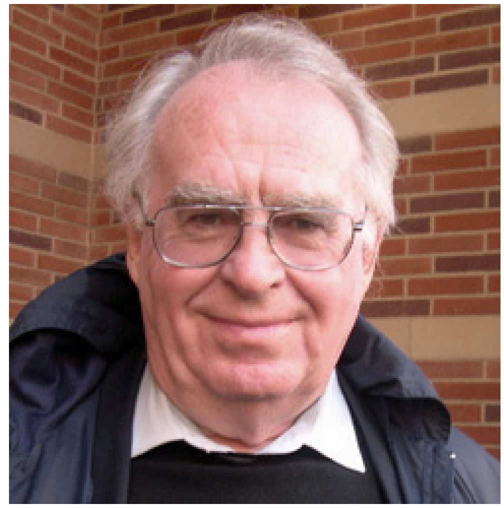

IN MEMORIAM

David B. Cline
Professor of Physics and Astronomy
UC Los Angeles
1933-2015

Distinguished Professor of Physics and Astronomy David B. Cline, a driving force behind experiments aimed at understanding the world of elementary particles and forces has died.

Still active in teaching and research at the time of his death, Cline had remarkably broad passions for both. He taught standard courses with content ranging from introductory astronomy and physics for non-science majors to advanced graduate topics; he also took great pleasure in communicating modern physics to students via both Honors Collegium and Fiat Lux courses of his invention.

Cline's scientific career branched out from its core in the study of elementary particles to related fields, including the acceleration of high-energy particle beams, the quest to identify the nature of dark matter, and the cosmological interpretation of astrophysical observations. In all these endeavors, he organized numerous workshops and conferences at UCLA to bring together the world's experts. His insatiable curiosity even extended to organizing a small conference to discuss the question of the physical origin of the homochirality of life, i.e., why certain molecules in living systems are always left-handed.

After receiving a B.S. and masters in physics at Kansas State University, Cline earned his Ph.D. in 1965 at the University of Wisconsin under the supervision of William Fry. At that time, the sub-nuclear "weak force" was hypothesized to be carried by an electrically charged particle, the W boson. A crucial question was whether or not the weak force also had an electrically neutral carrier, the Z boson. Cline and his collaborators studied the decays of a particle called the kaon, and appeared to rule out the existence of a Z boson, if it behaved as expected.

Beginning in the late 1960's, Cline, by then a physics professor at the University of Wisconsin, and his collaborators (including Carlo Rubbia, Alfred Mann and others) performed a series of difficult, innovative experiments to study the weak force at Fermilab outside Chicago. They used beams of neutrinos, electrically neutral particles observed to interact in such experiments only via the weak force. After a period of controversy, they agreed with the claim coming from the CERN laboratory in Geneva that certain neutrino interactions required the Z boson after all. The puzzle of consistency with the older kaon decay data was meanwhile solved by theorists who postulated the existence of a fourth type of quark, called charm (in addition to Gell-Mann's original up, down, and strange), which was discovered by others soon thereafter.

The next challenge was to produce these W and Z bosons directly. Carlo Rubbia, Peter McIntyre, and David Cline made a radical proposal, in a famous 1976 paper, to use existing proton accelerators to make antiprotons and collide them head-on with protons. Sufficient energy would then be concentrated in these collisions to produce the massive W and Z bosons. The proposal was first implemented at CERN, resulting in the discovery of W bosons and Z bosons in 1983 by physicists including Cline, leading to the Nobel Prize for Rubbia and Simon van der Meer (the inventor of the methods used to make the antiproton beams).

In 1984, shortly after the U.S. Congress enacted the Small Business Innovation Research program to assist small businesses, Cline took advantage by co-founding Particle Beam Lasers, Inc., a small company engaged in developing technologies and subsystems to accelerate and control elementary particle beams. Cline served as a director of the company until the time of his death.

In 1986, Cline moved from Wisconsin to UCLA, where he promoted new directions of research in the department. Foremost among these was to find new faculty dedicated to the rapidly growing field of accelerator physics that had outgrown its roots in nuclear and particle physics to develop novel accelerators for use in many other fields, including X-ray lasers and medical sciences. In addition to performing research on advanced particle physics accelerators, he recruited the first dedicated accelerator physics faculty member at UCLA, Claudio Pellegrini. Pellegrini further shaped the department, and recently was awarded the Enrico Fermi Presidential Award. Cline was also a champion of the emerging field of astroparticle physics both internationally and at UCLA, where he worked with others to attract new faculty and to pursue new intellectual directions including gamma ray astronomy. UCLA now has unique, world-class efforts in both accelerator physics and astroparticle physics.

Meanwhile in the early 1990's, a plan for an enormous circular accelerator, the Superconducting Supercollider with beam energies over ten times higher than the Tevatron, was being pursued in the U.S. Cline and a few others in the U.S. chose to work on a competing CERN-based effort called the Large Hadron Collider, and he was one of the founders of one of the large detector collaborations known as CMS. When the

U.S. supercollider was canceled by Congress in 1993, U.S. participation in the CERN collaborations dramatically increased, eventually reaching 30% of the 2000 member CMS Collaboration. Cline proposed that UCLA be a major CMS detector assembly and testing site, which led to a very successful project on the west campus of UCLA. From UCLA's early participation in CMS, the effort grew to include the involvement of several more professors, numerous undergraduate and graduate students and UCLA's international leadership in several aspects of CMS. In 2012, the CMS collaboration and the ATLAS collaboration announced the discovery at CERN of the Higgs boson, the particle associated with the mechanism giving rise to the masses of the W and Z bosons.

Cline was also one of the pioneers of the use of the liquefied noble gases as particle detectors, a technique having multiple applications in diverse areas of particle physics. Cline was involved in the realization of the ICARUS detector in Italy, which at 600 tons is the largest such detector to date. Originally built to study neutrinos from the sun, it was ultimately used to detect neutrinos beams from CERN. Cline was an early advocate of scaling up such detectors to tens of thousands of tons. A decades-long international effort eventually led to the current plan to place a 40,000 ton liquid argon detector deep underground in South Dakota to study neutrinos from a new Fermilab beam and to perform other frontier physics research. Cline remained enthusiastic about this line of research until the end of his life.

Cline and his UCLA group made innovations in the development of the use of liquid argon and xenon to detect dark matter, a substance that appears to make up most of the mass of the Milky Way and other galaxies. Such dark matter particles may be streaming through all of our matter, occasionally bumping into nuclei and depositing tiny amounts of energy that can be detected only by extremely sensitive detectors. The UCLA dark matter group continues to collaborate on experiments using both argon and xenon.

As the dark matter continues to evade unambiguous confirmed detection, numerous other techniques have been employed to understand its nature, and intense theoretical work is ongoing to try to put together pieces of the puzzle. Beginning in 1994, Cline has organized a biannual conference near UCLA, inviting all the international researchers in this area. This became an extremely popular, major event in the particle and astroparticle physics communities, and the organizing committee is enthusiastically continuing with plans for the twelfth such conference in February 2016.

While working on particle and astroparticle physics at UCLA, Cline continued his work on particle beam physics and particle accelerators, leading a group that performed many frontier experiments on advanced accelerators and detectors, in collaboration with Brookhaven National Laboratory. He made a strong contribution to the international program to develop a muon collider as an alternative to electron-positron colliders. Many of his students in this field now have important positions at national laboratories.

Cline had an inquisitive and insatiable thirst for knowledge and a remarkable memory. He was dynamic in spirit, and demanding and relentless in pursuing scientific ideas. His creativity, enthusiasm, and passion for new devices and experimental techniques kept him well placed at the forefront of physics research.

Cline was preceded in death by his beloved son David Bruce Cline Jr., his parents Ella Mae Cline and Andrew Bruce Cline, and his sister Sandra Cline. He is survived by his children Richard Andrew Cline, Heather Alane Cline, Daphne Aileen Boyle, and Yasmin Cline; and his eight grandchildren Connor, Brendan, and Ryan Boyle; Chiara, Gina, and Ilaria Cline; Myles Cline Cence; and Skye Rose Cline.