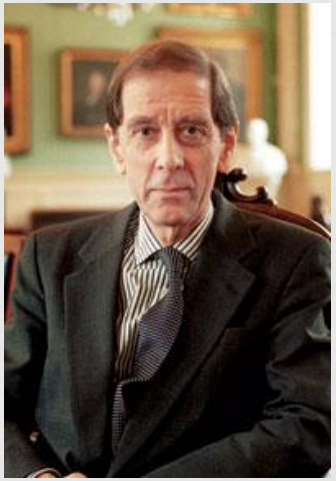
Cecilia Payne (1900 – 1979)

the woman who discovered what the universe is made of

"Every high school student knows that Isaac Newton discovered gravity, that Charles Darwin discovered evolution, and that Albert Einstein discovered the relativity of time. But when it comes to the composition of our universe, the textbooks simply say that the most abundant atom in the universe is hydrogen. And no one ever wonders how we know."

Jeremy Knowles,
dean of Harvard University



Edward John Payne,
a London barrister, historian and musician

Emma Leonora Helena Pertz

Cecilia Helena Payne

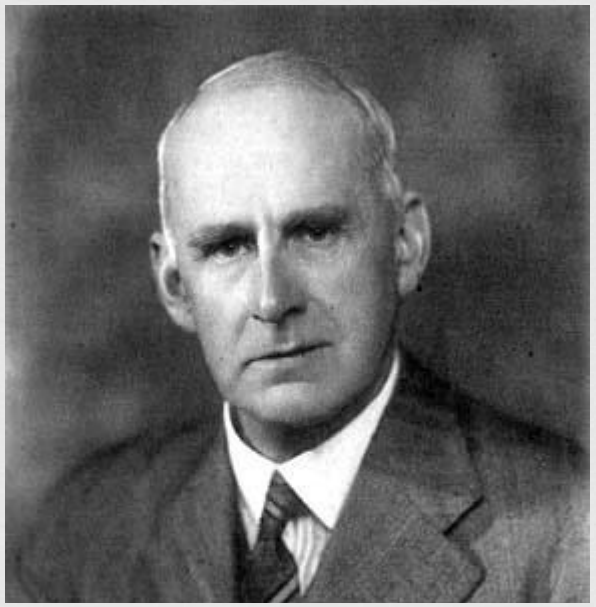
Humfry Payne,
an archeologist

Leonora Florence Mary Payne

- Cecilia's father died when she was four years old.
- Her mother refused to spend money on her college education, so she won a scholarship to Cambridge.
- However she paid for Cecilia's brother's education. He later became a famous archeologist.

- In 1919 while at Newham college at Cambridge, she became interested in astronomy after hearing a lecture by Professor *Arthur Eddington* about his eclipse expedition to Brazil.

- She received a fellowship to study at Harvard Observatory and so she headed across the seas to continue her career. The fellowship was offered to her by *Harlow Sharpley.*



Arthur Eddington

Harlow Sharpley

Harvard “computers”

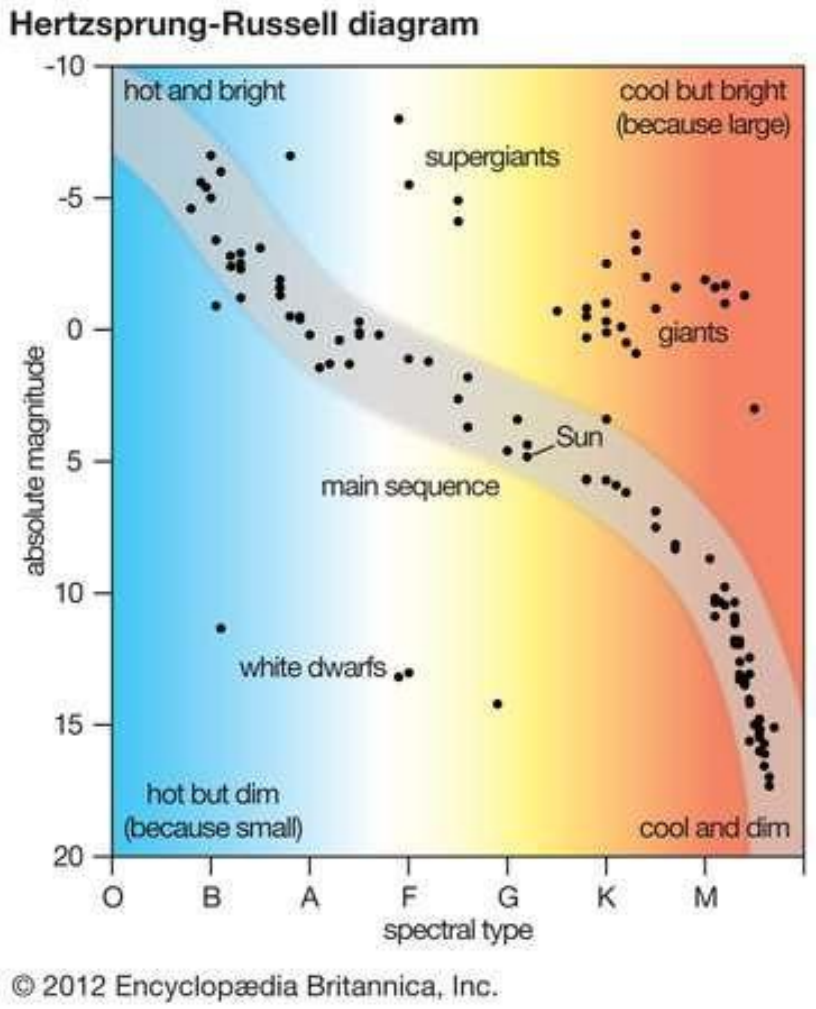
Before modern devices such as laptops and mobile phones were invented, a "computer" was a person who did calculations. At the Harvard College Observatory, between the late 19th century and early 20thcentury, several dozen women were "computers“.

Harvard "computers"

Edward Charles Pickering

Their job was to look over photographic plates of the night sky and compare the positions of stars between one plate and another. The computers were mainly hired by *Edward Charles Pickering*, who was director of the observatory from 1877 to 1918.

Annie Jump Cannon had sorted the spectra of several hundred thousand stars into seven distinct classes.



Annie Jump Cannon

- Payne was able to accurately relate the spectral classes of stars to their actual temperatures by applying the ionization theory developed by Indian physicist *Meghnad Saha.*

- Her thesis established that hydrogen was the overwhelming constituent of the stars, and accordingly was the most abundant element in the Universe.

Meghnad Saha

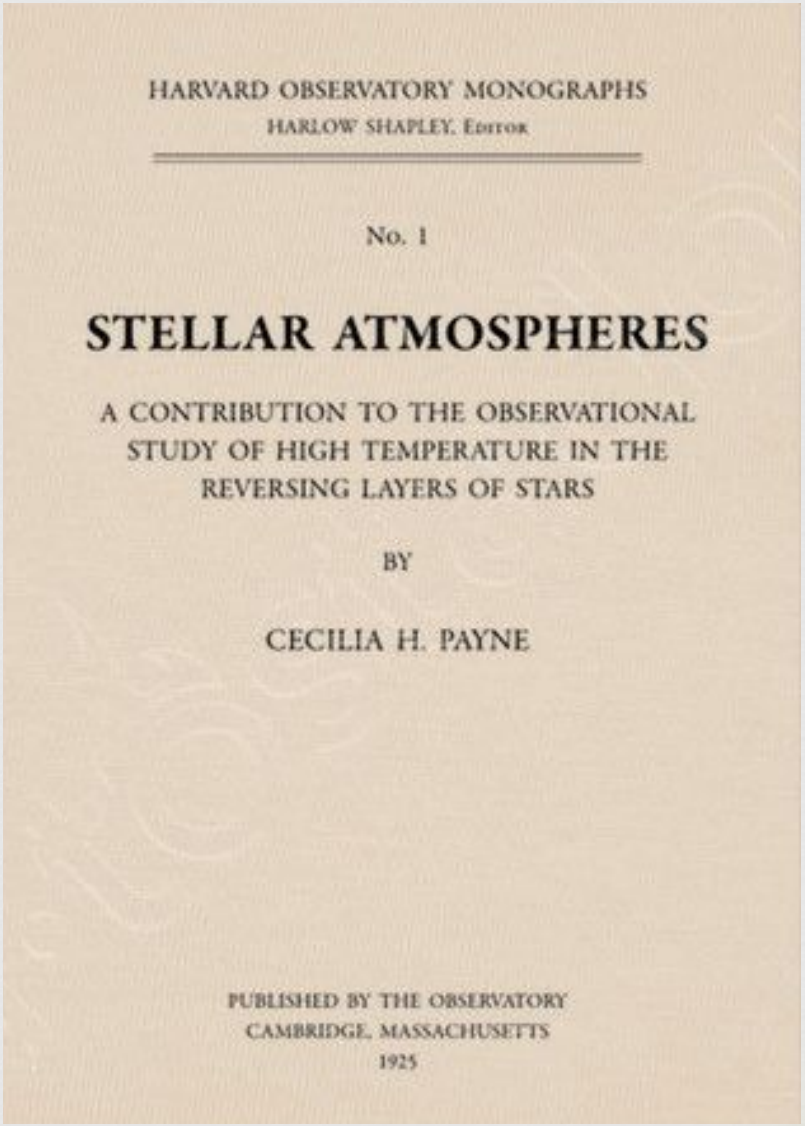
Before & after

- It was believed that stars are majorly made of calcium and iron.
- Cecilia Payne proved that calcium and iron are present in stars, but not in such a big amount as they thought, and the main compounds of stars are hydrogen and helium.

Stellar Atmospheres

- As she painstakingly examined these plates, Payne reached her controversial – and groundbreaking – conclusion: that unlike on Earth, ***hydrogen and helium*** are the dominant elements of the stars.

- However, at the time of her thesis publication the foremost authority on stellar composition, *Henry Norris Russell*, of Princeton University, convinced Payne that her conclusions had to be wrong.


HARVARD OBSERVATORY MONOGRAPHS

HARLOW SHAPLEY, Editor

No. 1

STELLAR ATMOSPHERES

A CONTRIBUTION TO THE OBSERVATIONAL STUDY OF HIGH TEMPERATURE IN THE REVERSING LAYERS OF STARS

BY

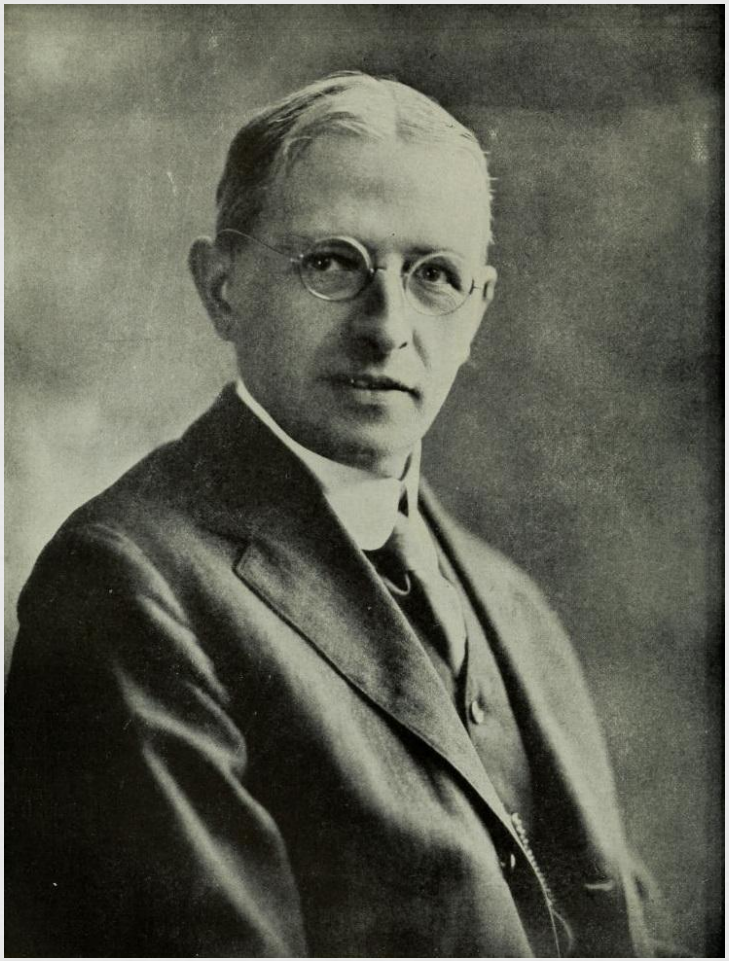
CECILIA H. PAYNE

PUBLISHED BY THE OBSERVATORY
CAMBRIDGE, MASSACHUSETTS
1925

“Almost certainly not real”

- But in brilliant vindication, Russell devoted the next four years to studying Payne's findings, and in the July 1929 issue of the *Astrophysical Journal*, he agreed with her and cited her **1925** study, concluding for the record that the great abundance of hydrogen "can hardly be doubted".

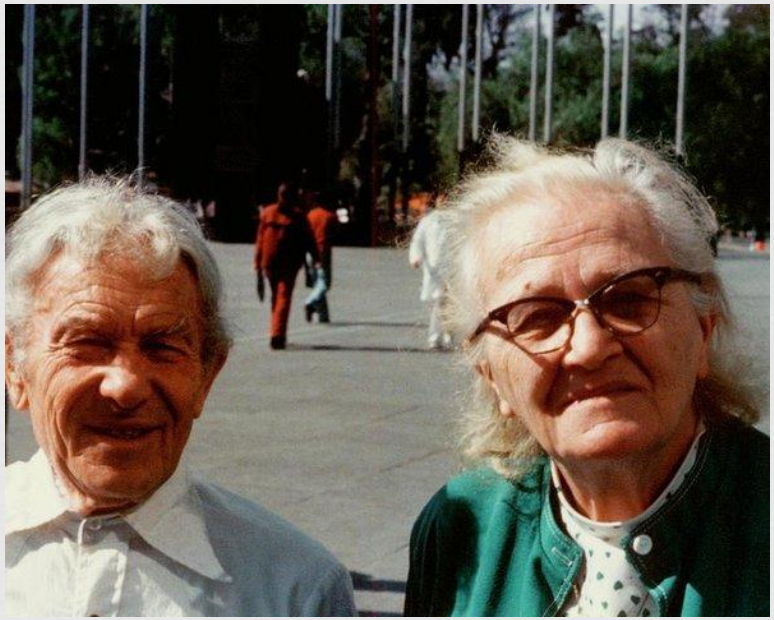
- Astronomers *Otto Struve* and *Velta Zeberg* called it ***"undoubtedly the most brilliant Ph.D. thesis ever written in astronomy".***



Henry Norris Russell

- Much of this work was done in association with the Russian astronomer Sergei Gaposchkin, whom she married in 1934.

- He and Harlow Shapley were two only men who supported her.



Finally, in 1956, Payne achieved two Harvard firsts: she became the first female professor, and the first woman to become department chair.

- http://www-groups.dcs.st-and.ac.uk/history/Biographies/Payne-Gaposchkin.html
- https://www.amnh.org/learn-teach/curriculum-collections/cosmic-horizons-book/cecilia-payne-profile
- https://cosmosmagazine.com/physics/this-week-in-science-history-the-woman-who-found-hydrogen-in-the-stars-is-born
- http://www.documentarytube.com/articles/cecilia-payne--the-woman-who-discovered-what-the-sun-was-made-of-but-never-given-credit
- https://scientificwomen.net/women/payne-gaposchkin-cecilia-77
- https://www.space.com/34675-harvard-computers.html
- https://www.britannica.com/biography/Annie-Jump-Cannon