Richard Mansergh Thorne (1942–2019)

A pioneering space plasma physicist who led the way in understanding how complex wave-particle interactions control Earth's radiation belts and low-level auroral light emissions.

Richard Mansergh Thorne. Credit: Richard Horne

By Richard B. Horne and Bruce Tsurutani 20 hours ago

Richard Thorne, distinguished professor emeritus at the University of California, Los Angeles, passed away on 12 July 2019 at the age of 76. He will be sadly missed by his family, friends, and former students.

Richard was born in England during an air raid in the Second World War. Attending grammar school, he honed his mathematical abilities and became captain of the school cricket team. His love for soccer, tennis, badminton, and other competitive sports never left him and was one of his hallmarks later in life. He obtained his bachelor of science in mathematical physics at the University of Birmingham in 1963 and completed his Ph.D. on the distribution of interstellar gas in the galaxy at the Massachusetts Institute of Technology in 1968. While pursuing his doctorate, Richard worked at the Avco Everett Research Laboratory in Massachusetts in 1965 and 1966, and it was during this time that he found his real forte: space plasma physics.

Illuminating Earth's Radiation Belts

In 1968, Richard was offered a faculty position at the University of California, Los Angeles (UCLA), in the Meteorological Department (as chair, he later changed the department's name to the Department of Atmospheric Sciences, and it is now the Department of Atmospheric and Oceanic Sciences). He spent the rest of his career there and once noted, "I have never applied for a job in my life"—a concept almost unthinkable today.

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At UCLA, Richard started researching the origin and structure of Earth's radiation belts (https://eos.org/research-spotlights/how-earths-outer-radiation-belts-lose-their-electrons)—the torus-shaped regions that encircle Earth and contain high-energy (relativistic) electrons and protons trapped by the geomagnetic field. At the time it was known that the electron belt was separated into inner and outer regions with a gap or slot region between them. But what causes the slot to form was unknown. Richard showed that a special type of plasma wave could interact with trapped electrons and precipitate them into the atmosphere. This loss process depletes the belts and creates the slot region. He led studies showing that the radiation belts' quiet time structure—the structure they have most of the time when not disrupted—could be explained by inward electron transport from the outer reaches of the geomagnetic field followed by losses due to wave-particle interactions. The impact of this work was profound. The model provides our basic understanding of the radiation belts at Earth, Jupiter, and Saturn.

Richard went on to point out that as relativistic electrons penetrate deeper into Earth's atmosphere, they cause chemical reactions that produce various ozone-depleting forms of nitric oxide. This work helped open a new area of research testing whether variability in solar output can be transmitted to the upper atmosphere through changes in chemistry caused by particle precipitation.

A Taste for Controversy

The 1960s and 1970s were a golden age of discovery in space research, during which major findings sparked several controversies. Richard was no stranger to controversies; in fact, he relished them. In one prominent example, Richard waded into a debate over the origin of a newly observed type of wave detected by satellites known as chorus waves (https://www.ucalgary.ca/above/science/chorus), which are characterized by short bursts of wave power lasting a few tens of milliseconds with a rapidly rising frequency. It had been suggested that the electric power grid, through a phenomenon called power line harmonic radiation, played a role in exciting chorus waves, but Richard thought otherwise.

The battle raged in a series of papers published in *Science* and elsewhere, hinging on the notion that if chorus waves were related to the power grid, then the satellite-detected signals should be stronger over land than water and should be weaker on Sundays, when power demand decreased. However, Richard could not find evidence to support this in the data. He also noted that power line harmonic radiation was not seen in the outer magnetosphere, where chorus was most prevalent, and that chorus was observed on geomagnetic field lines that mapped to much higher latitudes than the power grid. In the end, Richard was proven right: We now know that chorus is generated by a natural plasma instability.

Probing Wave-Particle Predictions

In the late 1980s, Richard developed a long-lasting collaboration with one of us (Richard Horne). We eventually published more than 80 papers together on wave-particle interactions and wave propagation at Earth and planets; these papers gained notoriety as the Thorne and Horne papers by the two Richards. Many of the ideas they detailed were conceived in England, in a rural Cambridgeshire pub over a pint of Old Speckled Hen—his favorite beer.

From 1998 onward, Richard led many studies demonstrating how chorus waves could accelerate electrons to relativistic energies.

As the 1990s drew to a close, it became clear that the electron radiation belts are highly dynamic and that new theories were required to explain their behavior. Although Richard was primarily a theorist, he kept a close eye on related observational work as a check on his theoretical predictions. From 1998 onward, he led many studies demonstrating how chorus waves could accelerate electrons to relativistic energies. Testing the wave theory of electron acceleration became one of the primary goals of NASA's Van Allen Probes (http://vanallenprobes.jhuapl.edu/) satellite mission. Launched in 2012, the mission did, indeed, detect the signatures predicted by wave theory—a tremendous result.

Richard led other seminal work on wave-particle interactions, showing, for example, the relative importance of ground-based radio transmissions (used to communicate with submarines) compared with other types of plasma waves in causing long-term loss of relativistic electrons from the radiation belts. This loss process is most effective in the inner electron belt and in removing some of the electrons injected into the belts by high-altitude nuclear detonations.

Richard also changed our ideas about the origin of the diffuse aurora (https://eos.org/research-spotlights/bringing-clarity-to-what-drives-auroras)—a low-level light emission quite separate from the visible and more commonly recognized discrete aurora. In 2010, he showed conclusively that chorus waves are responsible for the electron loss into the atmosphere that causes the diffuse aurora, a finding that resolved a long-standing controversy since the 1960s.

A Passion for Life

Richard had a relaxed manner and was never in awe of anyone who had a title or distinction. He highly respected good scientists who had done, as he would say, "something fundamental." Richard published over 400 research papers in AGU journals—articles that were cited more than 23,000 times. He was an AGU member since 1978 and was elected Fellow in 2000. As an excellent speaker, he always attracted an audience at AGU meetings. He served the community in many ways: as part of Geospace Environment Modeling working groups, the NASA Living with a Star Program (https://lws.gsfc.nasa.gov/), and NASA review boards. He was also a coinvestigator on the Galileo (https://www.jpl.nasa.gov/missions/galileo/), Juno (https://www.nasa.gov/mission_pages/juno/main/index.html), and Van Allen Probes missions.

Richard was passionate about everything he did in life. He loved his family and was never happier than when he was with his wife, Moni. He is famously remembered, from his early days, for his flamboyant shirts, bell-bottom trousers, and spectacular beard as well as his habit of dancing on tables. He loved gardening (which he learned from his grandfather), hiking, sports, and English beer, and he avidly followed the Manchester United football club.

But science was perhaps his greatest passion. He had a relaxed manner and was never in awe of anyone who had a title or distinction. He highly respected good scientists who had done, as he would say, "something fundamental." He approached each problem as a mystery to be better understood, seeking truth and not letting politics stand in his way. He inspired those of us who had the privilege of working with him to follow his example.

Author Information

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