at the High Energy Physics Laboratory. At first, when the Mark III was still being finished, the research was limited to a top energy of 200 Million Electron Volts (MeV), but eventually the maximum energy got up to its design value of 1000 MeV. These electron scattering studies continued over the next 20 years and elucidated the distribution of electric charge (and the associated magnetism) within atomic nuclei, and even in the alpha particle and the proton and the neutron. For the first time the proton and the neutron were shown to be non-point particles and therefore possessed structure. For this work Hofstadter was awarded the Nobel Prize in Physics in 1961.

Hofstadter continued his interest in particle detectors. In 1968-1970 and thereafter, Hofstadter and his colleague, Dr. E. Barrie Hughes, developed new detectors for high energy physics. The “Crystal Ball,” developed at Stanford and SLAC, was the outcome of this research. The Crystal Ball uncovered fundamental new results in the spectroscopy of charmonium and upsilonium, new mesons containing charmed and bottom quarks. In 1970 Hofstadter introduced the idea of a large high energy gamma ray detector which would be located on a satellite in earth orbit; the purpose of such a detector would be to do gamma ray astronomy, then a field in its infancy. Much of Hofstadter’s effort in the last decade was to help design, build and test the EGRET experiment, one of the four instruments on board the Gamma Ray Observatory (GRO). GRO was successfully launched in April, 1991, only a few months after Hofstadter’s death.

Hofstadter had a lifelong interest in new applications of gamma-ray detectors to problems in medical physics. The early use of his sodium iodide detectors in the Auger camera was perhaps the first such example. He made important contributions to the use of intense, tunable synchrotron radiation produced at electron storage rings as a source of x rays uniquely suited to measuring the K edge of the iodine dyes used in coronary angiography, an idea conceived by E. Barrie Hughes and Edward Rubenstein. The first experiments on this concept were carried out at the SPEAR electron storage ring at the Stanford Linear Accelerator Center in 1980. The approach is based on the principle of iodine dichrography, in which two monochromatic x-ray beams, closely bracketing the K edge of iodine (33.17 keV), are used to acquire line-scan images.

Hofstadter’s teaching was characterized by the extreme clarity of his lectures, which was much appreciated by the undergraduates in the introductory physics series which he often taught. He also used this teaching style effectively in upper division courses. His graduate students invariably found him to be helpful and caring. He was always concerned about his students’ welfare, and they usually thought of him as a friend in addition to his role as their mentor. Hofstadter was active in numerous committees of the University and the Physics Department. He was appointed the Max H. Stein Professor of Physics in 1971, was Director of the High Energy Physics Laboratory (1970-1972), and served on the Senate of the Academic Council (1971-1972 and 1981-1983). He retired in 1985 but was recalled to active duty every year after that until his death. He was an ardent supporter of Stanford athletic teams, and he enjoyed listening to music and spending time with his family on his ranch in northern California.

Hofstadter received many honorary degrees and was named California Scientist of the Year in 1959. In addition to the 1961 Nobel Prize, in 1985 he was awarded the Roentgen Medal and in 1986 was awarded the U.S. National Medal of Science and the Prize of the Cultural Foundation of Fiuggi (Italy). He was a member of the National Academy of Sciences, the American Philosophical Society, the Institute of Medicine, and the American Academy of Arts and Sciences. He was the author, or co-author, of nearly 400 scientific articles and two books. Robert Hofstadter died at his home on Stanford campus on November 17, 1990, at the age of 75.

The Robert Hofstadter Memorial Lecture series was established by the Department of Physics at Stanford University. Eminent speakers are invited each year to give lectures on the subjects of physics and the physics of medicine. We began this distinguished lecture series in 1993, and we appreciate the support of Robert Hofstadter’s friends and colleagues in helping to establish this fund in his memory.

--Patricia Burchat, Chair and Professor of Physics

Invited Speaker:  Professor Joachim Stöhr  
Director, Linac Coherent Light Source  
SLAC National Accelerator Laboratory

Public Lecture:  
Monday, April 12, 2010  
8:00 PM – Geology Corner, Bldg. 320  
Braun Hall, Rm. 105  
Stanford University

Members of the Robert Hofstadter Memorial Lecture Committee: 
Leonard Susskind, Savas Dimopoulos, Robert Laughlin, Douglas Osheroff, Doug and Laura Hofstadter
Joachim Stöhr
SLAC National Accelerator Laboratory

Joachim Stöhr joined Stanford University and SLAC in January 2000 as Professor of Photon Science after spending nearly fifteen years at the IBM Almaden Research Center. He was the Director of the Stanford Synchrotron Radiation Lightsource (SSRL) at SLAC from 2005 to 2009 before becoming Director of the world’s first x-ray laser, the Linac Coherent Light Source or LCLS.

Besides two books, Dr. Stöhr has authored over 250 scientific publications and several patents. He has received several scholarships, is a fellow of the American Physical Society and served on many national and international advisory committees, most notably the Basic Energy Sciences Advisory Committee of the U.S. Department of Energy.

Robert Hofstadter, 1915-1990

Throughout history, observation with sunlight has been the basis for understanding the world around us. In 1895, W. C. Röntgen discovered a new type of “light”, X-rays, which have allowed us to see the previously invisible. Today, x-rays play a key role in medical imaging, and collimated x-ray beams produced at synchrotron radiation facilities constitute a powerful research tool for exploring the invisible world of atoms and electrons inside materials. Around 1960, a new kind of visible light source, the LASER, was invented. Lasers have led to a revolution in science and technology. Laser beams have amazing properties; they are very intense, tightly bundled, and can be created as ultrashort pulses. The ordered nature of laser light has verified the concept that light itself consists of quantum objects called photons. The long wavelength of conventional laser photons, however, makes them blind to the important nanoworld. This deficiency is overcome in the X-ray LASER which can reveal details of matter down to the size of atoms.

We have now created the first X-ray laser at SLAC National Accelerator Laboratory at Stanford University and my talk tells the story of this facility, the Linac Coherent Light Source or LCLS. I will describe how this 20 year project succeeded in 2009, creating x-ray beams of unprecedented brilliance and ultrashort pulse lengths. LCLS is now available for scientists from around the world to explore scientific dreams in many fields, such as recording movies of molecular machines, taking snap shots of scattering of high energy electrons by atomic nuclei. This work utilized the Mark III linear electron accelerator

Robert Hofstadter was born in New York City in 1915. He graduated from the City College of New York in 1935 with a B.S. degree, magna cum laude. From 1935 to 1938 he was a graduate student in physics at Princeton University and received both M.A. and Ph.D. degrees. In his graduate work he concentrated on the infrared spectra of simple organic molecules and, in particular, on the elucidation of the structure in formic acid, now known as the “hydrogen bond”. In 1939, after receiving his Ph.D., he stayed at Princeton as a postdoctoral fellow. He received the Proctor Fellowship and began his life-long interest in solid state studies in luminescence and in photoconductivity. The following year was spent at the University of Pennsylvania, where he had received the Harrison Fellowship. He helped construct a large Van de Graaff generator, and he also began studying nuclear physics and thought about the particle detectors that would be necessary for any experimentation in nuclear physics.

The advent of World War II interrupted these studies. During the war, Bob worked at the National Bureau of Standards on proximity fuses. Later he worked at the Norden Laboratory Corporation on servo systems, automatic pilots for aircraft and radio altimeter devices.

In 1946, Bob returned to Princeton as an Assistant Professor of Physics, where he began serious studies of nuclear processes and particle detectors. These studies included work on the Compton effect, crystal conduction counters, scintillation counters, and the detection and measurement of gamma rays and their energies. In 1948 he made the important discovery that thallium-activated sodium iodide, NaI(Tl), made an excellent scintillation counter, and in 1950, with J. A. McIntyre, showed how NaI(Tl) could be used as a spectrometer for measuring gamma ray energies. This crucial discovery by Hofstadter has had far-reaching effects. This material has been in universal use as a gamma ray spectrometer ever since that initial discovery, and has made important contributions to all branches of nuclear and high energy physics, to astrophysics, as well as to medicine, biology, chemistry, geology, and many other fields. In later years, Hofstadter was to look back on his discovery of the linearity of response and high light output of NaI(Tl) as the most important contribution he made to science, in terms of its impact on a variety of fields.

In 1950, Hofstadter came to Stanford at the urging of Felix Bloch and Leonard Schiff. He was appointed Associate Professor of Physics and immediately embarked on a program of the study of elastic and inelastic scattering of high energy electrons by atomic nuclei. This work utilized the Mark III linear electron accelerator

Afternoon Colloquium (4:15 PM on Tuesday, April 13, 2010) Hewlett Teaching Center, 370 Serra Mall, Rm. 201


I will describe the evolution of modern X-ray sources, culminating in the construction of the world’s first X-ray laser, the Linac Coherent Light Source or LCLS at SLAC. I will describe how this project, proposed by Claudio Pellegrini of UCLA in 1992, succeeded in 2009, creating X-ray beams of unprecedented brilliance and coherence with pulse lengths down to a few femtoseconds and power densities close to boiling the vacuum. LCLS began operation in October 2009 and is now available for scientists from around the world to explore scientific challenges in various fields. The first experiments focused on exploring the interactions of high field, ultrashort x-ray pulses with atoms and molecules. Future studies will involve studies of ultrafast processes in materials and at surfaces, pump-probe studies of chemical reactions with atomic resolution, structural studies of single macromolecules, viruses and cells, as well as dynamic studies of molecular machines. Other studies will explore the intrinsic speed limits of future technologies, such as processing of information bits, that are imposed by nature not human ingenuity. Another application is the study of the properties of matter in extreme conditions, such as warm and hot dense matter, which in the laboratory can be created only for an instance of time. More generally, LCLS constitutes a new tool for addressing scientific grand challenges by its ability to probe matter on the fundamental length and time scales of their atomic and electronic building blocks.