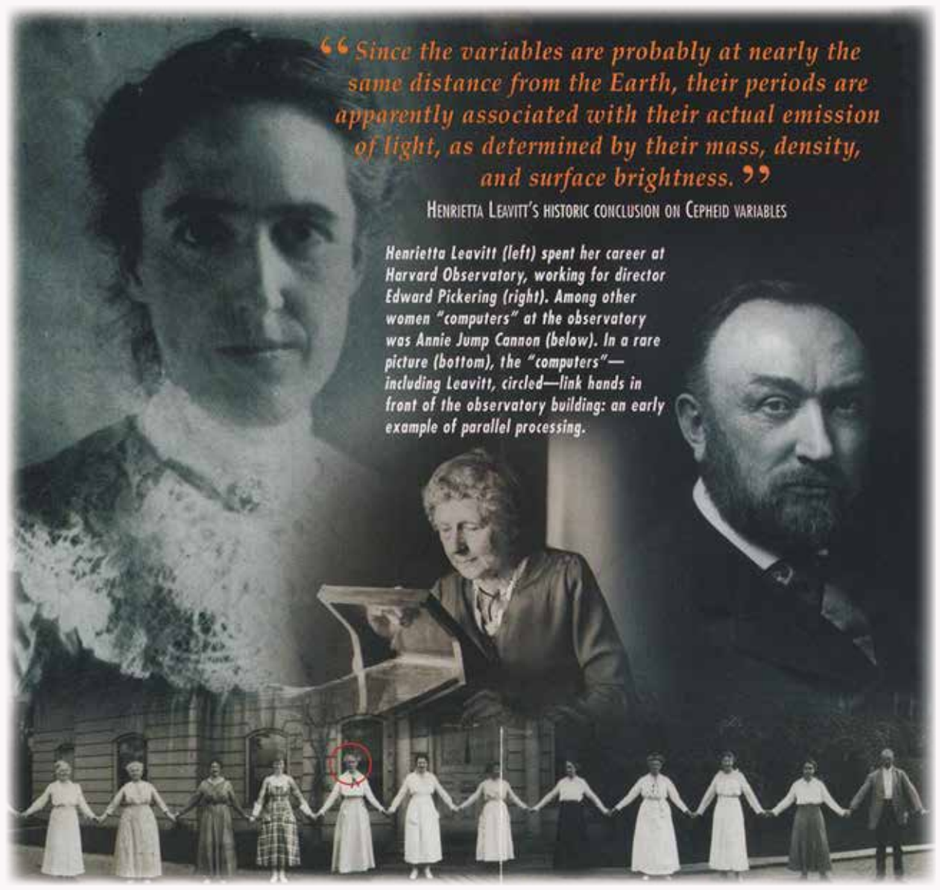
SPECTROSCOPY: HISTORY 1885-1927

Harvard Observatory director Edward Charles Pickering hired over 80 women as technicians to perform scientific and mathematical calculations by hand. They became known as the "Harvard Computers".

This was more than 40 years before women gained the right to vote. They received global recognition for their contributions that changed the science of astronomy. Due to their accomplishments, they paved the way for other women to work in scientific and engineering careers.



Credit: Secrets of the Universe: Space Pioneer, card 48

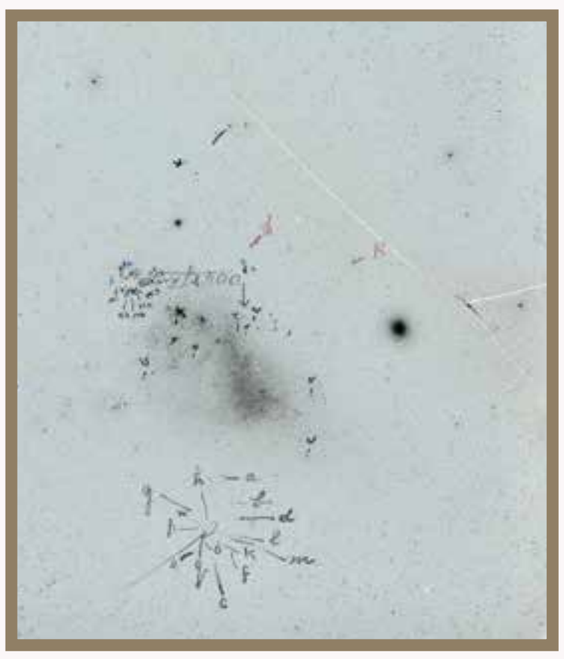
WHAT DID THEY DO:

- They studied glass photographic plates of stellar spectra created by using a spectroscope. Using a simple magnifying glass, they compared positions of stars between plates, calculating the temperature and motion of the stars.
- They measured the relative brightness of stars and analyzed spectra to determine the properties of celestial objects.
- These plates were gathered from observatories in Peru, South Africa, New Zealand, Chile and throughout the USA

Harvard University Plates Stacks Digitization Project

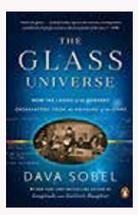
Harvard College Observatory's Plate Collection (also known as the *Plate Stacks*) is the world's largest archive of stellar glass plate negatives. Taken between the mid 1880s and 1989 (with a gap 1953-68) the collection grew to 500,000 and is currently being digitized.

Credit: Harvard College Observatory, Circa 1890



"*What, at first glance, may look like scribble and dust marks, are the precise mathematical measurements and analysis by the women computers on glass plate photos of stars and planets.*"

Credit: Harvard-Smithsonian Center for Astrophysics, Glass Plate Collection



FOR MORE INFORMATION

Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars
by Dava Sobel.

WHO WERE THEY:

- Some had college degrees, others received on-the job-training. A few were permitted to receive graduate degrees for their accomplishments.
- They worked for 25 cents an hour, six days a week in a small cramped library.
- Many of these women received numerous awards and honors for their contributions. Noteable among them were:

WILLIAMINA FLEMING (1857-1911) - developed the *Pickering-Fleming Star Classification System*. She classified 10,000 stars and discovered 10 novae, 52 nebulae including the *Horsehead Nebula*, and 310 new variable stars.

ANTONIA MAURY (1866-1952)- devised her own star classification system, but it was largely ignored as too cumbersome. She and Pickering discovered spectroscopic binaries.

ANNIE JUMP CANNON(1863-1941)- extended earlier schemes for classifying stars. Her method, now known as the *Harvard Classification Scheme* [OBAFGKM], is still used today. Throughout her 40 year career she classified almost 400,000 stars.

HENRIETTA SWAN LEAVITT (1868-1921)- focused on the brightness of variable stars. Still used today, her period-luminosity ratio became a reliable measure of stellar distances. Edwin Hubble used herwork to describe an expanding universe.

CECILIA PAYNE-GAPOSCHKIN (1900-1979)- discovered that stars are made mainly of hydrogen and helium. Also established that stars could be classified according to their temperatures, as well as their spectra.

Credit: Secrets of the Universe: Space Pioneers, card 43