Reaching for the Stars:
Cecilia Payne-Gaposchkin's Struggle to Break Social and Scientific Barriers
Bibliography

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Works Cited

Primary Sources

Arthur Eddington. *Encyclopædia Britannica*, www.britannica.com/biography/Arthur-Eddington#/media/1/178891/10331. Accessed 4 Jan. 2020. This is a primary source photograph of Arthur Eddington. We used it in our project to provide a visual reference of the man that grew Payne's excitement about astronomy. It helped us understand our topic by showing us one of the people that cultivated her interest in Astronomy, which eventually lead to her breaking many barriers in the future.

The British astronomer Cecilia Payne-Gaposhkin. Photograph. *Britannica ImageQuest*, Encyclopædia Britannica, 22 Oct 2018.quest.eb.com/search/132_1571391/1/132_1571391/cite. Accessed 2 Jan 2020. This is a primary source image of Cecilia Payne-Gaposchkin. We used this photo in our website as a title image. This helped us understand our topic and create our project because it allowed us to convey how Payne-Gaposchkin looked to the viewer of our website, allowing them to better visualize her journey.

The Constitution of the United States of America, in *, Original Sources*. 13 Nov. 2019. os.eb.com/Document.aspx?DocID=32RFTTS6G24I8DQ&H=1. This is a transcript of the United States Constitution containing its 19th Amendment, which states that a person's sex should not determine their rights. We used this in the Background section of our Project to describe the beginning of the Roaring 20's and the Beginning of gender equality in the United States. This helped us build our project and understand our topic because it gave us the primary source information of the *actual* Nineteenth Amendment, which showed that there was a large change in how the US government saw women

during the time period, eventually leading to the breaking of several major historical barriers.

Cushing, Cushing. *75th Anniversary Celebration*, 1954. This is a Primary Source Image depicting a celebration at Harvard in honor of several awardees, including Cecilia Payne. We used this source in the long-term consequences section of our project, which described what happened later in her life and her legacy. This helped us understand our topic and create our project because this gave us another example of how Harvard changed their ideology to celebrating and giving awards to people regardless of gender.

Ernest Rutherford. *Encyclopædia Britannica*, www.britannica.com/biography/Ernest-Rutherford#/media/1/514229/115396. Accessed 4 Jan. 2020. This is a primary source photograph of British scientist Ernest Rutherford, who was Cecilia Payne's professor at Cambridge University. We used it in our project to provide the viewer with a picture of Ernest Rutherford, which would allow them to better visualize the way he influenced Payne's terrible experiences at Cambridge University. It helped us understand what Ernest Rutherford looked like and what he looked like while teaching Cecilia Payne's classes.

FASHION: FLAPPER, 1926.. Fine Art. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/140_1641781/1/140_1641781/cite. Accessed 3 Jan 2020. This is a primary source image of a flapper from the 1920's. We used this image in the Roaring 20's section of our website as a visual aid to the content written about flappers and the Roaring Twenties. This helped us understand our topic and create our project by providing us a visual representation of how exactly a flapper would look, which we then used in our website to convey the same message to the viewer. Flappers were also a large

part of the Roaring 20's, when many women including Cecilia Payne were breaking several barriers.

Fay Foto Service, Fay Foto Service. *Harvard Law School Faculty, May 1927*, 1927. This is a primary source image that depicts Harvard faculty from 1927 around the time Cecilia Payne would have worked there. We used it in our project to show how a majority of the faculty at Harvard were men. It helped us understand our topic and create our project by showing the extent of male employees and professors at Harvard and by providing us a visual aide that allowed to viewer to properly visualize the majority.

Gaposchkin, Cecilia Helena Payne. Retrieved from the Digital Public Library of America. https://repository.si.edu/bitstream/handle/10088/19152/SCAS-0066.pdf?sequence=1&isAllowed=y. This is a primary source dissertation written by Cecilia Payne-Gaposchkin in 1974 on the period, color, and luminosity for Cepheid variables. We used this source in the short term section of our project to show the many other research papers Payne wrote. This helped us understand our topic and develop our project because it gave us another example of a discovery she made, showing us the amount of work she did on her many projects that broke many barriers during her lifetime.

H.N. Russell. Photography. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/139_1916908/1/139_1916908/cite. Accessed 22 Jan 2020. This is a primary source picture of Henry Norris Russell, an American astronomer, from Britannica ImageQuest. We used this source as a visual aide in the Breaking Gender Barriers page of our website. This helped us understand our topic and create our project because it provided a way for our viewer to visualize how he and Cecilia Payne-

Gaposchkin interacted and how him receiving more credit for the discovery eventually pushed her to claim her rightful recognition for Breaking Scientific Barriers.

Haramundanis, Katherine. Interview. Conducted by David DeVorkin. *American Institute of Physics*, www.aip.org/history-programs/niels-bohr-library/oral-histories/31784. Accessed 4 Jan. 2020. This is a primary source interview of Katherine Haramundanis, the daughter of Cecilia Payne. We used it to show the advances Payne made in her daily life towards equality from her daughter's perspective. It helped us understand our topic and create our project by showing us that she worked towards her goal even in her domestic life with proof from her daughter, proving her efforts towards establishing herself and unintentionally breaking barriers in science and gender equality.

Harlow Shapley. [No Date Recorded on Caption Card] Photograph. Retrieved from the Library of Congress, <www.loc.gov/item/2005691427/>. This is a primary source image from the Library of Congress depicting Harlow Shapley. We used this in our website on the Schooling page, as he provided her with the opportunity y come to the Harvard Observatory. This helped us create our project and understand our topic by providing us with a visual aid to show our website's viewers what Harlow Shapley looked like, because without him Payne might have never had the chance to break any barriers.

Harvard astronomers acting in a play. Photograph. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/132_1251680/1/132_1251680/cite. Accessed 26 Nov 2019. This is a picture of the members of the Harvard Observatory acting out a play, including Cecilia Payne and Harlow Shapely. We used this in the section of Payne's coming to America and joining Harvard. It helped us understand our topic and create our project by giving us concrete evidence about how the people of the

university acted with each other, as this shows they interacted in a casual way regardless of gender and how it influenced Payne-Gaposchkin to break more gender barriers.

Harvard College Observatory, 1917. Photograph. *Britannica ImageQuest*, Encyclopædia Britannica, 31 Aug 2017.quest.eb.com/search/132_1470233/1/132_1470233/cite. Accessed 14 Nov 2019. This is a primary source photograph from the Harvard Observatory. It depicts Cecilia Payne with the (few) other women that worked at the observatory. We used this in our project to show the collective nature of all the women at the Harvard observatory. This helped us understand our topic and create our project because it allowed us to show our viewer the increased measure of freedom and acceptance that Payne received there, leading her to eventually break social and scientific barriers.

Harvard Faculty, 1928-1929, 1928. This is a primary source image that depicts Harvard faculty from 1927 around the time Cecilia Payne would have worked there. We used it in our project to show the type of faculty at Harvard during that time: male. It helped us understand our topic and create our project by showing the extent of male employees and professors at Harvard, which we used to estalish the gravity of the gender barriers broken by Cecilia Payne.

Harvard Faculty Club [Interior] Main Dining Room, December 1939, 1939. This is a primary source image that depicts Harvard faculty from 1927 around the time Cecilia Payne would have worked there. We used it in our project to show that the majority of faculty at Harvard during that time was male. It helped us understand our topic and create our project by showing the extent of male employees and professors at Harvard, emphasizing the gravity of the gender barriers that Cecilia Payne broke.

Harvard Law School Faculty, Ca. 1900, 1900. This is a primary source image that depicts Harvard faculty from 1927 around the time Cecilia Payne would have worked there. We used it in our project to show that the type of faculty at Harvard during that time were male. It helped us understand our topic and create our project by showing the extent of male employees and professors at Harvard, which further highlighted the gender barriers that Payne broke.

Harvard Law School Faculty, 1936-1937, 1936. This is a primary source image that depicts Harvard faculty from 1927 around the time Cecilia Payne would have worked there. We used it in our project to show that the majority of faculty at Harvard during that time was male. It helped us understand our topic and create our project by showing the extent of male employees and professors at Harvard, emphasizing the gravity of the gender barriers that Cecilia Payne broke.

Hertzsprung-russell diagram of stars. Photography. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/132_1299160/1/132_1299160/cite. Accessed 23 Oct 2019. This is a primary source image of the original Hertzsprung-Russel Diagram. We used this to show the science that Payne used in her Thesis and discoveries. This helped us understand our topic and create our project because it she would have referenced this diagram in order to study the composition of the stars. It helped us understand the data and the classification system that she was dealing with, as well as how she was using data from previous astronomers to break barriers.

Hinkle, Kenneth, et al. *Infrared Atlas of the Arcturus Spectrum, 0.9-5.3 microns*. Astronomical Society of the Pacific, 11 July 1910, articles.adsabs.harvard.edu/pdf/1995PASP..107.1042H. This primary source research

report talks about research done on the spectra of a star called Arcturus. We used it in our project to show the preconceived notions that the stars had the same composition as the earth. This helped us understand our topic and create our project because it helped us understand more of the science that Payne-Gaposchkin used to break barriers.

Hirshberg, Charles. "My Mother the Scientist." *Popular Science*, 18 Apr. 2002, www.popsci.com/scitech/article/2002-04/my-mother-scientist/?single-page-view=true. This is a Primary Source article written by the daughter of the scientist Joan Feyman. We used in in our website to show the influence she got from Cecilia Payne in her time of need. It helped us understand our topic by showing us the extent to which women were discriminated against and how the mere thought that other women scientists exist could have propelled a whole career, an idea brought to the eyes of astronomer by Cecilia Payne-Gaposchkin.

History of Newnham. *Newnham College*, www.newn.cam.ac.uk/about/history/history-of-newnham/. Accessed 20 Jan. 2020. This is a primary source photograph of the inside of one of Newnham College's laboratories. We used it in our project in the Schooling page while talking about Cambridge and Newham College. It helped us understand and create our topic by giving the viewer a visual representation of what the actual college looked like inside, the college in which Payne discovered her passion for astronomy and would eventually leave to break astronomical barriers.

Information Bulletin on Variable Stars. Dec. 1980, babel.hathitrust.org/cgi/pt?id=ien.35556013782735&view=1up&seq=155. This is primary source bulletin board about the current thoughts and discoveries about variable stars. The information in this bulletin board clearly shows influence from Payne's work

and usage of her techniques. We used this in our project to show the influence of Cecilia Payne's barrier breaking work on other discoveries about variable stars. The text from 1980 clearly shows influences from Payne's discoveries and techniques.

Interview. Conducted by Owen Gingerich. *American Institute of Physics*, www.aip.org/history-programs/niels-bohr-library/oral-histories/4620. Accessed 30 Oct. 2019. This is a primary source interview of Cecilia Payne done by Owen Gingerich. It is a transcript of Gingerich interviewing her on her experiences in college. We used this source for our entire topic, specifically the Build-Up section where we talked about her College life and her transition from Botany to Physics to Astronomy. This helped us understand her career at Cambridge and Harvard, the different people and environments she found there, and the setting in which she was able to break barriers by making important discoveries.

Katherine Haramundanis at the American Astronomical Society (AAS) Meeting at Michigan State University. 17 Aug. 1972. *American Institute of Physics*, www.aip.org/history-programs/niels-bohr-library/oral-histories/31784. Accessed 4 Jan. 2020. This is a primary source photograph of Katherine Haramundanis, Cecilia Payne's daughter. We used it in our website as a visual representation of the face of many quotes about her mother from her interview. This helped us create our project because it conveyed to our viewer the face behind the voice in the interview, the daughter of a woman who broke several barriers in astronomy.

Payne, Cecilia H. "The Relative Abundances of the Elements." *A Source Book in Astronomy and Astrophysics, 1900-1975,* in *A Source Book in Astronomy and Astrophysics, 1900-1975,* edited by Kenneth R. Lang and Owen Gingerich, Cambridge, Harvard University Press, 1979, pp. 243–248. *Original Sources*. 16 Oct. 2019.

os.eb.com/Document.aspx?DocID=VHUYVJQN6YCMACN&H=1. This source is an online copy of one of Cecilia Payne-Gaposchkin's written dissertations, The Relative Abundances of the Elements, which we obtained from Britannica Original Sources. We found this source during our initial research and used it as a primary source to confirm that she discovered this, as well as to gain some insight into the science behind the discovery. This helped us understand our topic and create our project because it allowed us to read firsthand copies of the documents that Cecilia Payne-Gaposchkin wrote that broke barriers in science.

Payne-Gaposchkin, Cecilia, 1900-1979, author. Retrieved from the Digital Public Library of America. https://permanent.access.gpo.gov/gpo92112/SCAS-0055-Hi_res.pdf. This is an article written by Cecilia Payne about Stars in the Small Magellanic Cloud. We used this source in the short term section of our project as a discovery she made later in her life. This helped us understand our project and create our project because it gave us more concrete evidence that she made many more discoveries throughout her lifetime, because it provided us with another primary source, and because it showed us a firsthand copy of the document that Payne-Gaposchkin wrote that broke barriers in astronomy at the time.

Payne-Gaposchkin, Cecilia, 1900-1979, author. Retrieved from the Digital Public Library of America. https://permanent.access.gpo.gov/gpo92105/SCAS-0065.pdf. This is a dissertation written by Cecilia Payne-Gaposchkin on the Distribution and Ages of Magellanic Cepheids. We used this source in the short-term section of our project, which helped us understand our topic and create our project because it gave us another one of her discoveries to develop on and emphasize the large amount of work she did

throughout her lifetime. It also gave us a firsthand copy of the document that Payne-Gaposchkin wrote which broke scientific barriers.

Payne-Gaposchkin, Cecilia. *The Galactic Novae*. Constable and Company, 1964. *Archive.org*, archive.org/details/TheGalacticNovae. Accessed 8 Nov. 2019. This is a primary source book by Cecilia Payne. It talks about her discoveries of different novae, which are formed after a considerably large or variable star dies. It shows us the growth in her scientific discoveries after her main one but also her switch in direction from stellar composition to variable stars, which was prompted by her male colleagues. It also showed us a real copy of one of the documents through which she broke scientific barriers.

Payne - Gaposchkin, Cecilia. *Stars and Clusters*. Harvard UP, 1979. *Archive.org*, archive.org/details/StarsClusters. Accessed 8 Nov. 2019. This is primary source book by Cecilia Payne that talks about variable stars and the clusters that they are found in. We used this in our project in the Other Discoveries page of our website. It helped us understand our topic and create our project because it showed us the growth in her barrier breaking scientific discoveries after her main one regarding stellar composition. It also showed her switch in direction of study from stellar composition to variable stars, which was prompted by her male colleagues.

Payne-Gaposchkin, Cecilia. *Stars in the Making*. London, Fletcher and Son, 1952. *Archive.org*, archive.org/stream/StarsInTheMaking/Payne-gaposchkin-StarsInTheMaking_djvu.txt. This is a primary source book by Cecilia Payne that talks about the making of variable stars and what circumstances cause them. We used this in our website in the Other Discoveries page. It helped us understand our topic and create our project because it

showed us the impact of her initial discovery on her other scientific works and the growth in her scientific discoveries after her main one. It also shows her switch in direction from stellar composition to variable stars.

---. *Stellar Atmoshperes*. Cambridge, MA thesis. *Nasa Astrophysics Data System*, adsabs.harvard.edu/full/1925PhDT.....1P. Accessed 8 Nov. 2019. This is a primary source document of Payne's thesis, *Stellar Atmospheres*, in which she details how the stars are primarily made of hydrogen and helium. We used this in the Scientific Barriers page of our website. It helped us understand our topic and create our project by providing us with a copy of the thesis that explained her largest barrier-breaking discovery. It also allowed us to dive into the specific aspects of her reasoning for why the stars are made of these elements.

Payne-Gaposchkin, Cecilia Helena. *Cecilia Payne-Gaposchkin: An Autobiography and Other Recollections Second Edition*. Edited by Katherine Haramundanis, 2nd ed., Cambridge UP, 1996. This is a Primary Source Autobiography by Cecilia Payne herself which describes her entire life story, including how she was denied rights because she was a woman and how she struggled in life. We used this source to get more information for almost every aspect of our topic and Payne-Gaposchkin's life. This helped us understand our topic and create our project because it gave us more insight into how she saw her own life and how she thought while going through her life, as well as how she saw her own breaking of barriers in society and astronomy.

---. *Variable Stars of the Large Magellanic Cloud*. Washington, D.C., Smithsonian Institution Press, 1971. *Smithsonian Institution*, repository.si.edu/bitstream/handle/10088/6604/SCAS-0062-Hi_res.pdf. Accessed 20

Nov. 2019. This is a report written by Cecilia Payne-Gaposchkin in 1971 about variable stars specifically in the Large Magellanic Cloud. We used this to gather more information on her discoveries, and we also read it so that we could understand the concepts as well. This helped us understand our topic because it told us that she also made barrier-breaking discoveries later in her life (as she was in her early seventies when she finished writing this) and it helped us create our project by providing more concrete information of her discoveries that broke astronomical barriers.

"Percentage of Science, Technology, Engineering, and Math (STEM) Workers Who Are Women." *US Department of Labor*, 2013, www.dol.gov/agencies/wb/data/facts-over-time/women-in-the-labor-force#womenstem. Accessed 22 Mar. 2020. Chart. This is a primary source graph of women in science from 1970 to 2013 from the US department of labor's Women's Bureau. We used this in the Legacy page of our website when we explained how the number of women in scientific fields has increased dramatically over the last 50 years. It helped us understand our topic and create our project because it gave us both data and a visual of how the number of women in science has increased greatly, which was caused by Cecilia and various female scientists who acted as role models for women who wanted to pursue science as a career. Her actions broke several major scientific and gender barriers for women, which added another step towards greater gender inequality and inspired women all over the world to pursue science.

Petition and Record of Naturalization in the U.S. District Court for the District of Massachusetts. Publication no. 3481043, Boston, Massachusetts, U.S. District Court for the District of Massachusetts, 27 July 1931, catalog.archives.gov/id/66125758. This is a primary source document of the Naturalization Petition and Report for Ceclia Payne's American

Citizenship. We used this source to back up our previous evidence about Cecilia Payne from the U.K. to the United States. This helped us understand our topic and create our project because it gave us concrete proof of her immigration to the United States and it gave us more insight on Cecilia's life, which allowed her to break astronomical and gender barriers at Harvard University.

PHILADLPHIA: FACTORY, 1925. - Women working in large room of a factory in Philadelphia, Pennsylvania.. Fine Art. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/140_1703381/1/140_1703381/cite. Accessed 14 Jan 2020. This is a primary source photograph of women working in a factory during the Roaring 20's. We used it in our project in the Roaring 20's Page of our website. It helped us understand our topic and create our project because it allowed us to visualize exactly how many women were beginning to work, which would have influenced Payne-Gaposchkin to pursue astronomy and break barriers during this time.

Pickering's Women. *The Harvard Gazette*, Harvard University, 11 Apr. 2017, news.harvard.edu/gazette/story/2017/04/star-analysts-of-harvard-college-observatory-inspired-new-book-by-dava-sobel/. Accessed 29 Jan. 2020. This is a Primary Source Image depicting Pickering's Women, a group of women who worked at Harvard Observatory and was joined by Payne-Gaposchkin when she first came to Harvard. We used this source in as a visual aide for how the Harvard Observatory treated women. This helped us understand our topic and create our project because it allowed us to better understand how the Observatory used to think of women as subservient to men, as Pickering's women simply sat around in a room and computed equations that the

scientists found. This showed the need for Payne-Gaposchkin to break social and scientific barriers to oppose the way society thought.

Radcliffe Panorama., 1959. This is a primary source image depicting the Radcliffe University Panorama, which Cecilia Payne-Gaposchkin was a part of. This we used this in the long-term consequences section of our project, where we described events that happened later in her life and her legacy. This helped us understand our topic and create our project because it allowed us to better visualize and comprehend the various types of awards she received later in her life as a result of her breaking barriers, ranging from enormous honors to small awards such as being part of the Radcliffe Panorama.

Russell, Henry Norris. "Relations Between the Spectra and Other Characteristics of Stars." *A Source Book in Astronomy and Astrophysics, 1900-1975,* Vol. 22, in *A Source Book in Astronomy and Astrophysics, 1900-1975,* edited by Kenneth R. Lang and Owen Gingerich, Cambridge, Harvard University Press, 1979, pp. 212–220. *Original Sources*. 23 Oct. 2019. https://os.eb.com/Document.aspx?DocID=8JHW79EF7GU8MEA&H=1. This is an article written by Henry Norris Russell, a professor at Princeton University who developed the Hertzsprung-Russell Diagram, which categorizes stars' masses and heat based off colors they give off. We used this source in the background and build-up sections of our project to explain some of the previous discoveries made that influenced Payne's barrier-breaking discoveries, one of which was this discovery that correlated a star's color with its heat and size. This helped us understand our topic better because it indirectly taught us more about how Payne made her discovery and the science behind it.

Secchi's four classes of stellar spectra. Photograph. *Britannica ImageQuest*, Encyclopædia Britannica, 25 May 2016.quest.eb.com/search/132_1368414/1/132_1368414/cite.

Accessed 14 Nov 2019. This is primary source image of original stellar spectra. It depicts spectrum made by earlier scientists that explained what color each element looked like. She would have used this to as a comparison tool to understand what colors are in the stars and what aren't and what elements these correspond to. We used this in our project to show the kinds of spectra Payne would be working with while she made her barrier-breaking discoveries.

Sergei and Cecilia Gaposchkin, 1979. Photograph. *Britannica ImageQuest*, Encyclopædia Britannica, 31 Aug 2017.quest.eb.com/search/132_1470247/1/132_1470247/cite. Accessed 12 Nov 2019. This is a picture from Britannica ImageQuest depicting Cecilia Payne-Gaposchkin and her husband, Sergei Gaposchkin. We used this source to give a better visual aide to our project by showing a more modern color photo. This helped us create our project because it gave us a more clear understanding of what the two looked like (as this photo was in color and had better resolution) and it helped us understand how close the two were, which would have influenced the way they worked together in their older years while they also broke countless astronomical barriers.

St Paul's Girls School, The Studio (photo). Illustration. *Britannica ImageQuest*, Encyclopædia Britannica, 6 Dec 2017.quest.eb.com/search/108_2292960/1/108_2292960/cite. Accessed 14 Jan 2020. This is a primary source photograph of the inside of St. Paul's girls' school, the school that Cecilia Payne went to as a child. We used it in our project to showcase the atmosphere of creativity she grew up in. This helped us understand our topic and create our topic by illustrating the school that taught Cecilia Payne to effectively challenge gender norms and break barriers.

Tupper (Cambridge, Tupper (Cambridge. *Harvard Law School Faculty, 1913-1914?*, 1913. This is a primary source image that depicts Harvard faculty from 1913 to 1914, around the time Payne would have studied there. We used this source in the Roaring 20's section of our project under the Harvard Professors tab. It helped us understand our topic and create our project because it allowed us to visually represent to our viewer how many of Harvard's professors were male. It also helped us emphasize how Cecilia being promoted to full professor and head of the Department of Arts and Sciences at Harvard broke several gender barriers in astronomy and unspoken university barriers.

United States, Congress, House. House Joint Resolution 1. 26 Aug. 1920, catalog.archives.gov/id/596314. 66th Congress, 1st session. This is a primary source document that shows the resolution or the 19th amendment that was introduced in the early 1920's. We used this as a document that backed up information on the Roaring 20's page. This helped us understand our topic and create our project because it showed how the Roaring 20's were a progressive time for women in the United States, allowing for more barriers to be broken.

Secondary Sources

Cavendish Laboratory Staff and Research Students. *Research Gate*, www.researchgate.net/figure/Cavendish-Laboratory-Staff-and-Research-Students-1933-Names-from-left-to-right-Front_fig1_271608226. Accessed 20 Jan. 2020. This is a primary source photograph of the staff and students of Cavendish Laboratory, the Lab where Rutherford worked and taught many students including Cecilia Payne. We used it in our project to show the extent of male students compared to female students. It helped

us understand and create our project by giving us a visual reference of the discriminatory nature of the time and showing how Cecilia Payne being one of the only women would lead to her eventual breaking of gender barriers in science.

"Cecilia Payne-Gaposchkin." *Britannica School*, Encyclopædia Britannica, 21 Feb. 2011, school.eb.com/levels/high/article/Cecilia-Payne-Gaposchkin/543597. Accessed 16 Oct. 2019. This source is an article about Cecilia Payne-Gaposchkin from Britannica School. We used this source to give general information about Payne's life at Harvard as well as some aspects of her early life. This helped us create our project because it started off our research and gave us basic facts that we could branch off of, allowing us to effectively convey how Cecilia Payne-Gaposchkin broke barriers in both science and gender quality.

"Cecilia Payne-Gaposchkin." *Famous Scientists*, 7 Sept. 2018, www.famousscientists.org/cecilia-payne-gaposchkin/. Accessed 20 Jan. 2020. This is an an article from Famous Scientists about Cecilia Payne-Gaposchkin. We used this in our website in the form of quotes and relevant information throughout the website.

This source helped us understand our topic and create our project by providing information about Payne-Gaposchkin's life and discoveries, which supported the claims we made about how she broke barriers in astronomy and society.

Dattagupta, Sushanta. "On the Saha Ionization Equation." *Princeton.edu*, Jan. 2018, www.ias.ac.in/article/fulltext/reso/023/01/0041-0055. Accessed 13 Nov. 2019. This is a secondary source article that gave us information about a discovery made prior to Cecilia Payne called the Saha equation. We used this source in the background section of out project because it was imperative in Cecilia Payne's discovery of the elements that stars

were made of as she used this equation combined with stellar spectra to make her hypothesis. This helped us understand our topic and create our project because it allowed us to better understand the Saha equation and its impact on Payne's discoveries, which would eventually break scientific barriers.

Doane, Alison. "Cecilia Payne-Gaposchkin: The Courage to Succeed." *New Moon*, vol. 11, no. 2, 31 Dec 1994, pp. 22. *elibrary*, https://explore.proquest.com/elibrary/document/194785735?accountid=2402. This is an article about Cecilia Payne and her life from ProQuest eLibrary. We used this for general information on her life and discoveries. It helped us understand the topic and create our project because it validated previous information about how she broke barriers and because it gave us a starting point from we could branch out and find more information.

The Editors of Encyclopaedia Britannica. "Harlow Shapley." *Encyclopædia Britannica*, 29 Oct. 2019, www.britannica.com/biography/Harlow-Shapley. Accessed 15 Jan. 2020. This is a secondary source article from the Encyclopedia Britannica about American astronomer Harlow Shapley. We used this source in our website to get information on Harlow Shapley. This helped us understand our topic and create our project because it gave us background information on who Harlow Shapley was and how he helped Cecilia Payne-Gaposchkin in moving to Harvard University, eventually allowing her to break barriers in society and astronomy.

Gingerich, Owen. "Obituary - Payne-Gaposchkin Cecilia." *Quarterly Journal of the Royal Astronomical Society*, vol. 23, 1982, adsabs.harvard.edu/full/1982QJRAS..23..450G. Accessed 10 Dec. 2019. This secondary source is an obituary of Cecilia Payne Gaposhkin. It chronicles her life and accomplishments as well as some of her final words.

We used this obituary for some explanation about her personal life, her feelings on her discoveries and some of her advice to other women in the scientific field. It helped us understand and create our topic by giving us an outside perspective on her legacy and importance to the community, as she broke enormous social barriers for women in science.

Greenstein, George. "SCIENCE: The Ladies of Observatory Hill: Annie Jump Cannon and Cecilia Payne-Gaposchkin." *The American Scholar*, vol. 62, no. 3, Summer 1993, pp. 437-64. This is a secondary source journal article that talked about Payne and Anne Jump Cannon's experiments on Stellar Spectra at Harvard Observatory. We used this to show the details of how Payne made her discovery in our website, specifically in the Breaking Scientific Barriers page and the Schooling page. It helped us understand our project by showing us the specific nuances of her barrier-breaking discovery and all of the different, small things that she found out while working towards her larger goal.

Hughes, David W. "The Quarterly Journal, 1960-96." *SAO/NASA Astrophysics Data System*. Originally published in *Quarterly Journal of the Royal Astronomical Society*, vol. 37, p. 485. This is a secondary source article that talked about various prominent figures in astronomy after they died. We used the information from it in the Breaking Scientific Barrier page and Legacy page of our website. This helped us understand out topic and create our project because it talked about the death of Cecilia Payne-Gaposchkin and the barriers her discoveries broke in the scientific world.

Ignotfsky, Rachel. *Women in Science 50 Fearless Pioneers Who Changed the World*. 10 Speed Press, 2016. This secondary source is a book called Women in Science. We used this book for background information on Cecilia Payne's life and to gain more insight on her

discoveries. This helped us understand our topic and create our project because it gave us more information on Payne's life and it functioned as one of our major starting points for our research, giving us main points on how she broke barriers in history and science.

Kimmel, Leigh. "Family and Daily Life in the Roaring Twenties." *Family and Daily Life in the Roaring Twenties*, Facts On File, 2016. *American History*, online.infobase.com/Auth/Index?aid=101192&itemid=WE52&articleId=396997. Accessed 22 Oct. 2019. This is an article from American History Online that explained life in the 1920's, which was when Cecilia Payne moved to the United States and started her education in Radcliffe University as well as her career in Harvard University's Observatory. We used this source to gather information on the Roaring Twenties page of our website, as around her, Cecilia Payne's world was the American 1920's. This helped us understand our topic and create our project by allowing us to comprehend Payne's living conditions as a woman and the ideas of society, including the various gender barriers she broke during her lifetime.

"Learn about the Sun and Stars." *Generation Genius*, www.generationgenius.com/solar-system-for-kids/. Accessed 15 Mar. 2020. This is a secondary source website that is meant to teach children about stars. We used this in the Legacy page of our website to show the impact Cecilia Payne's discovery has today. It helped us understand our topic and create our project because it showed us how Payne's discovery broke barriers in astronomy and is now even being taught to children.

Nelson, Ken. "Astronomy for Kids: Stars." *Ducksters*, Technological Solutions, www.ducksters.com/science/star.php. Accessed 15 Mar. 2020. This is a secondary source website that is meant to teach astronomy to children. We used it in the Legacy part of our

project to show how Cecilia Payne-Gaposchkin broke astronomical barriers. This helped us understand our topic and create our project because it gave us a way to visually represent how now even children are learning that the stars are made of hydrogen and helium, showing the true extent of Payne-Gaposchkin's stellar discoveries.

"Nineteenth Amendment." *Britannica School*, Encyclopædia Britannica, 20 Aug. 2010, school.eb.com/levels/high/article/Nineteenth-Amendment/488730. Accessed 24 Oct. 2019. This is an article from Britannica School that explains the suffragette movement in the Unites States. This was used in our project in the background section of our project regarding the "Roaring 20's". This helped us understand our topic because it gave another fact proving that the 1920's were a significant time for Women's Rights, as 1920 was the year that the 19th Amendment was passed and women in the United States gained the right to vote. This also lead to significant societal changes that leaned towards gender Equality, including Payne's barrier breaking discoveries and appointing to Chairman and Professor.

Oakes, Elizabeth H. "Payne-Gaposchkin, Cecilia Helena." *Encyclopedia of World Scientists, Revised Edition*, Facts On File, 2007. *American History*, online.infobase.com/Auth/Index?aid=101192&itemid=WE52&articleId=297522. Accessed 16 Oct. 2019. We used this secondary source article from a database in order to learn more about her general life and childhood. We used it to learn about her parents and her childhood for the background section of our outline. This helped us understand our topic and create our project because it gave general information about the barriers she broke, which was a vital part of our research.

"Payne-Gaposchkin, Cecilia." *SIRS Discoverer*, ProQuest, 2006, explore.proquest.com/sirsdiscoverer/document/2267067189?searchid=1571798954&accountid=2402. Accessed 23 Oct. 2019. This source is an article from SIRS Discoverer by Proquest which summarizes Cecilia Payne-Gaposchkin's major achievements. We used this source in the Barriers Broken section of our website. This helped us create our project because it provided us with the vital piece of information that Cecilia Payne was the first student from Radcliffe University to obtain a Ph. D., which was one of the smaller barriers that she broke during her lifetime. It also supported previous statements from other sources.

Scholton, Robb. "History:A Brief History of the Harvard College Observatory." *Harvard Astronomy Department*, Harvard University, 2019, astronomy.fas.harvard.edu/history. Accessed 3 Oct. 2019. This source is an informational page about the Harvard University Department of Astronomy, which explained the history of their professors and other information about their department. We used this source to find more information about Cecilia Payne and what she was to the Department of Astronomy. This helped us create our project because it told us that Cecilia Payne broke barriers by becoming the first woman to become a professor in the Department of Astronomy at Harvard and that she was the first female chairman of the Department of Astronomy, which was a vital part of our research.

Smith, Amanda, et al. "Celebrating Women in Astronomy." *University of Cambridge*, 2019, www.ast.cam.ac.uk/about/history/celebrating.women.astronomy#poster4. Accessed 6 Nov. 2019. This is an article on the website for the University of Cambridge describing Payne's University life there and what she did. We used this article to get more

information on her college life and her overall achievements. This source helped us understand our topic and create our project because it shed us the later recognition that was given to Payne, years after her barrier-breaking discovery.

"Space Facts: Star Facts for Kids." *Science Kids*, www.sciencekids.co.nz/sciencefacts/space/stars.html. Accessed 15 Mar. 2020. This is a secondary source website, meant to teach children about stars and other heavenly. We used this in the Legacy page of our website. It helped us understand our topic and create our project because it showed us how Payne's discovery is now even being taught to children, representing how important and barrier-breaking her discovery was.

"Stars." *Our Universe for Kids*, www.ouruniverseforkids.com/star/. Accessed 15 Mar. 2020. This is a secondary source website that is meant to teach children about stars. We used this in the Legacy page of our website to show the impact Cecilia Payne's discovery has today. It helped us understand our topic and create our project because it showed us how Payne's discovery broke barriers in astronomy and is now even being taught to children.

"Stars and How They Are Formed." *Easy Science for Kids*, easyscienceforkids.com/all-about-the-stars/. Accessed 15 Mar. 2020. This is a secondary source website that is meant to teach astronomy to children. We used it in the Legacy part of our project to show how Cecilia Payne-Gaposchkin broke astronomical barriers. This helped us create our project and understand our topic because it gave us a way to visually represent how even children are now learning that the stars are made of hydrogen and helium, which truly represents how important Payne's discoveries were.

Tenenbaum, Laura Faye. "The Sun is Always Shining on Joan Feynman." *Jet Propulsion Laboratory*, NASA, 12 May 2015, www.jpl.nasa.gov/blog/2015/5/the-sun-is-always-

shining-on-joan-feynman. Accessed 7 Feb. 2020. This is a secondary source article about Joan Feynman, an astronomer influenced by Cecilia Payne-Gaposchkin. We used this source in our Legacy page to show how Payne-Gaposchkin's discoveries resonated with newer generations. We used this source to understand our topic and create our project by using information from this article to prove how Cecilia Payne-Gaposchkin's legacy is important to the field of astronomy and gender equality in general because of how she broke barriers in both fields.

Trimble, Virginia. "99 Things About the Last 100 Years of Astronomy." *SIRS Issues Researcher*, ProQuest, Nov. 1999, explore.proquest.com/sirsissuesresearcher/document/2262286947?searchid=1571799000&accountid=2402. Accessed 23 Oct. 2019. This is a source from SIRS Issues Researcher from ProQuest that explains the top 99 topics addressed or achievements of the last 100 years relative to the year 1999. We used this source to add to our background portion of our project and to confirm ideas of previous sources.. We used this to develop our project as a way to give us more information on Cecilia's barrier breaking achievements throughout her life in relation to other scientists, especially other female scientists.

Tyson, Neil DeGrasse, host. "Sisters of the Sun." *Cosmos: A Spacetime Odyssey*, hosted by Neil DeGrasse Tyson, season 1, episode 8, Fox, 27 Apr. 2014. This is a secondary source episode of *Cosmos: A Spacetime Odyssey*, a scientific series by Neil deGrasse Tyson. We used this episode for general information on Cecilia Payne. This helped us understand our topic and create our project because it was from this source that we heard about Cecilia Payne-Gaposchkin and her discoveries, and because it explained to us concepts

about Cecilia Payne-Gaposchkin's breaking of scientific barriers in a visual way that was easy to understand.