#### Oak Ridgers helped Fermi usher in Atomic Age (As published in The Oak Ridger's Historically Speaking column on December 17, 2012)

For the past three weeks, readers of *Historically Speaking* have been treated to articles written by Carolyn Krause, now retired, who was a science writer at Oak Ridge National Laboratory for 35 years and editor of the ORNL Review research magazine for 25 years. She is a good friend and offered to provide a few articles to give me a well needed break from weekly deadlines.

Previously, Carolyn worked as a feature writer for the Pittsburgh Press and science reporter for The Oak Ridger. She is a fellow of the Society for Technical Communication and served as president of STC's East Tennessee Chapter for a year. A native of Pittsburgh, Pa., Carolyn holds a B.A. degree in English from the College of Wooster, an M.A.T. degree from the University of Pittsburgh and an M.S.J. degree from the Medill School of Journalism of Northwestern University. So, she is well qualified to research and write historical materials for your reading pleasure.

Currently, she is engaged in volunteer publicity and newsletter writing for the Rotary Club of Oak Ridge, First Presbyterian Church, and Oak Ridge Institute for Continued Learning. She is a member of the ORICL board and the Oak Ridge Civic Music Association board, for which she does publicity for concerts and fundraising events and manages the content of the ORCMA website (<u>www.orcma.org</u>).

She is a volunteer in ORNL's History Room and has assisted in editing oral histories, which form the basis for contributions she has made and intends to make for The Oak Ridger's weekly *Historically Speaking* column. She and her husband Herb, retired atomic physicist from ORNL, have two grown children and two grandchildren.

I wanted you to know more about Carolyn as I see her epitomizing what is so valuable in Oak Ridgers. She has had an excellent career based on a well rounded education, is retired and devotes a major portion of her time volunteering. I think it is important to realize that Oak Ridge is blessed with a high percentage of people like Carolyn, many of whom not only impact Oak Ridge with their expertise used in volunteer service and also reach communities outside Oak Ridge and some even reach to the East Tennessee region, the state and across the nation. Some even have impact internationally. Such is Oak Ridge, and proudly so!

Now let's enjoy another of Carolyn's articles, this one featuring Enrico Fermi.

Just over 70 years ago, on Dec. 2, 1942, at 3:20 p.m. at the University of Chicago, the first self-sustaining nuclear chain reaction was achieved, initiating the controlled release of energy from atomic nuclei. The event was hailed as the Dawn of the Atomic Age.

Enrico Fermi, Nobel Laureate from Italy and one of the greatest scientists of the 20<sup>th</sup> century, supervised the design and assembly of an "atomic pile" in the squash courts under the west stand of the university's Stagg Field. Pile was a code word for nuclear reactor.

A nuclear chain reaction is a self-perpetuating reaction in which neutrons from radioactive uranium or plutonium nuclei "split" other nuclei into lighter radioactive nuclei (fission), with the release of more neutrons and lots of energy (heat). The neutron was identified in 1932, and nuclear fission was discovered and reported in 1939.

Fermi received the Nobel Prize in physics in 1938 for his "discovery of new radioactive elements produced by neutron irradiation, and for the discovery of nuclear reactions brought about by slow neutrons." After Fermi and his family traveled from Italy to Sweden so he could receive the award, they left permanently for the United States. Fermi's wife was Jewish and the Fascists of Italy were aligning their policies with those of their ally, the Nazis of Germany.

Fermi accepted a position as professor of physics at Columbia University. In 1942 he and his family moved to Chicago.

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Several people who later lived and worked in Oak Ridge interacted with Fermi in various ways during his Chicago days. They included Martin Whitaker, director of Clinton Laboratories in Oak Ridge, 1943-45; Richard Fox of Oak Ridge National Laboratory's Instrumentation and Controls Division; Ernest Wollan, who pioneered the use of reactor-based neutron scattering for research; Eugene Wigner, research and development director at Clinton Laboratories, 1946-47, and winner of a Nobel Prize in physics in 1963, and Alvin Weinberg, ORNL director from 1955 to 1973.

Nobel Laureate Arthur Compton headed the Metallurgical Laboratory, which he formed as cover at the University of Chicago. He recruited researchers from coast to coast, including Nobel Laureate Glenn Seaborg, who discovered the man-made element plutonium.

In his book "The First Nuclear Era," Weinberg wrote about his time at the Met Lab. He claimed he initially understood that its aim "was to investigate the possibility of creating a chain reaction in ordinary uranium. That the real purpose of the project was to create plutonium for use in an atomic bomb was not explained to me until after I had met Wigner."

Later, Weinberg learned that Compton had placed Seaborg "in charge of the research on plutonium chemistry and assigned him the task of devising methods to separate plutonium from irradiated uranium in quantities sufficient for bomb production." Producing plutonium from irradiated uranium for research purposes became an Oak Ridge mission in 1943.

Whitaker's assignment initially was to help Fermi and Walter Zinn build subcritical uranium and graphite piles, described by Weinberg as uranium raisins in a graphite cake. The purpose of the graphite was to slow down the neutrons so more would react with uranium atoms.

Wigner headed the theoretical physics group, which studied how best to arrange uranium and neutronabsorbing materials for achieving a controlled chain reaction. Besides Weinberg, Wigner's group included future Oak Ridgers Gale Young and Katherine Way.

Young became Wigner's technology guru, and Way helped Wigner estimate the residual radioactivity and heat production after a halted chain reaction. Arthur Snell, later an ORNL associate director, worked in Samuel Allison's cyclotron group assessing nuclear activities in uranium and graphite piles.

Impurity-free graphite from Union Carbide (future operator of the Oak Ridge nuclear plants) and pure uranium metal from a research team at Ames, Iowa, were obtained for the Chicago pile. Future ORNL chemist George Boyd helped analyze these materials to ensure they had no impurities that might impede the chain reaction.

To control the reaction, Fermi directed the phased withdrawal of a control rod coated with neutronabsorbing cadmium. As he stood behind Fermi, Fox, who rigged the control-rod mechanism for the pile, was concerned that his cotton clothesline tied to two lead weights would slip off the pulley. It didn't, and Fermi's experiment was successful.

Some 50 invited spectators viewed the historical event from a balcony, including Fox, Wigner and Wollan, who monitored and recorded the radiation emitted by the world's first sustained nuclear reaction. Wigner reported how the participants felt:

"Nothing very spectacular had happened. Nothing had moved and the pile itself had given no sound...For some time we had known that we were about to unlock a giant; still, we could not escape an eerie feeling when we knew we had actually done it. We felt as, I presume, everyone feels who has done something that he knows will have very far-reaching consequences which he cannot foresee."

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After the spectators departed, Wigner brought out a bottle of Italian Chianti in honor of Fermi's achievement and shared toasts with the workers.

"My only direct collaboration with Fermi," Weinberg wrote, "was in calculating the escape of neutrons through an empty cylindrical channel that traversed a reactor—for example, a channel carrying fast-flowing air or helium to cool the pile."

Weinberg was not present at the first chain reaction on Dec. 2, 1942. When asked about this during an ORNL oral history interview, Weinberg said, "That's because the admission badges were given out numerically and my number was too high; it was 54.

"But I went bowling with Wally Zinn and, I think, Fermi the evening before the pile went critical. I was invited to see the pile the following morning [after it went critical] by Walter Zinn, who was Fermi's chief assistant and later director of Argonne National Laboratory."

Weinberg had the good fortune to work in the company of intellectual giants at the Met Lab but the bad luck of missing its most historical scientific achievement.

Thank you Carolyn for another exceptional glimpse into Oak Ridge history that is not fully realized nor appreciated. Look for more articles from Carolyn in future *Historically Speaking* columns.



Carolyn Krause

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Enrico Fermi was possibly the greatest experimental and theoretical scientist of the 20<sup>th</sup> century. He interacted with several researchers who later lived and worked in Oak Ridge.