Process Paper

It all started with me on my couch, flipping through the pages of our old family album, when I saw it. An old, faded-out photo of my dad shaking hands with someone and an elderly woman beside him with a crinkled smile. Curious, I ran over to my dad, asking what he had done and who were the people that were congratulating him. He told me that the woman was a famous physicist named Chien-Shieng Wu, and the man shaking hands with him was her husband, Luke Chia-Liu Yuan. He was receiving a physics scholarship that had been sponsored by them. She was an inspiration, he said. From conducting world-changing experiments to fighting both sexism and racism, she expanded our knowledge and made the impossible possible. She inspired not only women but men like my father. That's when I knew I had found my topic.

I first began my research by using and reading short biographies about Wu on the internet. Wu lived a very private life and did not like to be interviewed, limiting any primary sources I could use, such as images of her and other materials. In addition to the relevant quotes and pictures I gathered from online databases, I also procured quotes from newspapers and records from government archives, and also borrowed numerous books and biographies about her from the local library. One source that I found particularly helpful in understanding her as a person, was an article in the Washington Post, written by her only granddaughter, Jada Yuan.

After having done exhibits in the past years, I decided to try and make a website for this year's 2023 NHD project. Though I struggled at first with setting up and putting all my pictures and information where I wanted them to be, I eventually got the hang of it with some small help from the internet. I then began to dig through information, finding images and quotes suitable for

my topic and inserting them into the website. For my layout, I looked at past NHD website winners for some inspiration and an idea of how I wanted my website to be organized.

Since her arrival in the United States in 1936, Chien-Shiung Wu changed and crossed the frontiers of physics, race, and gender, proving that women scientists were just as capable as men. She was one of the very few women known to have worked on nuclear physics on the Manhattan Project and achieved great success in a men-dominated physics world that most thought was unachievable for a woman like her. Although Wu's experiment confirmed the theory that was later given a Nobel Prize, she was overlooked and not included in the award due to her gender and race. Wu acts as a role model to young women who dream of becoming scientists, as well as young men like my father, who aspired to become a physicist. Wu continues to have a lasting impact on the world today.

Annotated Bibliography

Primary Sources

Images

American Institute of Physics, 18 Oct. 2022, https://www.aip.org/history-programs/physics-history/teaching-guides/chien-shiung-wu-chinese-nuclear-physicist. Accessed 21 Jan. 2023.

This is an image of Wu assembling an electro-static generator at a laboratory. It helped me understand what kind of work she did while in the United States.

American Institute of Physics, https://repository.aip.org/islandora/object/nbla%3A315170. Accessed 21 Mar. 2023.

This image shows Wu in an international conference. I used it on the thesis page to show the reality of a men-dominated physics world with Wu being one of the only women at the conference.

Atomic Archive, https://www.atomicarchive.com/resources/biographies/lawrence.html. Accessed 25 Nov. 2022.

This image shows Ernest Orlando Lawrence, who was Wu's academic advisor. I used an image of him to show his importance in Wu's academic life.

Broad, Willaim J. *The New York Times*, 30 Oct. 2007, https://www.nytimes.com/2007/10/30/science/30manh.html. Accessed 4 Dec. 2022.

This image portrays the Nevis cyclotron, built at Columbia University. I used it to give an example of what was being built for the Manhattan Project.

Chen, Peter C. *World War II Database*, 3 Jan. 2022, https://ww2db.com/image.php?image_id=31553. Accessed 12 Dec. 2022.

Wu married Luke Yuan in 1942. I used this image of their wedding to show part of her life in Berkeley.

Fan, Jiao. *US Dandelion*, 17 Aug. 2021, https://usdandelion.com/archives/5953. Accessed 7 Jan. 2023.

This is an image of Wu being awarded the Wolf Prize in Physics in 1978. I used it as an example of her scientific accomplishments and legacy to the world.

Gerald R. Ford Presidential Library and Museum, 2022, https://fordlibrarymuseum.tumblr.com/post/646727873012580352/womens-history-month-spotlight-dr-chien-shiung. Accessed 2023.

This image helped me understand one of the many awards Wu received. President Ford is seen presenting the National Medal of Science to Wu.

Historical Society of Princeton, https://princeton.pastperfectonline.com/photo/0F243E2F-BCD6-4BFB-941C-893029841615. Accessed 7 Jan. 2022.

This is an image of the Palmer Physical Laboratory in Princeton where Wu became the first female teacher to be ever hired there.

Institute for Advanced Study, 22 Sept. 2022, https://www.ias.edu/news/celebrating-chen-ning-yang-100. Accessed 4 Dec. 2022.

This image portrays Tsung Dao Lee and Chen Ning Yang, theoretical physicists who later won a Nobel Prize, while Wu's contribution to proving their theory was ignored.

International Campaign to Abolish Nuclear Weapons, https://www.icanw.org/hiroshima_and_nagasaki_bombings. Accessed 4 Dec. 2023.

I used this image to show the devastating effects the atomic bomb dropped on Hiroshima caused.

Kavli IPMU, https://www.ipmu.jp/en/job-opportunities/CSW2022. Accessed 3 Jan. 2023.

This image features Chien-Shiung Wu working in her lab. I used it to show viewers what kind of work she did.

Kelley, Robert W. *NBC News*, 11 Feb. 2021, https://www.nbcnews.com/science/science-news/new-postage-stamp-honors-trailblazing-first-lady-physics-rcna283. Accessed 23 Jan. 2023.

This is a striking close-up up image of Wu working on an experiment. I used it on the homepage to illustrate her love for her work.

Lawrence Berkeley National Laboratory, 26 Feb. 2020, https://stratcomm-elements.lbl.gov/2020/02/26/pioneering-lab-women/. Accessed 11 Jan. 2023.

I used this image of Wu at a dinner in UC Berkeley's International House to show what kinds of things she was doing during her stay in the US.

Liu, Matthew. *The Radiation Laboratory*, 18 Feb. 2019, http://large.stanford.edu/courses/2019/ph241/liu1/. Accessed 6 Jan. 2023.

This image shows the radiation lab at Berkeley. I used it to show how the facility of Berkeley attracting Wu was also a factor of her choosing to study there instead of the University of Michigan.

Lough, René. *Medium*, 20 Apr. 2018, https://lough-and-behold.medium.com/universe-in-reverse-the-queen-of-physics-chien-shiung-wu-1ba8f6b3cfff. Accessed 8 Dec. 2022.

This is an image of Wu while she studied at Berkeley in the United States. I used it to illustrate her life in Berkeley.

Michigan Union, https://uunions.umich.edu/history/. Accessed 2 Jan. 2023.

Until 1968, women were not allowed to use the front entrance of the University of Michigan and instead had to walk through a side door. This image of the building helps me understand the sexism they faced during this time.

National Archives, https://www.archives.gov/news/topics/hiroshima-nagasaki-75. Accessed 1 Jan. 2023.

This image features an atomic cloud over Nagasaki after an atomic bomb was dropped in 1945.

National Institute of Standards and Technology, 28 Apr. 2015, https://www.nist.gov/pml/fall-parity/reversal-parity-law-nuclear-physics. Accessed 29 Dec. 2022.

This image shows NBS staff members working on experiments related to the parity law in physics.

Office of Scientific and Technical Information, https://www.osti.gov/opennet/manhattan-project-history/images/oppenheimer_fermi_lawrence_image.htm. Accessed 5 Jan. 2023.

This image portrays Oppenheimer, Fermi, and Lawrence, all prominent scientists Wu met, and why she was asked to participate in the Manhattan Project.

Owlcation, 4 June 2022, https://owlcation.com/humanities/Chien-Shiung-Wu. Accessed 4 Dec. 2022.

A smiling Wu working on one of her experiments is illustrated in this image. I used it to represent the time she began teaching.

Republic of China, 24 Sept. 2020, https://www.minguowang.com/brand/8475/. Accessed 5 Jan. 2023.

This image shows China's prestigious school, National Central University, where Wu graduated from.

Scutts, Joanna. *Time*, 14 June 2016, https://time.com/4366137/chien-shiung-wu-history/. Accessed 29 Nov. 2022.

This image shows the recipients of the 1946 "Young Women of the Year." I used it as an example of one of Wu's many accomplishments.

Smithsonian Institution Archives,
https://www.si.edu/object/chien-shiung-wu-1912-1997%3Asiris_arc_306591. Accessed 19 Dec. 2022.

I used this image of Wu to show her working at Columbia University.

Taiwan Today,
https://taiwantoday.tw/news.php?unit=20&post=26170&unitname=Culture-Taiwan-Review&postname=Great-Physicist%2C-Wife-And-Mother. Accessed 21 Mar. 2023.

This is an image of Wu during her college years. I used it to show her progression from child to adult.

The Chinese University of Hong Kong, 2012, https://cnyangarchive.cuhk.edu.hk/album.aspx. Accessed 4 Feb. 2023.

This is an image of the 1957 Nobel Prize Ceremony in Hong Kong. It helped me understand how she was ignored by the committee despite her significant contribution.

"The Nobel Prize in Physics 1957." *The Nobel Prize*,
https://www.nobelprize.org/prizes/physics/1957/summary/. Accessed 22 Mar. 2023.

In 1957, Yang and Lee won the Nobel Prize in Physics. Despite Wu's significant work on their theory, she was not given the prize. I used this image of their award to mark a point of Wu's life.

UC Berkeley Library, 8 Dec. 2006,
https://bancroft.berkeley.edu/Exhibits/physics/learning01.html. Accessed 17 Dec. 2022.

This image portrays Raymond Birge, head of the physics department at UC Berkeley, who allowed Wu to enroll in the school.

U.S. Postal Service, 1 Feb. 2021,
https://about.usps.com/newsroom/national-releases/2021/0201ma-nuclear-physicist-chien-shiung-wu-to-be-honored-on-forever-stamp.htm. Accessed 4 Jan. 2023.

I used this image of Wu on a Forever Stamp to show just how much of an impact she has on the world today.

Wu, Chan. *Southeast University*, 14 June 2016,
https://www.seu.edu.cn/english/2016/0614/c238a161657/page.htm. Accessed 2022 Nov. 28AD.

This image portrays a smiling Wu surrounded by flowers. The image gave me a glimpse of her childhood.

Wu, Xuejian. *The Conversation*, 10 Feb. 2021, https://theconversation.com/new-postage-stamp-honors-chien-shiung-wu-trailblazing-nuclear-physicist-154687. Accessed 19 Dec. 2022.

I used this image of Chien-Shiung Wu receiving an honorary doctorate at Harvard in 1974 as an example of her legacy.

Yang, Yang. *China Daily*, 9 July 2022, https://www.chinadailyhk.com/article/279840. Accessed 28 Jan. 2023.

This image is Wu's graduation photo in 1940 where she stands in front of Berkeley. I used this to show when she graduated and to emphasize this mark in her life.

Yuan, Jada. *Washington Post*, 13 Dec. 2021, https://www.washingtonpost.com/lifestyle/2021/12/13/chien-shiung-wu-biography-physics-grandmother/. Accessed 2 Jan. 2023.

This is an image of young Wu with her family. The image helped me to understand the relationship between her and her family and what Wu's childhood was like.

Newspapers

"Petite Chinese Girl Shows Research in Atom Smashing." *The Oakland Tribune*, 25 Apr. 1941.

This newspaper talked about how Wu worked side-by-side with top physicists. I used an image of Wu from this.

Videos

Brown University Department of Physics. *Chien-Shiung Wu, "The First Lady of Physics,"* 2019, https://www.youtube.com/watch?v=Et4cY9msOWw. Accessed 5 Jan. 2023.

This video helped me understand Wu's life and her legacy to the world.

Keating, Brian. *Madame Wu & Parity Violation: The Most Important Experiment Ever!*, 2022, https://www.youtube.com/watch?v=lHi5tZkwpAM&t=3s. Accessed 7 Dec. 2022.

This video explained Wu and the Parity Experiment and how she was not given the Nobel Prize.

Secondary Sources

Books

Gaertner, Meg. *Chien-Shiung Wu: Physicist*. Focus Readers, 2021.

This book explained how Wu became a scientist and helped me understand her work in the Manhattan Project and how she proved a theory about particle movement.

Hammond, Richard. *Chien-Shiung Wu: Pioneering Nuclear Physicist*. Chelsea House, 2010.

This book is about Wu and the nuclear world. It provided me with information about the Manhattan project and the effects of it.

Robeson, Teresa. *Queen of Physics: How Wu Chien Shiung Helped Unlock the Secrets of the Atom*. Sterling Children's Books, 2019.

This book illustrated Wu's life from childhood to death and helped me understand the hardships she faced along the way.

Tsai-Chien, Chiang. *Madame Wu Chien-Shiung: The First Lady of Physics Research*. World Scientific, 2014.

This biography on Wu gave me very detailed information about her and I was able to use many useful quotes.

Images

Francis, Matthew R. *Galileo's Pendulum*, 2014, https://galileospendulum.org/2014/03/08/madame-wu-and-the-backward-universe/. Accessed 2 Jan. 2023.

I used an image from this source, illustrating the Wu experiment. It helped me understand how the weak force violates the law of parity.

Podcasts

Yuan, Jada, et al. "A Physics Legend Part Two: Chien-Shiung Wu's Granddaughter Reflects." *National Public Radio*, 11 Mar. 2022.

This podcast interviewing Jada Yuan, Wu's granddaughter, gave me insight to her perspective on Wu. I used it in the website as additional information about Wu.

Publications

Benczer-Koller, Naomi. "Chien-Shiung Wu 1912-1997." National Academy of Sciences, 2009, http://nasonline.org/publications/biographical-memoirs/memoir-pdfs/wu-chien-shiung.pdf.

This biographical memoir provided detailed information about her life. I was able to use many useful quotes from it.

Websites

Angelucci, Ashley. “Dr. Chien-Shiung Wu.” *National Women's History Museum*, 2021, https://www.womenshistory.org/education-resources/biographies/dr-chien-shiung-wu.

I used a quote from this website to explain her relations with Ernest Lawrence, showing how she got to meet many famous physicists.

Blakemore, Erin. “The Forgotten Female Physicist Who Played a Crucial Role in the Manhattan Project.” *Business Insider*, 20 Feb. 2015, https://www.businessinsider.com/chinese-woman-chien-shiung-wu-helped-with-the-manhattan-project-2015-2.

I used a quote from this website explaining how her life as an Asian-American scientist was full of obstacles.

“Chien-Shiung Wu.” *Atomic Heritage Foundation*, 2022, https://ahf.nuclearmuseum.org/ahf/profile/chien-shiung-wu/.

This website helped me understand Wu’s contribution to the Manhattan Project and how she was the only Chinese person to have worked on it.

“Chien-Shiung Wu.” *Columbia 250*, https://c250.columbia.edu/c250_celebrates/remarkable_columbians/chien-shiung_wu.html.

This source allowed me to explain how Wu’s work verified the theory that the interactions between decaying particles were not always symmetrical.

“Chien-Shiung Wu, Physicist Who Helped Change The World.” *Berkeley Lab*, 19 May 2015, https://diversity.lbl.gov/2015/05/19/chien-shiung-wu-physicist-who-helped-change-the-world/.

This website gave a powerful message on how, as girls get older and begin to pursue science, they don’t see their place in the science world.

“Chien-Shiung Wu.” Nuclear Museum, https://ahf.nuclearmuseum.org/ahf/profile/chien-shiung-wu/.

I used a quote from this website to explain Wu’s work in the Manhattan Project.

Davis, Jennifer. “Life Under Curfew.” *Alumni Association of the University of Michigan*, https://alumni.umich.edu/michigan-alum/life-under-curfew/.

This source helped me understand the sexism women faced at the University of Michigan and why Wu chose to study at Berkeley instead.

Dicke, William. “Chien-Shiung Wu, 84, Dies; Top Experimental Physicist.” *The New York Times*, 18 Feb. 1997, https://www.nytimes.com/1997/02/18/us/chien-shiung-wu-84-dies-top-experimental-physicist.html.

This quote helped me understand how Wu pushed through sexism and proved that women were just as capable as men.

"Dr. Chien-Shiung Wu, The First Lady of Physics." *National Park Service*, https://www.nps.gov/people/dr-chien-shiung-wu-the-first-lady-of-physics.htm.

I used a quote from this website to show how Wu's significant contribution to the Manhattan Project was ignored by the Nobel Prize committee.

Giustino, Marianna. "Chien-Shiung Wu: The Queen of Nuclear Research." *Cherenkov Telescope Array*, 30 Dec. 2022, https://www.cta-observatory.org/building-from-diversity-article-chien-shiung-wu/.

I used a quote from this source explaining how Wu was one of the only women who worked on the Manhattan project out of thousands of others.

Han, Xiaomeng. "Chien-Shiung Wu — A Heroic Experimental Physicist." *Harvard University*, 10 Dec. 2020, https://sitn.hms.harvard.edu/flash/2020/chien-shiung-wu-a-heroic-experimental-physicist/.

This quote helped me understand how esteemed Chien-Shiung Wu was among her peers and what she did to build this reputation.

"Life Story: Chien-Shiung Wu (1912-1997)." *New-York Historical Society*, 3 Aug. 2022, https://wams.nyhistory.org/confidence-and-crises/world-war-ii/chien-shiung-wu/.

This website provided me with information about Wu's family. I used a quote from this source explaining the support Wu got from her father.

Nakra, Rishabh. "The Amazing Story of How This Nuclear Physicist Disproved a Crucial Law of Nature." *The Secrets of the Universe*, https://www.secretsofuniverse.in/parity-violation-weak-experiment/.

This website explained Wu's contribution to the concept of parity and how she was excluded from a well-deserved Nobel Prize.

Tsjeng, Zing. "The Chinese Madame Curie." *Cosmos*, 14 May 2018, https://cosmosmagazine.com/science/physics/forgotten-women-in-science-chien-shiung-wu/.

This website talked about the forgotten contributions of female scientists and provided me with information about the Manhattan project. I used a quote from it explaining her regret about Hiroshima and Nagasaki.

Worthen, Meredith. "Chien-Shiung Wu." *Biography*, A&E Networks Television, 1 June 2016, https://www.biography.com/scientist/chien-shiung-wu.

I used a quote from this website to explain Wu's long-term impact on young women aspiring to be scientists.