There is growing documentation of the challenges women have faced and are facing in having an equal role in astronomy. At the same time, women are attaining important positions throughout the astronomical community, including the presidency of the International Astronomical Union and the American Astronomical Society. This means that excellent role models are now available to show girls that they can be an integral part of the human exploration of the universe. Many instructors of astronomy would like to present such role models during their class discussions, but don’t have the material to do so at hand or in their textbooks.

Therefore, the Higher Education Working Group within NASA’s Science Mission Directorate has sponsored this guide to English-language materials. It is not meant to be a comprehensive introduction to this complex topic, but merely a resource for educators and their students on where to begin looking at the history, the biographical information, and the current issues. Suggestions for additional materials that are both accessible and readable are most welcome.

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1. The History of Women in Astronomy in General

A. Books


McKenna-Lawlor, Susan *Whatever Shines Should Be Observed*. 2003, Springer. The story of five 19th century women who made contributions to astronomy and science; too bad the price from the publisher is inappropriately high for a popular book.

B. Print Articles


James, C. “Edward and Mina” in *Astronomy*, July 2002, p. 46. Despite the title, this treats several women who worked at the Harvard Observatory.


C. Web Resources

A far more comprehensive and scholarly bibliography, organized by last name, of written articles on women in astronomy. Ruth Freitag's work was the early inspiration for the resource guide you are reading.

4000 Years of Women in Science: http://www.astr.ua.edu/4000WS/
Maintained by two women astronomers, this site includes brief information on women from many fields of science, not just astronomy. Their site ends with the start of the 20th century, but you can see the much shorter “Contributions of 20th Century Women to Physics” at: http://cwp.library.ucla.edu/

History of Women in Astronomy:
http://astro.berkeley.edu/~gmarcy/women/history.html
The text and images from a slide set on women astronomers available from the Astronomical Society of the Pacific. Includes capsule biographies of women from Carolyn Herschel to Sidney Wolff.

She is an Astronomer: http://www.sheisanastronomer.org/
This relatively new site, a project of the 2009 International Year of Astronomy, has capsule biographies and useful links to discussions of issues that confront women in astronomy.

Gould, Paula “Two Good Women, or Too Good to Be True?” (a 2002 essay from Science, considering how Caroline Herschel and Mary Somerville are treated by history, in contrast with men of their time): http://www.sciencemag.org/content/296/5574/1805.full

Women in Astronomy: A Resource Guide by Andrew Fraknoi:
http://www.astrosociety.org/education/astronomy-resource-guides/women-in-astronomy-an-introductory-resource-guide/ (an expanded version of this guide, with many more listings for individual women).

D. Videos

Jocelyn Bell Burnell (Oxford): “A Celebration of Women in Astronomy” (a talk in 2012 in Edinburgh; we only hear the audio, there is no video, but it is a fascinating public talk with profiles of specific women, including Caroline Herschel and Vera Rubin, and discussions of trends): http://www.youtube.com/watch?v=_50PyimUE5s (a shorter version is a 2013 TED talk at: https://www.youtube.com/watch?v=jp7amRdr30Y)

Emily Rice (City University of New York) gives a talk on contributions of women to astronomy (with many historical and contemporary examples and an analysis of modern trends): http://www.youtube.com/watch?v=5vMR7su4fi8

Beverly J. Smith (East Tennessee State U.) gives a PowerPoint presentation on the history of women in astronomy and current statistics about their participation: https://www.youtube.com/watch?v=yAa-gCSUwFE
2. Materials on a Few Specific Women Astronomers of the Past

A. Books


Berglund, Renee *Maria Mitchell and the Sexing of Science*. 2008, Beacon Press. Story of her life and of the importance of her work and fame for women’s issues.


Wright, Helen Sweeper in the Sky: The Life of Maria Mitchell. 1950, Macmillan. (Recently updated and reprinted by College Avenue Press.)

B. Print Articles

C. Web Resources
Annie Cannon pages at Wellesley College: http://academics.wellesley.edu/Astronomy/Annie/
Part of a student project, but with good local historical information.
DeVorkin, David: Transcript of a 1980 Interview with Nancy Roman for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4846

DeVorkin, David: Transcript of a 1979 Interview with Helen Sawyer Hogg for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4679

Fleming, Wilhelmina: Obituary (1911) by Annie Cannon from the Astrophysical Journal: http://adsabs.harvard.edu/abs/1911ApJ....34..314C (click on the PDF box at the end to see the article itself)

Gingerich, Owen: Transcript of a 1986 Interview with Margaret Mayall for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/28323-1


Maria Mitchell reminiscences about her meetings with the Herschels (a magazine article from 1889): http://womenshistory.about.com/od/mariamitchell/a/Reminiscences-Of-The-Herschels.htm


Taibi, Richard “Rose O’Halloran”: http://www.usskyhistory.blogspot.com (click 2012 in the blog archives and scroll down to the July 18, 2012 entry in this blog; O’Halloran was an astronomer and educator in San Francisco in the late 19th and early 20th century and the first woman board member of the Astronomical Society of the Pacific).


Vassar Encyclopedia Entry on Antonia Maury: http://vcencyclopedia.vassar.edu/alumni/antonia-maury.html

Women in Science site (San Diego Supercomputer Center), contains brief biographies of Helen Sawyer Hogg and Annie Cannon: http://www.sdsc.edu/ScienceWomen/contents.html


**D. Videos**

Video about Annie Cannon’s life and work, described at: http://cfa-www.harvard.edu/~alexg/ajc.html

Video of talk by George Johnson on his “Search for Miss Leavitt”: http://perimeterinstitute.ca/videos/search-miss-leavitt


Henrietta Leavitt
E. Plays


Nicholas, Siobhán: *Stella* (a play about Caroline Herschel): http://www.guardian.co.uk/science/blog/2012/may/14/play-astronomer-caroline-herschel and http://www.youtube.com/watch?v=_nzf1wZNQhY

3. Issues Facing Women in Astronomy Today

A. Books and Conference Proceedings


B. Print Articles


C. Web Resources

American Astronomical Society Committee on the Status of Women: http://www.aas.org/cswa/ A rich site with back issues of the valuable “STATUS” newsletter, a database of living women astronomers, legal resources, conference proceedings, and discussion of issues related to the role of professional women in the astronomy.

Women at NASA: http://women.nasa.gov/ (Profiles of women who work for the US Space Agency, including a number of astronomers and astrobiologists. The profiles include personal statements that can be quite moving and inspiring.)


Women in Planetary Science: http://womeninplanetaryscience.wordpress.com/profiles/ (Profiles of more than 50 women active in studying the solar system, and a discussion of issues they face)

She is an Astronomer: http://www.sheisanastronomer.org/ (A European site kept by Helen Walker, with profiles of women astronomers outside the U.S., discussions of issues, conference proceedings, varied resources, and more.)

International Astronomical Union Women in Astronomy Working Group (with international statistics and news of world-wide meetings): http://iauwomeninastronomy.org/


Seager, Sara “So Many Exoplanets, So Few Women Astronomers” (an article in the Huffington Post Jan. 2013 about the hardship that constant travel imposes on women scientists with small children): [http://www.huffingtonpost.com/sara-seager/women-in-science_b_2471980.html](http://www.huffingtonpost.com/sara-seager/women-in-science_b_2471980.html)

The Baltimore Charter (spelling out what can be done to help improve the status and working conditions of women in astronomy): [http://www.aas.org/cswa/bc.html](http://www.aas.org/cswa/bc.html)


Geller, Margaret “The Black Ribbon” (2004, a poignant essay from Science magazine about how discrimination and poverty hold back full participation in science in the U.S.): [http://www.sciencemag.org/content/281/5381/1278.full](http://www.sciencemag.org/content/281/5381/1278.full)

Encouraging Girls in STEM: A Page of Useful Resources: [http://www.ngcproject.org/engaging-girls-stem](http://www.ngcproject.org/engaging-girls-stem) (STEM is Science, Technology, Engineering, and Math)

The Global Survey of Physicists: A Collaborative Effort Illuminates the Situation of Women in Physics (from the American Institute of Physics): [http://scitation.aip.org/content/aip/proceeding/aipcp/10.1063/1.4794221](http://scitation.aip.org/content/aip/proceeding/aipcp/10.1063/1.4794221) (click in the grey box near the authors’ names to download a PDF copy).

### D. Videos

Women in Astronomy 2009 (a 3-minute video, made in conjunction with the 2009 meeting about women in astronomy. Concise framing of issues through interviews with leaders such as Vera Rubin, Meg Urry, and Dara Norman): [http://www.youtube.com/watch?v=1QyMB0qagZs](http://www.youtube.com/watch?v=1QyMB0qagZs)

Jocelyn Bell Burnell TED talk on “Reflections on Women in Science: Diversity and Discomfort” (a 15-minute talk with some of her personal history and statistics about women in astronomy): [http://www.youtube.com/watch?v=jp7amRdr30Y](http://www.youtube.com/watch?v=jp7amRdr30Y)


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Jane Luu
4. Materials on a Few Specific Women Astronomers Today

A. Books


Goldsmith, Donald The Astronomers. 1991, St. Martin's Press. The chapter entitled “Mapping the Universe” profiles Margaret Geller's life and work; there is also material on the work of Vera Rubin and Anneila Sargent in the book.


Lightman, Alan & Brawer, Roberta “Interview with Sandra Faber” in Origins. 1990, Harvard U. Press. (Also has interviews with Margaret Geller and Vera Rubin.)

Rubin, Vera Bright Galaxies, Dark Matters. 1997, American Institute of Physics Press. A collection of her articles, including several personal reminiscences.


B. Print Articles


Chaikin, A. “Surveyor of the Universe” in Air & Space, Aug./Sept. 1991; vol. 6, p. 84. About the work of Margaret Geller.

Davies, John Beyond Pluto: Exploring the Outer Limits of the Solar System. Chapter 4 features Jane Luu's life and work.

C. Selected Web Resources

Bell Burnell, Jocelyn: Text of a 1977 After-dinner Speech about her Discovery of Pulsars: http://www.bigear.org/vol1no1/burnell.htm
Billings, Lee: May 2009 article about Debra Fischer and her work from *Seed Magazine*: http://seedmagazine.com/content/article/the_long_shot/
Burbidge, Margaret “Watcher of the Skies” (an autobiographical article from *Annual Reviews* 1994; 37-page PDF): http://www.annualreviews.org/doi/pdf/10.1146/annurev.aa.32.090194.000245
Chapman, Mary: Carolyn Shoemaker Profile (USGS): http://astrogeology.usgs.gov/people/carolyn-shoemaker
DeVorkin, David “Interview with Margaret Burbidge” 1978, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/25487
DeVorkin, David “Interview with Nan Dieter-Conklin” 1977, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4573

DeVorkin, David “Interview with Dorrit Hoffleit” 1979, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4677

DeVorkin, David “Interview with Charlotte Moore (Sitterly)” 1978, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4784

DeVorkin, David “Interview with Nancy Roman” 1980, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4846


Sandra Faber 1995 Biographical Sketch: http://cwp.library.ucla.edu/articles/faber.htm


Geller, Margaret “1995 Phi Beta Kappa Speech at Harvard (with some personal reminiscences): http://gos.sbc.edu/g/geller.html

Ghez, Andrea: Interview for PBS NOVA series, first about her work, but then about her development as a scientist): http://www.pbs.org/wgbh/nova/space/andrea-ghez.html


Lightman, Alan “Interview with Sandra Faber” 1988, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/33932

Lightman, Alan “Interview with Vera Rubin” 1989, for the Center for the History of Physics: https://www.aip.org/history-programs/niels-bohr-library/oral-histories/33963

Lopes, Rosaly (a brief biography and interview in Volcano World): http://volcanoworld.wordpress.com/2011/12/19/rosaly-lopess/

Luu, Jane: Interview from 2003 (with a lot of biographical information): http://www.imagiverse.org/interviews/janeluu/jane_luu_21_03_03.htm

McCray, Patrick “Interview with Sidney Wolff” (Wolff was the first woman in history to be the head of a national observatory; Part of the Oral History Interviews at the American Institute of Physics): https://www.aip.org/history-programs/niels-bohr-library/oral-histories/23363-1

Vera Rubin
Mestel, Rosie “Carolyn Shoemaker and Her Comet” (1994 profile from New Scientist magazine):
http://www.bibliotecapleyades.net/esp_shoemaker_a.htm

My Hero Project: France Cordova (includes biographical information and interview):

My Hero Project: Andrea Ghez (includes information about her life and her work, with quotes):

My Hero Project: Lucy McFadden (short discussion of her work and how she got into astronomy):


Shoemaker, Carolyn: 1998 Essay from Science Magazine on Space Exploration (with thoughts about her own life and work): http://www.sciencemag.org/cgi/content/full/282/5394/1637

Snedegar, Jean and Higgins, Suzanne “Kimberly Weaver, Astrophysicist and Inspiring West Virginian”:

Sommerville, Iain “From Burtisland to the Outer Limits: The Journey of Anneila Cassells [Sargent]” (mostly about her early life): http://www.burntisland.net/sargent.htm

Soter, Stephen & Tyson, Neil: Excerpt from the book Cosmic Horizons about Vera Rubin and her work:

Werner, Debra “Profile of Ellen Stofan, NASA Chief Scientist” (brief):
http://spacenews.com/37599profile-ellen-stofan-nasa-chief-scientist/


D. Selected Videos

Claudia Alexander: “Rosetta: Wild Bounce at comet Churyumov-Gerasimenko” (Dec. 2014 talk on the European mission to match course with and land on a comet; 1 hr 4 min): https://www.youtube.com/watch?v=kW4t-8v13aQ

Natalie Batalha: “Finding the Next Earth” (a 2012 talk in the Silicon Valley Astronomy Lecture Series; 1 hr 29 min):
http://www.youtube.com/watch?v=ZbijR_AALo

Jocelyn Bell Burnell: Royal Institution (Public) Discourse in 1997, with nontechnical information about stellar evolution and some reminiscences about her discovery of pulsars (“Tick Tick Tick Pulsating Star”):
http://www.vega.org.uk/video/programme/69

France Cordova: Last Lecture as President of Purdue University (includes the history of her development as a scientist): https://www.youtube.com/watch?v=6ng2Qh-J0jE

Laura Danly: “History of Gravity” at the World Science Festival (7 min):
Also see an interview with her at RoadtripNation:
http://roadtripnation.com/leader/laura-danly
Sandra Faber: Interview on the occasion of her winning the 2009 Bower Prize (includes images and reminiscences from many parts of her career; 8 minutes): https://www.youtube.com/watch?v=D5Rc85Ggkp
(Another short video about her work can be seen at:
or https://www.youtube.com/watch?v=Goe8vRNxI1M)

Debra Fischer: 2012 interview on “Yale Live” (22 min):
http://www.youtube.com/watch?v=UahXYEPHoHc
(also see her Yale lecture Oct. 2013: https://www.youtube.com/atch?v=fomk3IakRQ0)

Margaret Geller: 2013 interview when she won the APS Lillienfeld Prize (6 min):
http://www.youtube.com/watch?v=8c3lM8v68Hw

Andrea Ghez: 2009 TED talk on the supermassive black hole at the center of the Milky Way (16 min): http://www.ted.com/talks/andrea_ghez_the_hunt_for_a_supernasive_black_hole.html

Heidi Hammel: Three minutes on how she got into astronomy, how a mentor helped her, and what she likes to do (great to show young people):
http://www.youtube.com/watch?v=7eSslCoEjE

Rosaly Lopes: Discusses her work and work history on “Through the Eyes of Scientists” (3 min, 2011): http://www.youtube.com/watch?v=ntCPur1SQ4Y (See also her talk Planetfest 2012 at: https://www.youtube.com/watch?v=nAtsRehiE7E)


Carolyn Porco: TED Talk in 2007 on “This is Saturn” (17 min): http://www.ted.com/talks/carolyn_porco_flies_us_to_saturn.html (Also see the 2014 interview with Andrew Chaikin about her career and her “life at Saturn”: http://www.universetoday.com/111405/video-carolyn-porco-discusses-her-life-at-saturn/)

Sara Seager: Public talk on “Origins and Aliens: The Search for Other Earths” at McMaster University in March 2009 (54 min): http://www.youtube.com/watch?v=z1-yz0JTmK4
(Also see her 2013 TEDX talk at: https://www.youtube.com/watch?v=NnM4SaGc8R0)


Jill Tarter has given many public talks that are on the web. Here are two shorter ones.
At Zeitgeist 2012: http://www.youtube.com/watch?v=4EABW8WYTV0
In 2009, receiving the TED Prize: http://www.youtube.com/watch?v=EszGlvRdgTE
Jill Tarter's talk in the Silicon Valley Astronomy Lecture Series in 2008 is a good summary of her SETI work: https://www.youtube.com/watch?v=aqsI1HZCgUM

Maria Zuber discussing the Grail spacecraft and the MoonKAM educational project at Zeitgeist 2012 (11 min video): http://www.youtube.com/watch?v=q52AWjZn1Ko