

## PREFACE

With the death of Edward Teller in 2003, the world lost one of the last giants of twentieth century physics. Of all the larger-than-life theoretical physicists who developed and applied the ‘new physics’ in the revolutionary years 1925–40, he was survived only by Hans Bethe and John Wheeler; now they too are gone.

For Teller’s many friends, colleagues and students, it was impossible not to commemorate his centenary, particularly for those of us who have had the privilege of being part of his proudest legacy, the Lawrence Livermore National Laboratory. We decided that a fitting tribute to his memory would be a celebration of his science. Science was his lifelong passion and importantly, we wanted to focus on Teller’s remarkable achievements in basic and applied science, which, in the past, have often been overshadowed by Teller’s broader impact on national defense.

From the outset, we were aware that arranging the one-day symposium would pose a challenge. Teller’s significant contributions to science and education were numerous and very wide-ranging, and we wanted speakers who were not only world-leaders in the topics he had pioneered or enriched, but also knew how to capture and present the ideas in a way that reflected Teller’s own approach to science: beginning from basics and always grounded in physical phenomena. In this regard, we feel that we succeeded with the ten lectures that were presented at the symposium. Held on May 28<sup>th</sup>, 2008 in the Bankhead Theatre in Livermore, California, the symposium was attended by over 200 guests from around the world. Focusing on snapshots of Teller’s key achievements in science, their still growing impact, as well as Teller’s legacy in scientific education, the speakers illuminated his contributions in a wide variety of areas ranging from

quantum chemistry, basic nuclear and particle physics, condensed matter, and plasma physics.

Beginning with charming reminiscences of Teller at the labs by George Miller, Bruce Tarter, Siegfried Hecker, current and former directors of the Livermore and Los Alamos labs, the program continued with an overview (by one of us, SBL) of Teller's intellectual origins and his science. Partly anticipating some of the subsequent speakers, examples discussed here included Teller's physical explanation of Landau diamagnetism, the Jahn-Teller effect, Gamow-Teller interactions in beta decay, conical intersections (and how they later led to 'Berry's phase'), the Lyddane-Sachs-Teller relation in dielectrics and, by analogy Goldhaber-Teller nuclear resonances, and the Northrop-Teller adiabatic invariant in charged particle motion in dipole magnetic fields.

Then, Robert Littlejohn, of UC Berkeley, discussed Teller's 1930's work on the conical intersections of the energy surfaces of three or more interacting atoms and their ramifications for chemical kinetics, beautiful generalizations to Stern-Gerlach systems, and Littlejohn's and his collaborators' work on the consequences of mode crossings for ionospheric waves.

Wick Haxton, of the University of Washington, next took up the legacy of two of Teller's major contributions to nuclear and particle physics: Gamow-Teller transitions and Goldhaber-Teller resonances. Gamow-Teller transitions, are, of course, a key ingredient in the theory of beta decay and overall electro-weak unification. Haxton's talk focused on how neutrino physics has shed particular clarity on the role of G-T transitions in the standard model of elementary particles and beyond. In addition, keeping to his theme of neutrino physics, he described how, in his own work, a standard model vector-axial vector current generalization of Goldhaber-Teller resonances led to the understanding of the astrophysical production of fluorine.

The afternoon sessions began with talks on Teller's influence on the development of plasma physics — in both 'high energy density' physics and magnetic fusion. Steven Rose, of Imperial College, London, described Teller's post war intellectual influence over development of the theory and application of dense plasmas including equations of state, radiation opacities, laser-plasma physics and inertial fusion, finally bringing it into contact with his own recent

work on novel ‘fast ignition’ configurations. Illustrating Teller’s physics teaching style from the same period, he gave interesting examples from the written notes for a quantum mechanics course Teller and Konopinski gave at Los Alamos in 1946.

Nathaniel Fisch, of Princeton University, followed, describing Teller’s tremendous impact on fusion, beginning with the demonstration of the Teller-Ulam invention, as well as his insights with Northrop concerning the stability of charged particle motion in magnetic dipole fields (the latter being important to Fisch’s own work). Fisch also discussed how many of Teller’s students and colleagues from the 1940s and 1950s (such as Marshall Rosenbluth, Harold Furth, and Richard Post) played important roles in driving developments in magnetic fusion.

Turning back to the microscopic properties of matter and statistical physics, Malvin Kalos of Livermore, described the powerful impact of the Monte Carlo method on modern computational physics. In particular, Kalos discussed applications of the ‘MR<sup>2</sup>T<sup>2</sup>’, or Metropolis, Rosenbluth, Rosenbluth, Teller, and Teller method, often cited as one of the ten most important numerical methods of all time.

Janos Kirz (of Lawrence Berkeley National Laboratory and Stony Brook University) talk beautifully wove together family reminiscences of living the Teller house in Berkeley several years in the late 1950’s after Kirz’s escape from Hungary, with a discussion of Teller’s ideas about future energy systems. Kirz pointed out that many of Teller’s ideas (for example, concerning reactors) are becoming more relevant today and deserve another look.

Finally, John Holzrichter, President of the Hertz Foundation, described Teller’s remarkable impact on education, from his own students, to university life (both in Europe and the US), then driving applied physics education, and in the Hertz Foundation (which has funded over 1050 graduate fellows since its inception).

In addition to the written contributions of these speakers, we have also appended DVD’s with videos of the presentations. These videos as well as the speakers’ slides may also be seen at: <https://tellercentennial.llnl.gov>. In this volume, we have also added the transcript of a never-before published April 2000 recording of Teller speaking on the history of science, his own role in the

twentieth century physics and its applications, as well as his thoughts on the challenges facing the twenty-first.

An event like this required the hard work of many dedicated colleagues. We would particularly like to thank Tiffany Ashworth, Lauren de Vore, George Kitrinis, Evelyn Laurant, Jim Mcinnis, Barbara Nichols, Joanne Smith, Kirsten Sprott, Denise Steele, Jeannette Tootle, and Kathy Young for their terrific efforts making the symposium a reality. Two local wineries, Retzlaff Estate Wines, and Fenestra Winery graciously contributed wines for the event.

Finally, we would like to thank the Lawrence Livermore National Laboratory, The University of California, The Hoover Institution of Stanford University, and The Fannie and John Hertz Foundation for their generous support. Without them, this symposium would not have been possible.

Stephen B. Libby  
*Physics Department*  
*Lawrence Livermore National Laboratory*  
*Livermore, California*

Karl A. van Bibber  
*Vice President and Dean of Research*  
*Naval Postgraduate School*  
*Monterey, California*

# Edward Teller Centennial Symposium

Modern Physics and the Scientific Legacy of Edward Teller

## AGENDA May 28, 2008

**8:00 a.m.** Registration & Continental Breakfast

**Session 1** **Chair:** Karl van Bibber, LLNL

**8:30 a.m.** Welcome

George Miller, LLNL

**8:45 a.m.** Scientific Reflections

Bruce Tarter, LLNL

Siegfried Hecker, Stanford University & LANL

**9:30 a.m.** Edward Teller's Scientific Legacy

Stephen Libby, LLNL

**10:15 a.m.** Break

**Session 2** **Chair:** Hans Mark, University of Texas at Austin

**10:30 a.m.** Conical Intersection, Light Cones, and Mode Conversion

Robert Littlejohn, UC Berkeley

**11:15 a.m.** Edward Teller and Nuclei: Along the Trail to Neutrinos

Wick Haxton, University of Washington

**12:00 p.m.** Lunch

**Session 3** **Chair:** Cherry A. Murray, LLNL

**1:15 p.m.** Surprises in High-Energy-Density Physics

Steven Rose, Imperial College

**2:00 p.m.** Plasma Physics and Controlled Nuclear Fusion

Nathaniel Fisch, Princeton University

**2:45 p.m.** Monte Carlo Methods in the Physical Sciences

Malvin Kalos, LLNL

**3:30 p.m.** Break

**Session 4** **Chair:** Lowell Wood, Hoover Institution

**3:45 p.m.** Energy

Janos Kirz, LBNL & Stony Brook University

**4:30 p.m.** Edward Teller and Higher Education

John Holzrichter, Hertz Foundation

**5:30 p.m.** Reception

**6:30 p.m.** Adjourn



### Symposium Sponsors

Lawrence Livermore National Laboratory is a premier research and development laboratory dedicated to the application of science and technology to enhance national security, meet energy and environment needs, and advance economic competitiveness.

The mission of the University of California is to serve society as a center of higher learning, providing long-term societal benefits through transmitting advanced knowledge, discovering new knowledge, and functioning as an active working repository of organized knowledge.

The Hertz Foundation mission is to provide unique financial and fellowship support to the nation's most remarkable Ph.D. students in the physical, biological and engineering sciences. Hertz Fellows become innovators and leaders serving in ways that benefit us all.

The Hoover Institution, Stanford University, is a public policy research center devoted to advanced study of politics, economics, and political economy—both domestic and foreign—as well as international affairs. The institution puts its accumulated knowledge to work as a prominent contributor to the world marketplace of ideas defining a free society.

Wines for this event were most graciously provided by Fenestra Winery ([www.fenestrawinery.com](http://www.fenestrawinery.com)) and Retzlaff Estate Wines ([www.retzlaffwinery.com](http://www.retzlaffwinery.com)).

Catering presented by Checkers Catering & Special Events ([www.checkerscatering.com](http://www.checkerscatering.com)).

