

FOOD FOR THOUGHT

A companion guide to BETC's production of *Silent Sky*
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For the beauty of the earth,
For the beauty of the skies,
For the love which from our birth
Over and around us lies,
Lord of all, to thee we raise
This our hymn of grateful praise.

For the beauty of each hour
Of the day and of the night,
Hill and vale, and tree and flow'r,
Sun and moon, and stars of light,
Lord of all, to thee we raise
This our hymn of grateful praise.

– Follott S. Pierpoint, “*For the Beauty of the Earth*” lyrics, c. 1864

Playwright Lauren Gunderson repeats this hymn several times within *Silent Sky*, as a gateway into the conversation of faith and scientific ideas taking place in early 20th century America. It was her grandmother Beatrice’s favorite hymn, as she told a lecture audience at the 2015 Wisconsin Science Festival, and Gunderson loves the importance it places on the sense of wonder: “Both science and storytelling share that same taproot in curiosity and the wonder of each hour.”

Where religious practitioners may respond to the beauty of the earth with grateful praise, scientists respond with observations and structured inquiry. In *Silent Sky*, Margaret’s piano playing leads Henrietta to respond to its beauty by crafting new connections between math and music, ultimately creating a new standard for measuring the distances between the stars.

Henrietta Swan Leavitt



At Harvard during the time period of *Silent Sky*, faith and science were not seen as opposing disciplines, but rather as different intellectual approaches to understanding a world filled with beauties and wonders yet to be explained. Harvard Divinity School, founded in 1816, was the first nonsectarian theological school in the country, and the second professional school founded at Harvard (after the medical school). The school was unofficially associated with American Unitarianism for several decades, but had already begun accepting scholars from various religious backgrounds by the turn of the 20th century.

The *Harvard Theological Review* was founded in 1908, publishing articles on the history and philosophy of religious thought in all traditions and periods. The inaugural issue of the *Review* noted its mission was to include “not only theology, in the wider meaning of the word, but the history and philosophy of religion, ethics, sociology, economics, and education in so far as these have a bearing on religious thought or the practical work of the church.” The *Review*’s work drew from many disciplines in illuminating the work of religion in the world.

In that same year of 1908, across the campus, Henrietta Swan Leavitt discovered the Cepheid variables. The Harvard College Observatory (HCO) employed multiple research fellows seeking to add to human understandings of our solar system and our universe, as well as dozens of women “computers,” a few of whom we see in our play. Edward Charles Pickering, who was Director of the HCO during the time period of *Silent Sky*, was

"We're the dirt. From which mighty oaks grow."

– *Williamina*

often called a professor of astronomy, but there wasn't a formal Department of Astronomy at Harvard until 1931! Pickering himself had taught physics at MIT prior to his appointment as HCO Director. At the turn of the century, "natural philosophy" was still splitting into the formal academic departments of astronomy, physics, and chemistry. And the Harvard astronomers were trying all kinds of approaches to better understanding our universe, from experimental photography to observations made from earth's remotest corners.

Thus, mapping today's academic language onto yesterday's science isn't quite right. We have trouble imagining our greatest American universities without research as specialized by discipline as it is today. Yet the more specialized academia has grown, the less likely scholars are to encounter others' work on intersecting topics in disparate fields.

Some of the most exciting scholarly work being done today is at the intersections of fields like neuroscience and nanotechnology. We know that when different systems of belief and inquiry smash up against each other, it's uncomfortable, but it can lead us to the vital moments of inspiration and insight we need to transform our understanding and solve critical problems. As Henrietta learns, we may need to encounter corners of the truth through music, faith, and starlight to fully discover our place in the universe.



"WHEN I HEARD THE LEARNED ASTRONOMER"
WALT WHITMAN, 1819 - 1892

When I heard the learn'd astronomer,
When the proofs, the figures, were ranged in columns before me,
When I was shown the charts and diagrams, to add, divide,
and measure them,
When I sitting heard the astronomer where he lectured with
much applause in the lecture-room,
How soon unaccountable I became tired and sick,
Till rising and gliding out I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.

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ANNIE JUMP CANNON (DECEMBER 11, 1863 – APRIL 13, 1941)

Born in Delaware to a shipbuilder & Senator father and his second wife, Annie had 2 younger sisters. She was deaf from early in life, probably due to a childhood illness. Her mother, Mary Jump, was the first person to encourage her daughter's love of learning in mathematics, chemistry, and astronomy. Because of her encouragement, Annie went on to graduate from Wellesley College, where she was a valedictorian in 1884.

In the following decade, she developed a love for photography. Following a tour of Europe, her book/pamphlet "In the Footsteps of Columbus" was published in 1893. In 1896, she began work at the Harvard Observatory, and in 1907 she received her master's in Astronomy from Wellesley College. She is credited with developing the system for classification of stars based on spectral class – OBAFGKM.

Cannon retired in 1940, after 40 years of work in astronomy. She earned the nickname "Census Taker of the Stars" after classifying more stars (350,000) than any other astronomer. She died in Cambridge in 1941.

To this day, the American Astronomical Society presents the Annie Jump Cannon award to female astronomers for distinguished work in the field.



WILLIAMINA FLEMING (MAY 15, 1857 – MAY 21, 1911)

Williamina Fleming was born into a Scottish family where her father and brothers worked in early daguerreotype photography. A good student and quick study, she began teaching in Dundee at the age of 14. She married James Orr Fleming, a widower, in 1877, when she was 20 years old. She worked as a teacher in the first year of their marriage, but then they emigrated to Boston in 1878, and shortly thereafter James abandoned her and their young child. To make ends meet, she took work as a housekeeper in the home of Edward Pickering, Director of the Harvard College Observatory.

In 1881, Pickering hired "Mina," as she referred to herself, to join his team at the Harvard College Observatory and taught her to analyze stars. Growing up in a family of photographers contributed to her comfort with handling the Observatory telescopes' photographic plates. Mina was the first of what became an all-female team doing observational analysis and star cataloguing. In 1886, she was placed in charge of the Harvard Observatory's team of women "computers," and in 1899 she was named Curator of Astronomical Photographs at Harvard. She was named the first woman member of the Royal Astronomical Society of London in 1906. After her death, a lunar crater was named jointly for her and fellow Scottish scientist Alexander Fleming.

*"I have fundamental problems with
the state of human knowledge!"*

–Henrietta

FOOD FOR THOUGHT



HENRIETTA SWAN LEAVITT (JULY 4, 1868 – DECEMBER 12, 1921)

Born in Boston to a Congregational Church Minister and his wife, Henrietta was one of five children in a family whose ancestors dated back to settlers in the Massachusetts Bay Colony.

Henrietta attended Oberlin College as a music major. She later transferred to Radcliffe College (since Harvard did not admit women at that time) and graduated in 1892. At Radcliffe, she had a classics education with one astronomy course; she earned an A-. Following an illness in college, Henrietta slowly grew deaf over the remainder of her life.

Henrietta volunteered at Harvard Observatory from 1893 to 1895, where her work was to catalogue the stars of the Small Magellanic Cloud. She then spent two years in Europe. Upon her return, she spent a few years with her family in Wisconsin before returning to a paid position at the Observatory in 1902, where she was paid 30 cents an hour for her analysis of variable stars. Leavitt is best known for her discovery of the period-luminosity relationship in Cepheid stars, allowing us to measure the distance across the universe. She published her first results in 1908, then confirmed the relationships in a breakthrough analysis published in 1912.

In 1921 she became the Harvard College Observatory's head of stellar photometry, but by the end of that year she died of stomach cancer. Fellow astronomer Solon Bailey said in her obituary that "she had the happy faculty of appreciating all that was worthy and lovable in others, and was possessed of a nature so full of sunshine that, to her, all of life became beautiful and full of meaning."

Magnus Gösta Mittag-Leffler of the Swedish Academy of Sciences tried to nominate her for the 1926 Nobel Prize in physics, but discovered that she was no longer alive. (Nobel Prizes are not awarded posthumously.) She has been honored in other ways within the astronomical community, though: both an asteroid (5383 Leavitt) and the Leavitt Crater on the moon are named for her.

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FOOD FOR THOUGHT

TIMELINE

- 1867: The 14th Amendment to the US Constitution defines a citizen as "male." Susan B. Anthony forms the Equal Rights Association.
- 1868: **Henrietta Leavitt** is born.
- 1869: Women gain suffrage in the territory of Wyoming.
- 1870: 15th Amendment ratified; African-American men gain the right to vote. Women's suffrage passes in Utah territory. 43 women vote in Massachusetts, but their votes are ignored.
- 1872: Henry Draper takes 1st photo of star spectrum (Vega).
- 1875: The Sun's age is estimated at 20 million years.
- 1877: Moons & canals are discovered on and around Mars.
- 1878: Women's Suffrage Amendment introduced in Congress by Senator Aaron A. Sargeant.
- 1888: Eastman-Kodak camera comes out, triggering amateur photography interest.
- 1890: Idaho & Wyoming admitted as states. National American Women's Suffrage Association forms; its members focus on changing voter laws on the state level.
- 1893: Colorado adopts women's suffrage. **Henrietta Leavitt begins work at Harvard Observatory.**
- 1895: Wilhelm Rontgen discovers x-rays.
- 1896: Utah is admitted as a state. Women gain suffrage in Idaho.
- 1903: Wright Brothers' first successful airplane flight.
- 1905: Einstein's Theory of Special Relativity is released. Mount Wilson Observatory is founded.
- 1908: Giant & dwarf stars are first described. **Henrietta Swan Leavitt discovers Cepheid variables** and publishes her finding that brighter stars have longer luminosity periods. First women's suffrage parade in New York City: 23 women of the Progressive Woman Suffrage Union boldly and illegally march down Broadway.
- 1911: California women win suffrage.
- 1912: Women gain full suffrage in Oregon, Kansas, and Arizona. 20,000 suffragettes join a NYC parade. **Leavitt publishes confirmation of her Cepheid variable theory with corresponding linear equations for this period-luminosity relationship.** Ejnar Herzprung presents an "H-R" diagram to the Royal Astronomical Society that plots stars on a graph measuring each star's brightness against its temperature (color).
- 1913: Herzprung determines the distance to several Cepheid variables using Henrietta's period-luminosity relationship.
- 1914: World War I begins.
- 1915: 40,000 march in the NYC Suffrage Parade.
- 1916: Einstein's General Theory of Relativity describes gravity as a geometric property of space and time, or space-time.
- 1917: Russian Revolution. United States declares war on Germany.
- 1918: Harlow Shapley determines that the sun is part of the Milky Way galaxy.
- 1920: The 19th Amendment to the Constitution passes, and American women win the right to vote.
- 1921: **Henrietta Leavitt dies.**
- 1923: Edwin Hubble demonstrates that galaxies exist outside the Milky Way.