

Bill Arnold: from “fission” to photosynthesis

(As published in The Oak Ridger’s Historically Speaking column on January 21, 2013)

Carolyn Krause continues her series of stories based on Oral Histories, this one features William “Bill” Arnold and is based on an interview with Clarence Larson, the only Oak Ridger to ever serve on the Atomic Energy Commission. Larson worked with Ernest Lawrence to help solve early problems with the Calutrons used to separate uranium 235 from natural uranium.

Larson went on to become the Y-12 Plant Manager in 1948. In 1950 he became director of the Oak Ridge National Laboratory during the \$20 million expansion program, was instrumental in arranging for ORNL activities to be housed in buildings at the Y-12 site that were no longer being used after the Calutrons were removed.

Four of ORNL’s 13 nuclear reactors were completed while Larson was the director of the laboratory, the first computer was installed and a nuclear reactor exhibit was a huge hit at the first “Atoms for Peace” conference held in Geneva, Switzerland.

In 1955, Larson became a vice president with Union Carbide Corporation and left Oak Ridge returning in 1961 as president of Union Carbide Nuclear Division. He then served as a commissioner for the Atomic Energy Commission from 1969 through 1974

He also conducted Oral History interviews, on which Carolyn bases the following story.

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William Arnold, a plant physiologist, physicist and biologist employed in Oak Ridge National Laboratory’s Biology Division from 1946 to 1970, had at least two claims to scientific fame.

One claim was his set of scientific discoveries on the effects of light on the vital process that makes green plants grow. The other was his contribution to the term “fission” used to describe the process that makes nuclear power plants work.

Some Oak Ridgers remember that the pipe-smoking Bill Arnold kept a blackboard in his living room. Liane Russell, former section head of the ORNL Biology Division, recalled that he built a fallout shelter under his cemento house.

One of Arnold’s two daughters, Helen Herron of Indianapolis (who supplied two photos of Arnold), wrote in a 1996 “Photosynthesis Research” journal issue dedicated to her father that he considered himself “lucky to have been able to make a living doing what he would cheerfully have done for free.”

She noted that her father’s “sense of humor and easy way with people reflected his self-confidence and his enjoyment of life, friends and science.”

Arnold, a Wyoming native who died in 2001, contributed greatly to the understanding of photosynthesis. That’s the life-giving process by which green plants convert airborne carbon dioxide and water to plant food using the sunlight’s energy and then emit to the atmosphere the oxygen we breathe.

When Arnold came to Oak Ridge, he had already made a name for himself through his research in 1932 with Robert Emerson. The two discovered the “photosynthetic unit” in plants. At the time Arnold was an undergraduate student at Cal Tech and was coauthor of the famous paper.

They found that if they increased the intensity or constantly changed the frequency of light flashes on chlorophyll in the algae Chlorella, they observed more and more photosynthesis per flash, Arnold told Clarence Larson, former ORNL director and chairman of the U.S. Atomic Energy Commission, in an oral history interview. “Then it saturated, meaning that a chemical reaction in the plant was finishing up.”

They exposed plants to instantaneous flashes of light and found that one molecule of oxygen was produced for every 2400 molecules of chlorophyll, the green pigment that carries out photosynthesis.

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In the 1960s Arnold proved that plants exposed to light flashes after their temperature was raised produce “delayed light emissions” for a limited time. Jack Davidson of ORNL worked with Arnold to develop the apparatus to measure the light emissions. “Jim Azzi made a real good spectrum of the emission of delayed light,” Arnold told Larson.

Eli Greenbaum, an ORNL corporate fellow who has conducted research on photosynthesis for many years, said, “Bill discovered the electronic nature of energy transfer in photosynthesis.” For his work Arnold received the Kettering Award from the American Society of Plant Physiologists, which cited him for “his application of rigorous principles of physics to a biological phenomenon.”

In a tribute to Arnold, Jean Lavorel, a French scientist who visited him in March 1957, called him “a giant and pioneer of biophysics of photosynthesis.” He described Arnold as “straight, plain, even-tempered, attentive and nice,” and also as “utterly methodical but resourceful and imaginative.”

Now, for the nuclear fission story. In 1939, after completing graduate work at Harvard, Arnold received a Rockefeller Fellowship. It enabled him to work for a year at Nobel Laureate Niels Bohr’s Institute for Theoretical Physics in Copenhagen, Denmark. There Arnold learned the technique of using radioactive tracers from future Nobel Laureate Georg de Hevesy.

At the Institute, Arnold met Otto Frisch, the nephew of Lise Meitner. Both Frisch and Meitner had left Nazi Germany because of their Jewish heritage.

During the Christmas holiday in 1938, Frisch visited his aunt in Sweden. While there Meitner received the news that her former colleague Otto Hahn and Fritz Strassmann in Berlin were astonished to discover that a neutron colliding with a uranium nucleus produced the lighter element barium.

Hahn was continuing the research that Italian scientist Enrico Fermi started in 1934 (nine years before he became director of ORNL’s Graphite Reactor project). Hahn originally believed that Fermi was right: bombarding uranium with neutrons creates elements heavier, not lighter, than uranium.

The German chemist Ida Noddack was the first to disagree with Fermi. In a 1934 scientific paper, she wrote, “It is conceivable that when heavy nuclei are bombarded with neutrons, these nuclei could break down into several fairly large fragments, which are certainly isotopes of known elements, but not neighbors of the irradiated elements.”

In 1939 Meitner and Frisch, employing Bohr and George Gamow’s liquid-drop model, hypothesized that the uranium nucleus had split in two, explained the process and estimated the energy released. Frisch used the term fission to describe this nuclear process.

Here’s how that came about. On Jan. 14, 1939, Hilde Levi, de Hevesy’s woman assistant, told Arnold that Frisch “has got a marvelous experiment in the basement. Go down and see him.”

Arriving in Frisch’s lab, Arnold saw small pulses on the oscilloscope screen produced by the uranium sample’s alpha particles in a proportional counter. Frisch invited Arnold to pick up a radium-beryllium neutron source by the handle and aim it at the sample. Arnold saw “big spikes” on the oscilloscope, indicating breakdown of nuclei into radioactive fragments.

“I had gone back up into my lab when Frisch poked his head in,” Arnold said. Frisch was looking for a name for the world-changing process for which he had a direct experimental proof.

“You work in a microbiology lab,” Frisch said to Arnold. “What do you call the process in which one bacterium divides into two cells?” “Binary fission,” Arnold replied. “I don’t want a two-word name,” said Frisch. “Can I call it fission alone?” Arnold said, “Yes, sir.”

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“It’s a good thing he didn’t use the whole name because some of the nuclei split into three fragments,” Arnold told Larson.

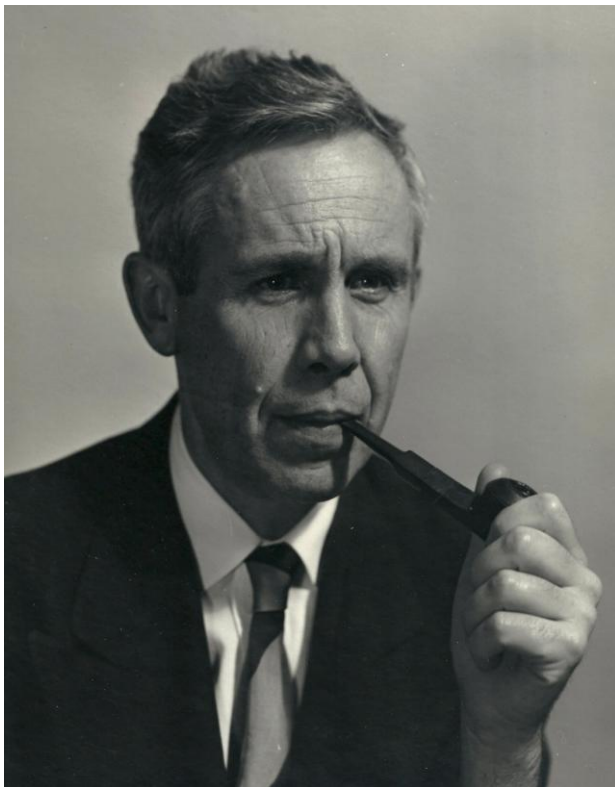
Meitner and Frisch published a famous paper that explained the physics behind “fission.” But unlike Hahn, Meitner did not win the Nobel Prize for the discovery of fission, and Noddack’s paper, although correct, was ignored for years.

In 1966, in recognition of their work on nuclear fission, Meitner, Strassmann and Hahn shared the Atomic Energy Commission’s Enrico Fermi Award. But Meitner was too ill to attend the awards ceremony.

Arnold may well have derived more satisfaction out of his small contribution to nuclear fission than many of the key players...

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Thank you Carolyn, for yet another glimpse into Oak Ridge history. Thank you also for persisting until you obtained the two photographs of Bill Arnold from his daughter and for sharing those photographs with a variety of Oak Ridge historians and archives that might retain the photo of one of Oak Ridge’s great scientists. I find it hard to image that we did not have a photo of Bill Arnold, but that seems to be the case. You fixed that.



Bill Arnold relaxing with his favorite pipe



Clarence Larson did early Oral History interviews