

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Juerg Xavier Saladin

Juerg Xavier Saladin, a pioneer in nuclear structure studies and a professor emeritus at the University of Pittsburgh, passed away on 29 May 2014 in Pittsburgh, Pennsylvania.

Born on 25 July 1929 in Solothurn, Switzerland, Juerg pursued his undergraduate and doctoral studies at ETH Zürich, from which he received BS and PhD degrees in nuclear physics in 1954 and 1959, respectively. His doctoral thesis on nuclear scattering and polarization was completed under the direction of Pierre Marmier. As a postdoctoral researcher at the University of Wisconsin–Madison, Juerg continued to pursue his interest in polarization measurements in transfer reactions.

Juerg joined the faculty of the department of physics and astronomy at the University of Pittsburgh in 1961. Shortly afterward, he began his research studies using the newly installed, and the world's first, three-stage Van de Graaff accelerator. He was among the first to use the reorientation effect in Coulomb excitation to carry out precise measurements of the quadrupole moments of nuclear excited states and infer nuclear shapes. Particularly noteworthy were his group's

comprehensive studies of the transition of nuclear deformation from a prolate shape to an oblate shape.

In the early 1970s, Juerg developed a quantum mechanical formulation of the Coulomb excitation process, which allowed a more accurate computation of cross sections compared with the earlier semiclassical calculations. That code was used for an extensive study of hexadecapole deformation in rare-earth nuclei. His results showed a beautiful evolution from positive deformation values ("barrel" nuclei) at the beginning of the nuclear shell to negative values ("clover-leafed" nuclei) in the second half of the shell.

In the 1980s Juerg used gamma-ray spectroscopy to study nuclear structure at high spins. He conceived and constructed the Pittsburgh array of Compton-suppressed germanium detectors—a first for a university group. He and his collaborators used the array at several laboratories to explore the structure and shapes of nuclei, how different shapes might coexist and mix, and how nuclear shapes could evolve with increasing angular momentum. That work, with collaborators who were, in many cases, his former students, culminated in studies of highly elongated "super-deformed" medium-mass nuclei.

Juerg was the director of Pitt's Nuclear Physics Laboratory from 1980 until 1997. Although he retired from the university in 1998, he maintained his passion for nuclear physics and continued his research for many years as a professor emeritus.

During an academic career spanning nearly 40 years, Juerg mentored more than 30 graduate students and postdoctoral fellows. Not only did he provide his students with a superb, broad, and balanced training experience, he also invariably acted as their greatest advocate as they launched their careers. Remarkably, Juerg continued his personal and professional association with his former students long after they had graduated, and he followed their careers with great interest. Many of his former students considered him a dear friend and a father figure to whom they turned regularly for support, wise counsel, and sound advice. Their appreciation was in evidence when 17 of his former students, including several from overseas, attended the symposium held in honor of his retirement.

A lover of classical music, Juerg had a great sense of humor and was full of interesting life stories, which he loved to relay. A particularly memorable event occurred when he was a young

captain in the Swiss Army and was leading an armored column on practice maneuvers during a storm. They got lost and arrived at a nondescript barbed-wire fence. Undeterred, Juerg ordered the wires to be cut and the column to keep moving. Sometime later, the column reached a border crossing that was manned by French border guards—on the wrong side! Only then did he realize that they had been conducting their military exercise in the wrong country, making him the most recent commander to invade France.

Juerg had boundless energy and a contagious enthusiasm for science, which he conveyed to the next generation. He will be remembered for his warm, vibrant personality and for the profound and lasting effect he has had on his friends, students, and colleagues.

Cyrus Baktash

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Charles Hard Townes

Charles Hard Townes died peacefully on 27 January 2015 in Oakland, California. Coinventor of the maser and laser, he was famous as well for his research in microwave spectroscopy and astronomy.

Charlie was born on 28 July 1915 in Greenville, South Carolina, the fourth of six children. He grew up on a farm, and he often emphasized that his interest in science and nature started there, when he and his older brother, Henry (later a well-known entomologist), explored the woods and streams around their home. After graduating from Furman University in 1935, he got his master's at Duke University and carried out his PhD work at Caltech. His thesis, completed in 1939 under William Smythe, was on the separation of isotopes and the determination of their nuclear spins. He then took a position at Bell Labs in New York, where he worked on secondary electron emission from surfaces bombarded with ions.

During World War II, Charlie worked on shortwave aircraft radar. Profiting from the technical know-how he had gained, in 1945 he began exploring the properties of molecules with high-resolution microwave spectroscopy, initially at Bell Labs and, starting in 1948, as an associate professor at

UNIVERSITY OF PITTSBURGH CIDDE



Juerg Xavier Saladin