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Richard Lewis Arnowitt

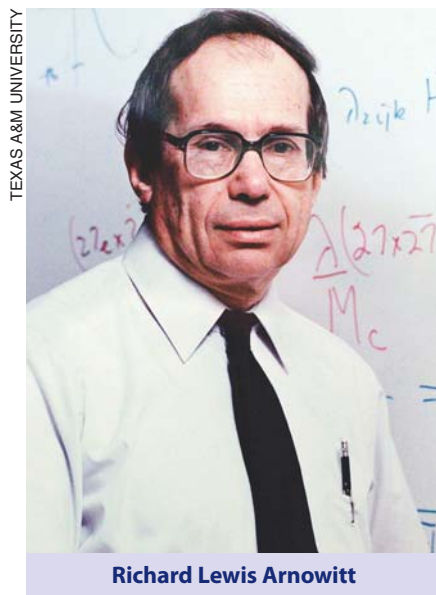
Richard Lewis Arnowitt, distinguished professor emeritus at Texas A&M University (TAMU) and an internationally renowned figure in general relativity (GR) and high-energy physics, died on 12 June 2014 after a gallant struggle with cancer. His older brother, Edwin, has begun an endowment in Dick's name for graduate student support at TAMU.

In GR, Dick is best known for the Arnowitt-Deser-Misner (ADM) formulation, which expresses GR as a modern field theory. His major work in high-energy physics was with Ali Chamseddine and one of us (Nath) on the development of supergravity grand unification, specifically the minimal SUGRA model, a tool commonly used in the search for new physics beyond the standard model.

Dick was born in New York City on 3 May 1928 and grew up there when it was the center of production of future physicists. A science prodigy, he finished high school early and went to Rensselaer Polytechnic Institute (RPI), where he obtained simultaneous bachelor's and master's degrees at 20. The oldest technical institute in the US, RPI was a mecca for young scientists during the postwar years, in part due to the proximity of General Electric's renowned Schenectady research laboratory.

Dick then went to Harvard University with his fellow RPI graduate George Benedek. Benedek remembers his RPI and Harvard years with Dick with pleasure, as does another of us (Deser), who shared classes, projects, and desks with him all four years. Dick's thesis with Julian Schwinger, on radiative corrections to hydrogen's hyperfine structure, was one of the last of the postwar quantum electrodynamics loop calculations. Schwinger mentioned to one of us (Scully) that he always appreciated Dick and regarded him very warmly. Given Schwinger's elevated standards, that is high praise indeed!

After postdoc stints at the Berkeley Radiation Laboratory in 1952–54 and the Institute for Advanced Study in 1954–56, Dick joined Syracuse University's fac-



Richard Lewis Arnowitt

ulty in 1956. He moved to Northeastern University in 1959 and in 1986 was called to TAMU, where he founded its Center for Theoretical Physics.

Dick's physics career was illustrious and prolific, with more than 330 publications on a wide range of topics. His Syracuse years included the work, with his student Marvin Girardeau, on the highly cited pair theory for many-boson systems. The Girardeau-Arnowitt formalism is particle-number conserving and thus avoids subtle pitfalls associated with, for example, a perturbative analysis of the S-matrix.

The ADM formulation, published in a series of some 15 papers in 1958–62, garnered its authors the American Physical Society's 1994 Dannie Heine-man Prize for Mathematical Physics. The ADM definition of GR energy is one of the formulation's best-known consequences. More generally, ADM remains a standard tool in GR—for example, in numerical methods to compute nonlinear gravitational radiation from black hole mergers.

With Chamseddine and Nath, Dick coauthored a highly cited paper on supergravity grand unification in 1982. Their mSUGRA model is part of the theoretical arsenal in the search for new physics at CERN's Large Hadron Collider. With Marvin Friedman and Nath, Dick developed an effective Lagrangian

method for current-algebra analyses, and, with Nath, he provided a solution to the so-called $U(1)$ problem of why the ninth pseudoscalar meson, η' , is so much heavier than the octet pseudoscalars. He was a coauthor with Nath and Bruno Zumino of the first local supersymmetry via a superspace formulation, a precursor of supergravity.

While he was at TAMU, Dick's other contributions—some in collaboration with Bhaskar Dutta, Teruki Kamon, and other colleagues—ranged from future accelerator designs to topics in CP violation, dark matter, and cosmology.

Dick's distinguished teaching career included mentoring a number of PhD students; publishing many review papers; and presenting a vast array of courses, plenary talks at international conferences, and summer school lectures. In recent years he was a frequent invited lecturer at the Erice International School of Subnuclear Physics in Sicily. Dick was an exemplary citizen as well and contributed to the building up and the welfare of his physics departments, as the undersigned can attest. Dick's more than six decades in physics, as well as his personal qualities, will long be remembered by the many students, colleagues, and friends he attracted worldwide.

Stanley Deser

*Brandeis University
Waltham, Massachusetts
California Institute of Technology
Pasadena*

Charles Misner

*University of Maryland
College Park*

Pran Nath

*Northeastern University
Boston, Massachusetts*

Marlan Scully

*Texas A&M University
College Station
Princeton University
Princeton, New Jersey*

Warren Keith Sinclair

Warren Keith Sinclair celebrated his 90th birthday amid family shortly before his death on 14 May 2014 in Escondido, California. We personally have lost a dear friend, and the radiation science community has lost a most respected colleague. His career, which spanned three continents and almost 50 years, can be divided into three phases: medical physics, radiobiology, and radiation protection. He excelled in all.