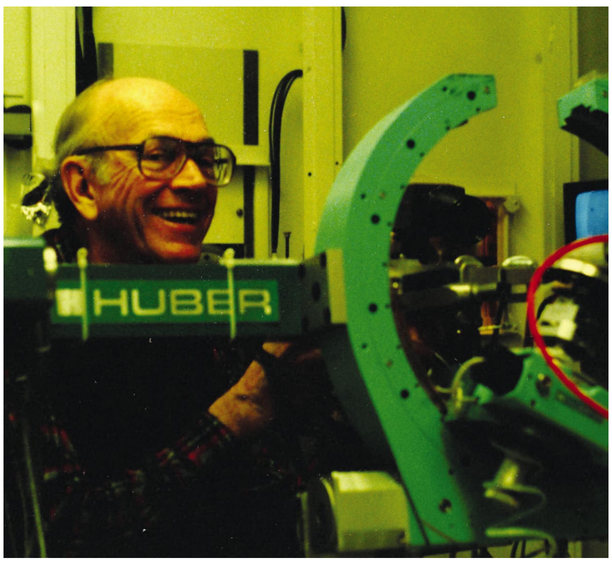
Cullie Sparks, 1929–2004

Cullie Sparks, a pioneer in synchrotron radiation research, died on 19 March 2004. Dr Sparks made major contributions to materials science, X-ray physics and synchrotron science that continue to have a worldwide impact. After earning a metallurgical PhD from the University of Kentucky, Sparks joined the Oak Ridge National Laboratory in 1957. In the mid-1960s Sparks and his group leader, Bernard Borie, used symmetry to interpret variations in the weak so-called diffuse X-ray scattering from crystalline alloys. By quantitatively studying patterns in the diffuse X-ray scattering, they found that local structural fluctuations could be measured with unprecedented sensitivity. This early research explored the tendency for some materials to have a long-ranged average structure but with important nanoscale fluctuations about the average. Later, this research led to elegant experiments at the NSLS that measured chemically specific bond distances to less than a tenth of a picometer (<0.001 Å).



Cullie Sparks aligning a sample on beamline X14.

Their Borie–Sparks method for analyzing diffuse X-ray and neutron scattering is still used worldwide to interpret diffuse neutron scattering and forms the basis for modern diffuse X-ray techniques. Research based on their pioneering work continues at synchrotron light sources.

Also in the 1960s, Dr Sparks recognized the potential of artificial graphite crystals for high-performance X-ray and neutron monochromators. He worked with researchers at Union Carbide Corporation to perfect the manufacture and performance of graphite monochromators and became the world's expert on mosaic graphite optics. By combining the natural tendency of mosaic graphite crystals to focus in the plane-of-scatter with out-of-plane focusing based on curved surfaces, he created powerful doubly focusing crystal optics. Union Carbide continues to make a range of graphite monochromators that are used throughout the world both for X-rays and neutrons.

Armed with a vastly more powerful way of producing intense X-ray beams, Sparks began a systematic search for inelastic X-ray scattering contributions that might have contributed background in his diffuse scattering measurements. His careful research uncovered an unsuspected resonant-inelastic scattering mechanism. Although a respected reviewer from Bell Laboratories, who specialized in inelastic X-ray scattering, could find no fault in Sparks' 1974 *Physical Review Letters* paper, the reviewer personally performed definitive synchrotron experiments at the Stanford Synchrotron Radiation Laboratory to check Sparks' results, and verified, much to his surprise, that Sparks was correct! Resonant Raman X-ray scattering or 'Sparks scattering' is still widely used at synchrotron radiation facilities to study the dynamics of X-ray-induced atomic transitions.

In 1976, proton microprobe measurements on monozite inclusions with anomalously large halos in micas from Madagascar indicated the presence of primordial superheavy elements. This 'discovery' reverberated throughout the scientific community, as the presence of primordial superheavy elements suggested that the earth might be only a few thousand years old, a compact atomic weapon might be made of these unusual elements, and even the shape of the nucleus might differ from standard materials.

In a crash program to settle the issue, Sparks designed the first synchrotron-based X-ray fluorescence microprobe and led a team of distinguished scientists that installed and executed the critical test at the Stanford Synchrotron Radiation Laboratory. Sparks and his team convincingly showed that primordial superheavy elements do not exist in these micas. As a result, the US and other governments avoided the enormous resources that might otherwise have been expended to understand something for which there is no evidence. This experiment clearly illustrated the critical need for intense synchrotron radiation sources.

In the summer of 1979, during a sabbatical at BNL, Dr Sparks began studying how to focus X-rays with bent perfect crystals. He was motivated by the fact that crystals, with roughly a 20 times larger scattering angle than mirrors, can collect much larger divergences and focus them onto a sample. Although Dr Sparks was greatly challenged by computer programming, he worked with scientists at BNL and ORNL to study ways to utilize the potential of crystal focusing. He discovered that in a non-dispersive geometry the Bragg angle of each ray reflected from a first flat crystal is virtually the same as that off a second crystal bent to focus at a magnification of 1/3. This discovery opened the possibility of dynamically bent sagittal focusing optics. Despite major technical challenges and a general consensus that the method could not work, sagittal focusing optics were demonstrated, paving the way for beamline X14 at the NSLS and future sagittal focusing beamlines elsewhere. Sagittal focusing optics are now installed around the world.

Not only were the sagittal focusing optics widely adopted by the worldwide synchrotron community, but the efficiency and flexibility of sagittal focusing optics on beamline X14 also led to numerous exciting collaborations. First or early measurements included fluorescence tomography, resonant magnetic scattering, multiple wavelength holography, anomalous powder and diffuse X-ray scattering, nuclear resonant scattering, glancing-angle scattering from lipids, scattering from liquid crystals, quasi crystals and other experiments.

In short, Sparks was a gifted experimentalist and an enthusiastic supporter of synchrotron radiation research. His career spanned and contributed to the rise of synchrotron radiation research as an essential tool of science. His scientific legacy continues through advanced X-ray optics, new fields of atomic physics, materials and synchrotron science.

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