

Lesson Plan

Leona Woods Marshall Libby: American Nuclear Physicist



*Leona Woods Marshall (left) with husband John Marshall at the Third International Conference on High Energy Physics (ICHEP), Rochester, 1952, (AKA) The Rochester Conference.
Photo Courtesy AIP Emilio Segre Visual Archives, Marshak Collection.*

Grade Level(s): 9+

Subject(s): History, Physics

In-Class Time: 55-70 minutes

Prep Time: 10-15 minutes

Materials

- Copies of the American Physical Society Article on Leona Woods Marshall Libby, and research project summaries (all found in the Supplemental Materials)
- Copies of the Discussion Questions (found in the Supplemental Materials)
- Classroom Internet Access
- A/V equipment

Objective

Students will learn about Leona Woods Marshall Libby, who worked on the Manhattan Project and afterward had a successful and diverse career as a research physicist. They will read about her life and work, which included spectroscopy, high-energy nuclear research, engineering, environmental studies and climate change. Students will then discuss the interdisciplinary nature of Libby's work and the values of this approach.

Introduction

Leona Woods was born in 1919 in Illinois. She was a very strong student, and by age 19 had earned a B.S. degree in chemistry from the University of Chicago. She immediately began graduate coursework. As soon as she had finished her Ph.D. dissertation on spectroscopy in 1942, she was hired to work with Enrico Fermi's group of physicists on the Manhattan Project at the Chicago Metallurgical Laboratory (Met Lab).¹

Leona was the only woman physicist at the Met Lab, and was in attendance when Pile 1 sustained the world's first controlled critical nuclear reaction. Enrico Fermi's wife Laura described her as a strong, capable young woman "who could do a man's job and do it well." When she wasn't working on the reactor's detection devices, she helped her mother run their family farm just outside of Chicago, dividing "her time and her allegiance between atoms and potatoes."² In 1944, Leona and her husband John Marshall traveled to Hanford, Washington to help Fermi in getting the nuclear reactor there operational. Afterwards, the family returned to Chicago and Leona worked at Fermi's Institute for Nuclear Studies as a research associate and (briefly) assistant professor in 1954.

Leona and John Marshall separated in 1954 and afterwards she bounced between several positions. In 1957 she spent a year at the Institute for Advanced Study in Princeton, NJ, before moving to Brookhaven National Laboratory as a visiting scientist until 1960. That year she became a professor of physics at New York University, and in 1963 she moved to the University of Colorado, Boulder to work as a professor. During this time, she married her second husband, Willard Libby (1966). Finally, in 1972 she moved to the University of California, Los Angeles (UCLA) and worked as a visiting professor of environmental studies and engineering for over a decade.³

A prolific writer, Leona published three books and roughly 200 scientific articles during her time.⁴ Despite this, as a woman she was almost always denied full research professorships, instead referred to as a visiting, associate, or adjunct professor. That said, she was not dissuaded by the dismissiveness. She continued to work on high-energy nuclear physics into the 1960s, but also began expanding her interests and work into other fields. While working for the RAND Corporation think tank in the 1960s and 70s, she turned her attention to particle physics, cosmic rays, and environmental concerns.⁵ Near the end of her career she began studying quasi-stellar (quasars) objects through spectroscopy, and became a proponent of dendroclimatology, the science of using tree rings as proxies to determine climate change. She published a book on the subject in 1983, three years before her death.⁶

¹ "This Month in Physics History: November 10, 1986: The Death of Leona Woods Marshall Libby," *APS News* 23 no. 10 (2014): 2-5.

² Laura Fermi, *Atoms in the Family: My Life with Enrico Fermi* (Chicago and London: Chicago University Press, 1954), 178-179.

³ "This Month," 5.

⁴ Burt A. Folkart, "Leona Marshall Libby Dies: Sole Woman to Work on Fermi's 1st Nuclear Reactor," *Los Angeles Times*, November 13, 1986, accessed July 26, 2016, http://articles.latimes.com/1986-11-13/local/me-24930_1_nuclear-reactor.

⁵ "Leona Marshall Libby," RAND Corporation, accessed July 26, 2016, http://www.rand.org/pubs/authors/l/libby_leona_marshall.html.

⁶ Leona Marshall Libby, *Past Climates: Tree Thermometers, Commodities, and People* (Austin: University of Texas Press, 1983).

In the 1940s and 1950s, Leona developed a close working friendship with Fermi. She once asked him about making great discoveries. He responded:

“Bah! That was a stupid question. What you do is, you choose some problem new on the research horizon about which little is known, but which promises to be important...Then you find out everything you can about it, using the techniques available and, if possible, inventing new ones. That is the way to make discoveries.”⁷

Leona appears to have subscribed to this ideal, and regularly applied her knowledge and acquired skills to new and emerging subjects. This interdisciplinary approach to research was not anomalous, however. There are many historical instances of scientists working in a discipline other than the one they are most associated with. It is important for students to recognize that developing expertise in a field does not necessarily confine a scientist to that field for their entire career.

Instructions/Activities

Engage: 3-5 Minutes

The teacher will introduce students to Leona Woods Marshall Libby, who worked at the Chicago site of the Manhattan Project and had a long career as a research scientist afterward. Teachers will play short audio excerpt from an oral history interview with Leona (about 1.5 min.)

What is the teacher doing?

Introduce students to Leona Woods Marshall Libby through a short lecture. Then, present the short section of her oral history interview from the Voices of the Manhattan Project (link found [here](#) and in the Required Resources.) Only play the portion of the interview from the 1:08 mark to the 2:40 mark.

What are the students doing?

Listen to the introduction to Leona Woods Marshall Libby, and then listen to the segment of her oral history interview.

Explore: 20-25 Minutes

Students will read a brief article about Leona Woods Marshall Libby’s life and work. They will also read summaries of research projects that list Leona as the principal investigator. Students will then answer Discussion Questions based on the readings (found in the Supplemental Materials).

What is the teacher doing?

Provide students copies of the APS article on Leona Woods Marshall Libby, summaries of some of her research projects, and the Discussion Questions (all found in the Supplemental Materials). Have students read the documents and answer the Discussion Questions.

What are the students doing?

Receive copies of the APS article, the research project summaries, and the Discussion Questions. Read the documents and answer the corresponding Questions.

Explain: 15-20 Minutes

The teacher will provide the students with the correct answers to the Discussion Questions. The class will then review Leona Woods Marshall Libby’s story. After reviewing the Discussion Question

⁷ Leona Marshall Libby, *The Uranium People* (New York: Crane Russak and Charles Scribner’s Sons, 1979), 108.

<p>answers, shift the focus of the class discussion to Leona’s later career, specifically her varied research interests.</p>	
<p>What is the teacher doing? Review the correct answers to the Discussion Questions with students (Answer Key found in the Supplemental Materials.) If desired, collect student responses for evaluation.</p> <p>Afterward, focus the students’ attention on Leona’s later career. Project her RAND Corporation publication list for a sample of her diverse research interests (link found here and in the Required Resources). Select a publication to display a brief summary. Ask students to contemplate the reasons for this diversity. Accept student suggestions and evaluate them as a class.</p>	<p>What are the students doing? Review the answers to the Discussion Questions provided by the teacher. If instructed, submit the answers to the teacher.</p> <p>Contemplate Leona Woods Marshall Libby’s various research interests and the reasons for the diversity. Suggest reasons to the teacher and discuss them as a class.</p>

Elaborate: 15-20 Minutes

<p>The Elaborate section of this lesson emerges organically from the Explain section. After examining Leona’s diverse research projects, the class will discuss the general ideas of interdisciplinary research and scientists working across fields or branches.</p>	
<p>What is the teacher doing? Project or read aloud the quote from Enrico Fermi found in the introduction to this lesson, (“Bah! That was a stupid question. What you do is...”) and explain that he said this to Leona when she asked him about making scientific discoveries. Ask students if they think this factored into Leona’s research.</p> <p>Discuss with students how there have been many scientists who switched fields of study, often from physics into one of the life sciences. Examples include:</p> <ul style="list-style-type: none"> • Linus Pauling: quantum mechanics, chemistry, biology • Max Delbrück: theoretical and nuclear physics, molecular biology • Leo Szilard: nuclear physics, biology • Walter Gilbert: chemistry, physics, molecular biology • Leon Cooper: physics, neuroscience <p>Ask students if they can name any other examples. Emphasize that scientists who move into different fields of research take the</p>	<p>What are the students doing? Listen to read the quote from Enrico Fermi. Share opinions about whether this influenced Leona’s diverse research.</p> <p>As a class discuss historical examples of scientists switching research interests. Contribute examples if known. Think about and share what skills would be useful across scientific subjects. Be sure to understand the viability of inter- and cross-disciplinary research.</p>

knowledge and skills they have acquired in one field and apply them to another. Ask students to consider what skills would be useful across fields. Ensure they understand that interdisciplinary and cross-disciplinary research—while difficult—is completely viable, and that many prominent scientists have worked across research fields.

Evaluate:

The main opportunity for evaluation emerged during the Explore/Explain sections of the lesson. Students answered Discussion Questions based on the readings, and teachers could collect the students' responses for evaluation.

Required/Recommended Reading and Resources

- “This Month in Physics History: November 10, 1986: Death of Leona Woods Marshall Libby.” *APS News* 23, no. 10 (2014): 2-5. Accessed July 26, 2016.
<http://www.aps.org/publications/apsnews/201411/physicshistory.cfm>. (Found in the Supplemental Materials)
- Saltzman, J.D., editor. *Summaries of Physical Research in Physics and Mathematics*. Washington, D.C.: Atomic Energy Commission Division of Research, 1961. (Transcription found in the Supplemental Document “Research Summaries”.)
 - This resource contains a summary of a research project in high-energy physics that Leona Marshall began for New York University in 1961 on page 21
- *Summaries of Physical Research in Physics and Mathematics*. Washington, D.C.: Atomic Energy Commission Division of Research, 1964. (Transcription found in the Supplemental Document “Research Summaries”.)
 - This resource contains a summary of a research project in high-energy physics that Leona Marshall was working on with Frank Oppenheimer at the University of Colorado in 1964 on page 75
- Leona Marshall Libby. Interviewed by S.L. Sanger. Los Angeles, 1986. *Voices of the Manhattan Project*. Atomic Heritage Foundation. <http://manhattanprojectvoices.org/oral-histories/leona-marshall-libbys-interview>
 - Teachers should only play the segment of this interview from 1:08 to 2:40 for the Engage section of this lesson.
- RAND Corporation. “Leona Marshall Libby.” Accessed July 26, 2016.
http://www.rand.org/pubs/authors/l/libby_leona_marshall.html
 - This web page contains a list of publications that Leona submitted to the RAND Corporation, a nonprofit research/analysis think-tank. The list is diverse in subject, and selecting a paper from the list will display a brief summary.

Discussion Questions

Discussion Questions can be found as a Handout with a corresponding Answer Key in the Supplemental Materials to this lesson plan.

1. In what subject did Leona Woods Marshall Libby earn her Ph.D.? Where was her first job after graduation?
2. What was her job at the nuclear pile in Chicago?
3. How did her work at Hanford compare to that of her first husband, John Marshall?
4. What was her opinion on the dropping of the bombs on Hiroshima and Nagasaki?
5. Where did she find work after World War II?
6. At UCLA, what was her position? What did she research while there?
7. What was the subject of her last published paper?
8. Describe the subject of her research contracts that used Atomic Energy Commission funding.

Further Reading and Additional Resources

On Leona Woods Marshall Libby:

- Libby, Leona Marshall. *The Uranium People*. New York: Crane Russak and Charles Scribner's Sons, 1979.
- Libby, Leona Marshall. *Past Climates: Tree Thermometers, Commodities, and People*. Austin: University of Texas Press, 1983.

On Interdisciplinary Research:

- Devons, Samuel, editor. *Biology and the Physical Sciences*. New York and London: Columbia University Press, 1969.
- Jogalekar, Ashutosh. "Physicists in Biology; and Other Quirks of the Genomic Age." *Scientific American*, The Curious Wavefunction blog, December 10, 2012. Accessed July 26, 2016. <http://blogs.scientificamerican.com/the-curious-wavefunction/physicists-in-biology-and-other-quirks-of-the-genomic-age/>

Extensions

Related AIP Teacher's Guides on Women and Minorities in the Physical Sciences:

- Outcasts and Opportunities: The Effects of World War II on the Careers of Female Physicists
- Women and the Manhattan Project

Common Core Standards

For more information on Common Core Standards, visit <http://www.corestandards.org/>.

Speaking & Listening	
CCSS.ELA-LITERACY.SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

<u>CCSS.ELA-LITERACY.SL.11-12.1</u>	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
History/Social Studies	
<u>CCSS.ELA-LITERACY.RH.9-10.1</u>	Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.
<u>CCSS.ELA-LITERACY.RH.9-10.2</u>	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.
<u>CCSS.ELA-LITERACY.RH.9-10.3</u>	Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.
<u>CCSS.ELA-LITERACY.RH.9-10.4</u>	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
<u>CCSS.ELA-LITERACY.RH.11-12.1</u>	Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
<u>CCSS.ELA-LITERACY.RH.11-12.2</u>	Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
<u>CCSS.ELA-LITERACY.RH.11-12.3</u>	Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.
<u>CCSS.ELA-LITERACY.RH.11-12.4</u>	Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines <i>faction</i> in <i>Federalist</i> No. 10).

Next Generation Science Standards

For more information on the Next Generation Science Standards, visit <http://www.nextgenscience.org/>.
N/A