

MEMORIAL RESOLUTION
PAUL HARMON KIRKPATRICK
(1894 – 1992)

Paul Harmon Kirkpatrick, Professor Emeritus of physics, died in his sleep on December 26, 1992 at the age of 98.

He was an extraordinary human being with many interests and talents, including research, teaching, music, poetry, and athletics. In some of his publications, he demonstrated the connections between physics and these other areas. He touched many lives, including that of the writer, in many different ways.

He was a gifted experimentalist, a pioneer in the use of X-rays for scientific purposes and the earliest practitioner of holography. He was the inventor of the grazing incidence reflection X-ray microscope. The imaging techniques he and his students developed are routinely used today in medical and nuclear fusion research. They are also used in astronomy to take X-ray pictures of the galaxy.

Before working in X-ray optics, he had made several other important contributions to fundamental X-ray research. The historical memoir he wrote at the request of the American Institute of Physics contains a bibliography of over 175 entries.

Kirkpatrick was born near Wessington, South Dakota, July 21, 1894, to a family of homesteaders. He attended a one-room schoolhouse where approximately 20 students, ranging in ages from six to 12, were all taught by the same teacher. To get a better education for their children, his parents moved to Southern California where he went to high school and later graduated from Occidental College.

He accepted a two year job teaching physics at a Presbyterian mission on Hangchow, China, and later served in the United States Army during World War I. On his return, he went to the University of California at Berkeley for his doctorate, specializing in X-ray research. He received his doctorate in 1923. His first job after that was at the University of Hawaii, where he was the sole member of the physics department. The university had virtually no facilities for X-ray research and he wound up using used hospital equipment to study the polarization of X-rays when reflected from crystals.

While in Hawaii he met David Webster, the head of Stanford's physics department at the time and developed a relationship which eventually brought him to Stanford. After spending six years at the University of Hawaii, he went to Cornell for more research and then Webster offered him a teaching position at Stanford.

The following example shows how his refined measurements led to a new theory. In his early days at Stanford, he collaborated with P.A. Ross whose ability in the construction of technical equipment permitted them to build a very sensitive two-crystal X-ray spectrometer concerning which Kirkpatrick writes: "With this equipment Ross and I discovered that the

magnitude of the Compton shift is measurably less than the value given by Compton's formula. We traced the shift defect as a function of wavelength and of scatterer composition, and we correctly (as it developed) ascribed the effect to atomic binding of the scattering electrons. Felix Bloch, a newcomer to our Department, showed interest in the matter and in short order elaborated a theory of the effect of electron binding. Neither Ross nor I could possibly have formulated the kind of sophisticated argument that Bloch constructed, and as a matter of fact neither of us really understood the compact paper he published, but we were gratified by his good agreement with our observations."

During World War II, Kirkpatrick was acting head of the physics department at Stanford University. This was a time when physics departments became service units to the military. Hundreds of young soldiers were given instruction in Physics at the request of the Army. The younger professors had left to work at places like Los Alamos and Cambridge on projects related to the war. The staff that helped Kirkpatrick teach at Stanford included many young and less prepared individuals, including the writer, who were brought in specifically for that task from far and near. Neither time nor resources were available for research. But as soon as the war was over, Kirkpatrick was anxious to do research again with whatever was available in terms of resources and manpower on a subject about which he had thought for some years, namely, X-ray microscopy.

His previous experience with total grazing incidence reflection of X-rays and the experiments he had done on the absolute intensity of X-ray radiation from thin metal targets using successive reflections from crystal probably suggested to him how to build an X-ray microscope.

The essence of Kirkpatrick's X-ray microscope is a crossed pair of curved mirrors. Experiments had shown that a single curved mirror reflecting X-rays at grazing incidence produced a highly astigmatic image—a line—from a point source. He proved experimentally that the astigmatism could be corrected by allowing the radiation from one mirror to land on a second one at right angles to the first. The second mirror essentially "squeezes" the line down to a point. The image of a point source now becomes a point and the image of an extended object is an extended image which exhibits magnification when the distance parameters are chosen properly. The basic paper on this subject appeared in 1948.

Sensing that the process of image formation by reconstructed wavefronts recently proposed by Gabor in his seminal of 1948 paper on holography might be a route to another form of X-ray microscopy, Kirkpatrick put his graduate student, Hussein El Sum, to study holography both theoretically and experimentally. They were the first serious students of holography in the United States and they produced holograms and reconstructions using monochromatic light approximately ten years before the invention of the laser. El-Sum's dissertation was one of the first to be put on microfiche. As interest in holography mounted the demand for reprints set a record. It has become, among other things, a learning manual for the recently initiated.

Recently what has been called a renaissance in X-ray optics has taken place. The Center for X-ray Optics has been created in Berkeley. The journal of X-ray Science and Technology has been launched by Academic Press. X-ray optics is alive and well in places like Berkeley, Livermore, Göttingen, Princeton and MIT. Kirkpatrick was awarded the 1991 Dennis Gabor

Award by SPIE, the International Society for Optical Engineering, for his pioneering contributions to X-ray optics.

Kirkpatrick was an early critic of the growing dominance of research over teaching at major universities and received the Oersted Medal for Excellence in physics instruction. He had been an athlete in his youth and continued to ride his bicycle on the Stanford Campus well into his nineties. He was a vegetarian and did not use alcohol or tobacco. He was a popular but ruthlessly demanding teacher. He had a marvelous sense of humor which enlivened his lectures. He wrote poetry and loved music. He invented a musical instrument which he played accompanied by his wife Mary Rose. For several successive seasons in the 1940's, he formed a "bottle orchestra" in which members of the Stanford physics staff played Christmas carols by blowing across bottles partially filled with water and tuned to a musical scale. His human warmth extended to his immediate family and to all of his associates. He promoted peace-making activities and participated in a science education mission for UNESCO in India in the 1960's.

Kirkpatrick was survived by his wife, Mary Rose, recently deceased, by two of his three daughters, Pauline Abbe and Nancy Morrell, and by many grandchildren and great grandchildren.

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