



Williamina Fleming and the Women "Computers" of Harvard College Observatory

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NASA's "hidden figures"



Tuesday, February 21, 2017

Many of you might have seen Hidden Figures, a great movie about black female computers at NASA the late 1950s and early 1960s. But they were actually preceded by female computers assisting both the US military and the British military in WWII, and by female computers at NASA's Jet Propulsion Laboratory in the late 1940s and early 1950s. The machines we know of today as "computers" were named after humans, called computers, whose jobs involved carrying out complex mathematics for scientists and engineers. But human computers have been around for much longer, and today I'd like to focus on the human computers of the Harvard College Observatory at the turn of the 19th century.



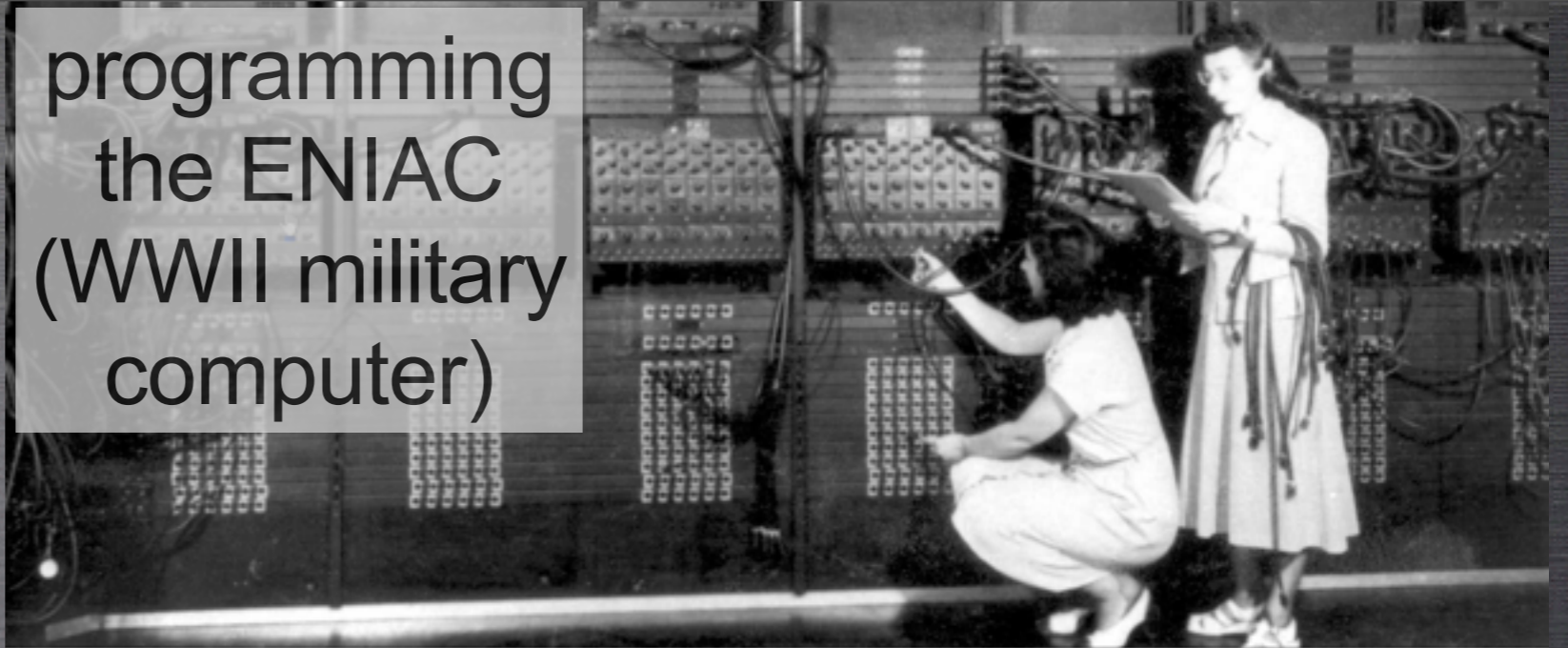
NASA's "hidden figures"



JPL computers, 1953



programming the ENIAC (WWII military computer)



Bletchley Park codebreakers, WWII



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"Computers" of Harvard College Observatory, c.1891



Harvard University, Harvard University Archives, W289689_1

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the "computer room" – Fleming is supervising, Pickering at the side

Williamina Fleming (b. 1857) grew up in Dundee, Scotland.
She had 8 siblings and their father died when she was 7.

At age 14 she became a teacher-student to help support the family.



North Berwick Burgh, Scotland 1870

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1872 Education Act mandated that all children age 5-13 attend school, led to an immediate shortage of teachers

1877 (age 20), married James Fleming
1878, they emigrated to Boston

Less than a year later, James abandoned her,
leaving her alone and pregnant in a new country



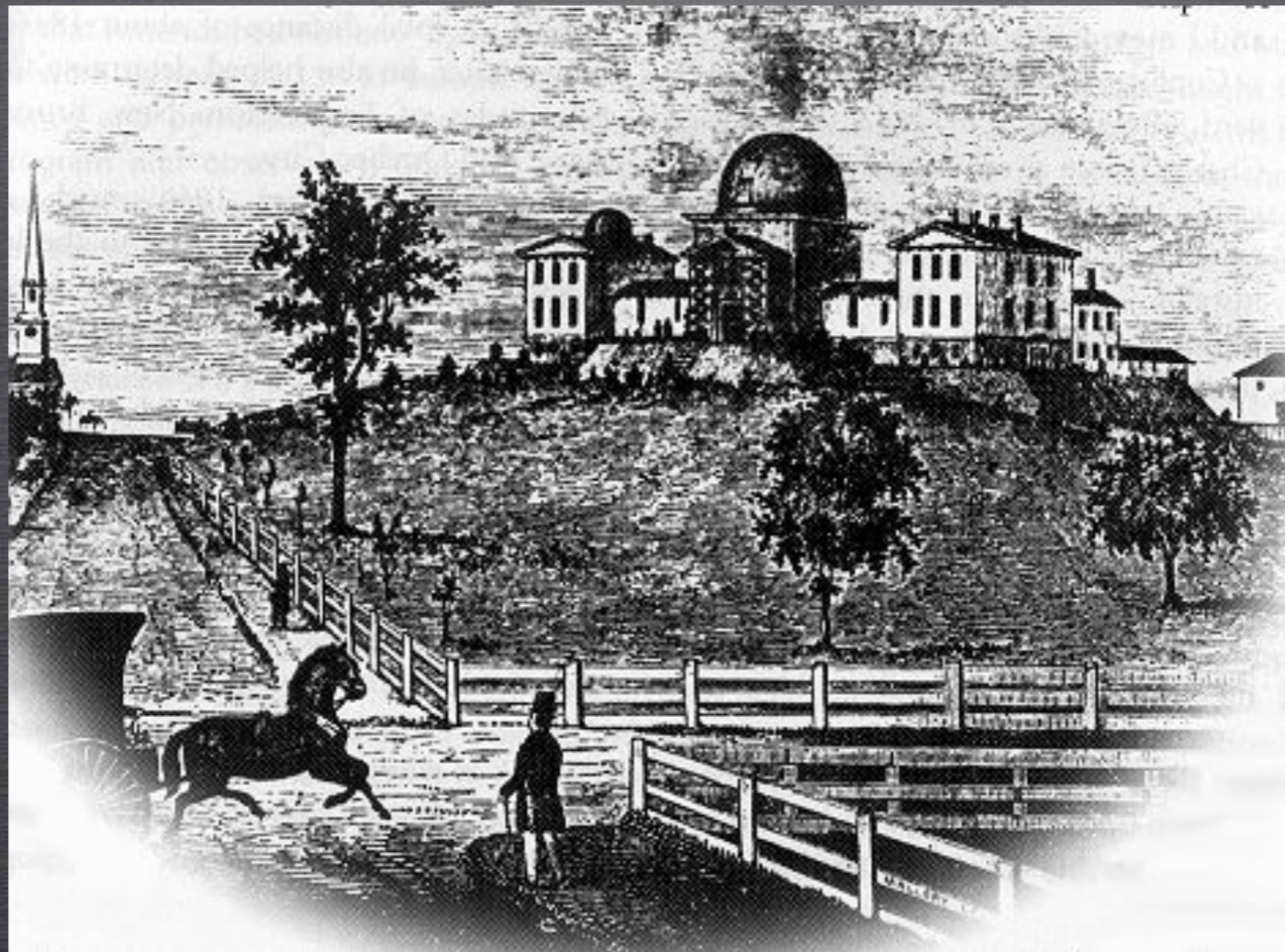
Parthia I of Cunard Line, UK to Boston 1870-1884

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James Fleming was 16 years older than her, a widower and a banker. We don't know much more about him, or why they came to the US.

Mina gained employment as a 2nd maid

Worked in Edward Charles Pickering's household,
Director's residence at Harvard College Observatory



Harvard College Observatory, c.1870

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Working as a maid (2nd maid, even) was probably a big step down for a former teacher and the wife of a banker, but her early life would have made her no stranger to hard work.

As the story goes, one day in 1881 Pickering grew so frustrated with his male assistants that he exclaimed “my maid could do a better job!”



Edward Pickering, credit Harvard

He hired Fleming and found she was capable and a hard worker, and he could pay her less

She started with clerical work and some basic calculations, but soon graduated to more important tasks

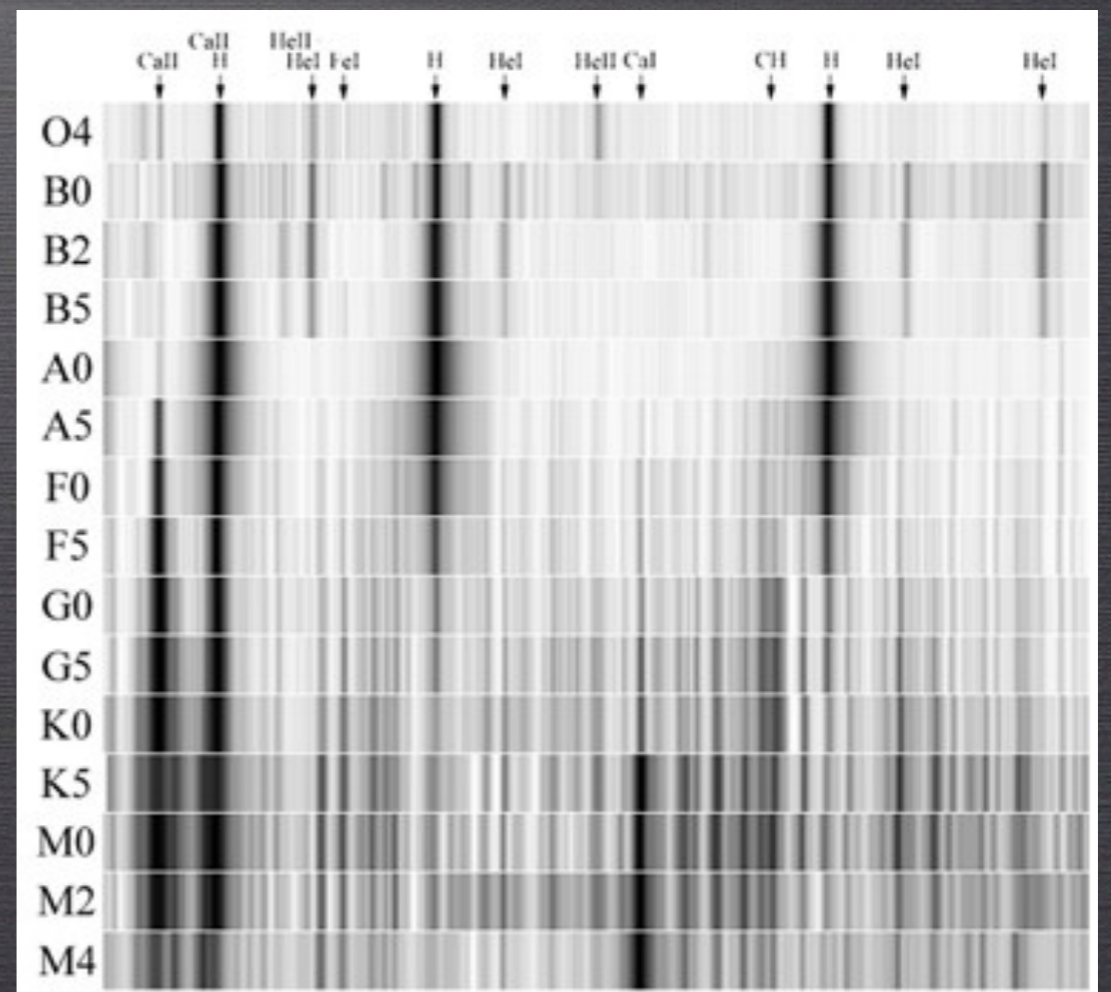
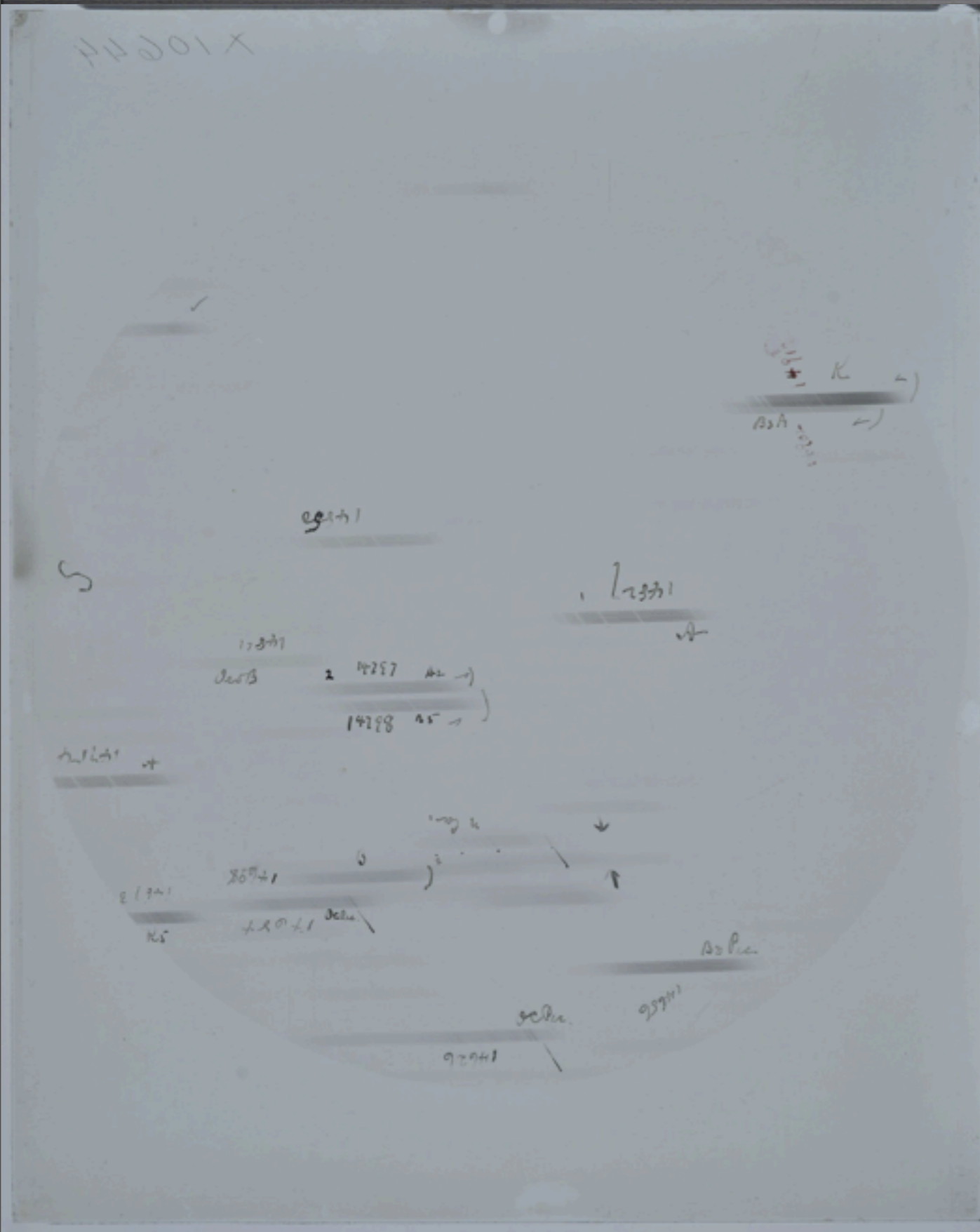
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Fleming wasn't the absolute first, but was one of the first; 1875, daughter of former director started working as computer after her father's death left them in straitened circumstances

By 1890, Fleming had:

- Developed the first stellar classification system
- Classified almost 30,000 spectra (most of the *Draper Catalog of Stellar Spectra*)

Fleming's system forms the basis for the system we still use today



Harvard plate with stellar spectra

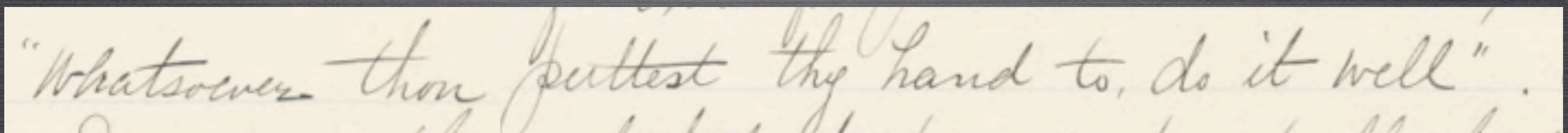
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Photography was starting a revolution in astronomy -- first unbiased recording of the night sky, rather than notes jotted by astronomer based on what they saw. Stellar spectroscopy just starting, so this was the time when astronomy started transitioning to astrophysics.

In her own words:

“If one could only go on and on with original work, looking for new stars, variables, classifying spectra and studying their peculiarities and changes, life would be a most beautiful dream... However, ‘Whatsoever thou puttest thy hand to, do it well.’ ”

~ *Journal of Williamina Fleming, March 5 1900*

A photograph of a handwritten note on aged paper. The text is written in a cursive script and reads: "Whatsoever thou puttest thy hand to, do it well". The note is slightly tilted and has some faint markings below the main text.

“During the last half of the month when I was unable to write anything in the evening I thought it was due to laziness, which with me would be something heretofore unknown.”

~ *Journal of Williamina Fleming, March 31 1900*

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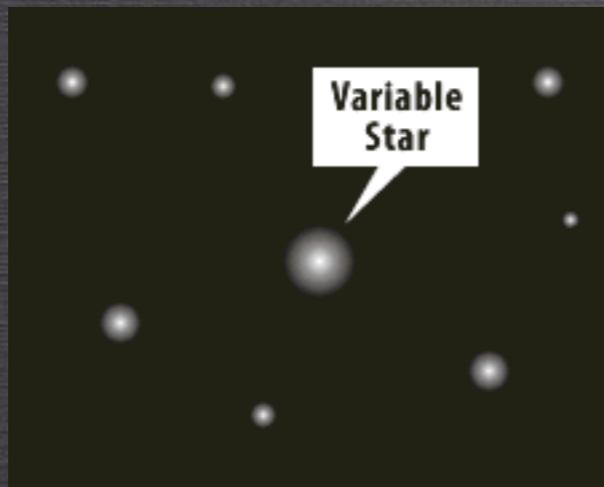
She was obviously a hard worker, as evidenced by her accomplishments, and a self-proclaimed workaholic

Journal included in the Chest of 1900, a time capsule project for Harvard College. Librarian William Coolidge Lane solicited contributions from the Harvard community, collected the contents, and placed them into the chest which was then sealed and kept in the University Archives. It was supposed to be opened in 1960, but remained forgotten in the Archives until some time later. Interest was rekindled in 1999 with the impending millennium.

Fleming also:

- Discovered and analyzed hundreds of variable stars
- Found that certain spectra were always associated with some variable stars
 - Devised the first standardized photometry scale

Variable star work was described as “heroic” and earned her an ovation at an 1898 national meeting of astronomers



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Need many plates covering the same area of the sky over a period of time; have to use the other stars in the field as comparisons to determine the variability characteristics --- really hard to do with photographic plates because the emulsions are different from plate to plate

Mid-1890s, Fleming was promoted to supervisor for all “computers”

Also appointed as Production Editor for all scientific papers, catalogs, and other writings published by the Observatory.



Harvard University, Harvard University Archives, W289692_1

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Fleming is standing, overseeing the work of one of her computers

In her own words:

“Looking after the numerous pieces of routine work which have to be kept progressing, searching for confirmation of objects discovered elsewhere, attending to scientific correspondence, getting material in form for publication, etc., has consumed so much of my time during the past few years that little is left for the particular investigations in which I am especially interested.”

~ *Journal of Williamina Fleming, March 3 1900*



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As a faculty member, I could empathize with her lament over the lack of time for research after all the emails are answered and paperwork is finished. Fleming is seated at right, working quietly for a few stolen moments

In 1899, Fleming was appointed Curator of Astronomical Photographs, the first-ever appointment of a woman to any position by the President and Fellows of Harvard College



Harvard University, Harvard University Archives, W289695_1

Observatory stack room, c.1891

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After Fleming's death in 1911, Pickering advocated for Annie Jump Cannon to receive the position. Response from Harvard's President, Abbott Lawrence Lowell, brother of noted astronomer Percival Lowell: "I always felt that Mrs. Fleming's position was somewhat anomalous and that it would be better not to make a regular practice of treating her successors in the same way."

“During the morning’s work on correspondence, etc., I had some conversation with the Director regarding women’s salaries. He seems to think that no work is too much or too hard for me, no matter what the responsibility or how long the hours. But let me raise the question of salary and I am immediately told that I receive an excellent salary as women’s salaries stand... Does he ever think that I have a home to keep and a family to take care of as well as the men?... And this is considered an enlightened age!”
~ *Journal of Williamina Fleming, March 12 1900*

Fleming was nominated multiple times by Pickering for the prestigious Astronomical Society of the Pacific's Bruce Medal, but she was passed over



In 1906, she became the first woman from the US to be elected to honorary membership in the Royal Astronomical Society



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Bruce Medal is for outstanding lifetime contributions to astronomy. Ironically, Pickering himself was awarded the Bruce Medal in 1908.

The RAS declined to admit women as full fellows until 1916, with male concerns such as 'it was practically a proposal to introduce into these dull meetings a social element, and all we shall require is a piano and a fiddle'

Fleming also discovered the now-iconic Horsehead Nebula and 58 other nebulae

“a semicircular indentation 5 minutes in diameter 30 minutes south of Zeta (Orionis).”
~ *log book of Williamina Fleming*



*“positive” image photographic plate
courtesy of Harvard*

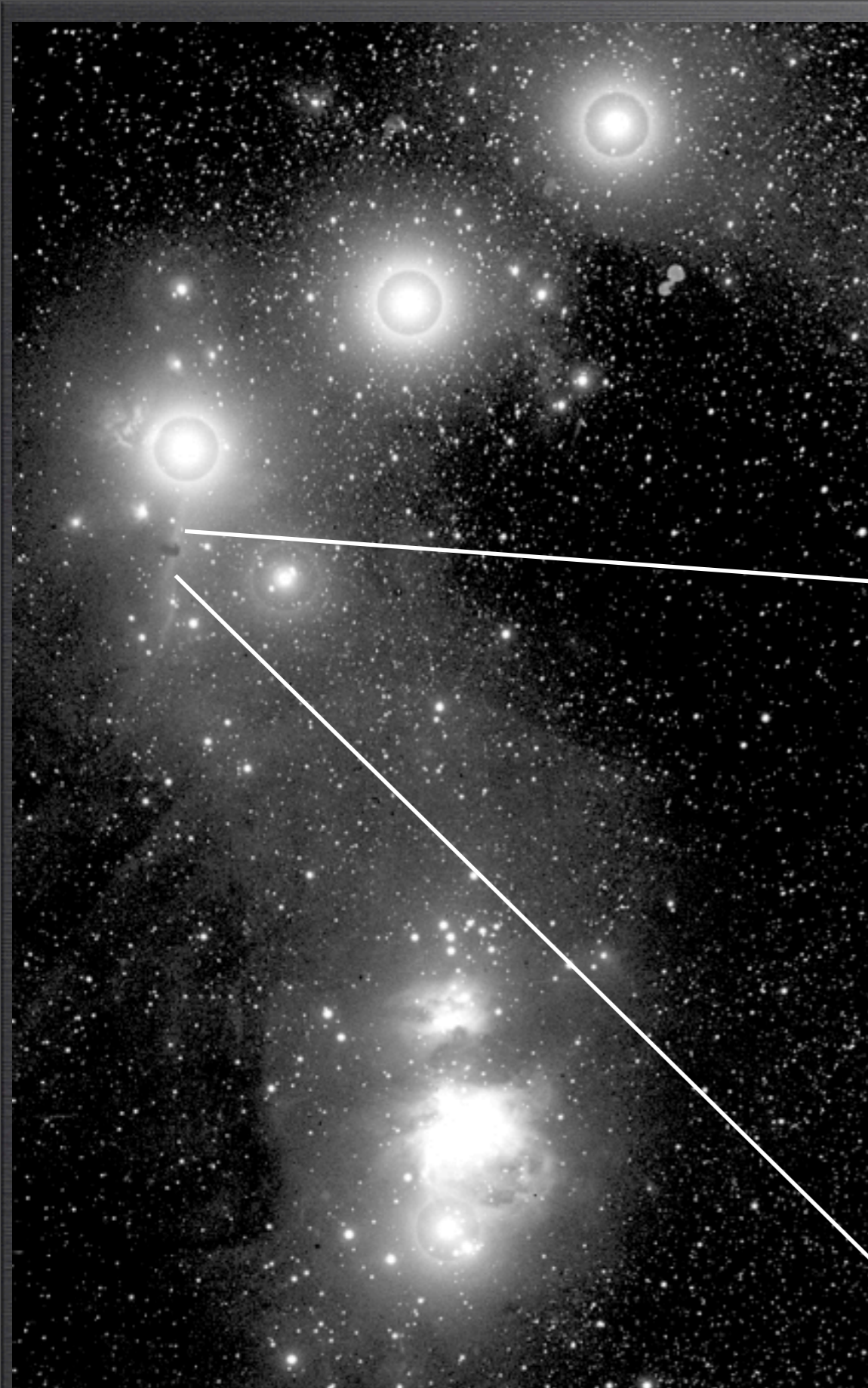
Credit: Jean-Charles Cuillandre, CFHT

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she also played a key role in the identification of white dwarfs, the leftover hot remnants of Sun-like stars that have burned out, which eventually led to our understanding that stars evolve

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“Mrs. Fleming was possessed of an extremely magnetic personality and an attractive countenance, enlivened by remarkably bright eyes... Fond of people and excitement, there was no more enthusiastic spectator in the stadium for the football games... Her bright face, her attractive manner, and her cheery greeting with its charming Scotch accent, will long be remembered by even the most casual visitors to the Harvard College Observatory.”

~ Obituary written by Annie Jump Cannon, published in Astrophysical Journal



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Women computers on an outing, onboard the C.S. Minia, a transatlantic cable repair ship Fleming is seated at center front. The Observatory was an official timekeeper for the city of Boston and sent time signals via telegraph, so there was a professional connection between the observatory and telegraph companies. Fleming mentions the Minia in her journal. Short overview of the Observatory's timekeeping history here: <http://www.thecrimson.com/article/2017/2/16/on-harvard-time-retro/>

“While we cannot maintain that in everything woman is man's equal, yet in many things her patience, perseverance and method make her his superior.”

~ *Williamina Fleming, “A Field for Women’s Work”,
Congress of Astronomy and Astro-Physics, Chicago, 1893*



Observatory computers, 1918

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Things haven't changed as much as you might think in the last 120-some years.

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nevertheless,
she persisted

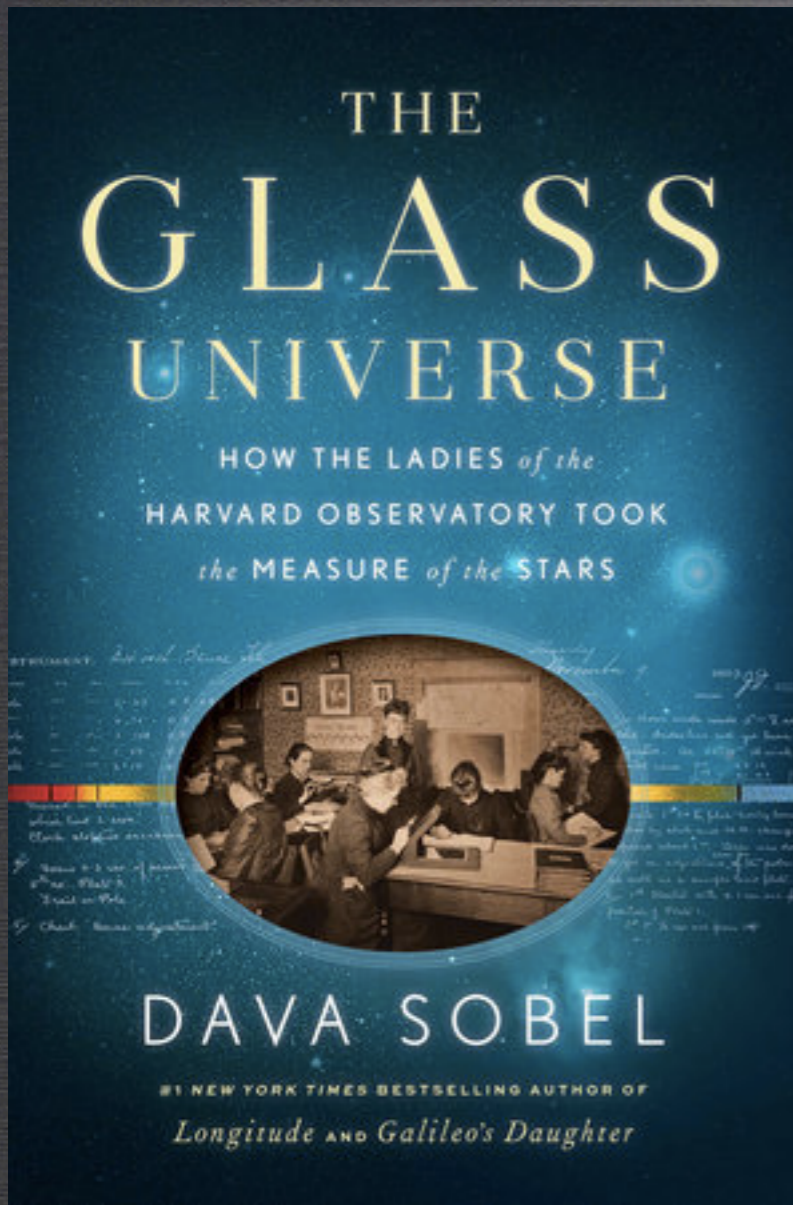


Observatory computers, 1918

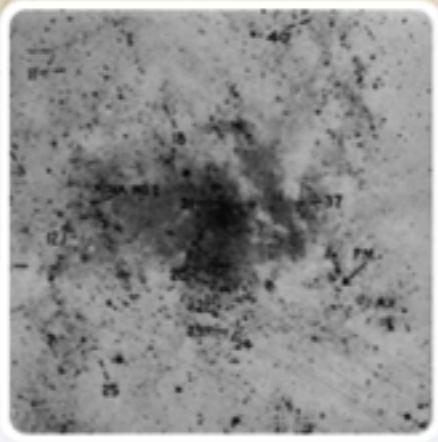
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Recommended



INSTRUMENT, <i>16 inch M. C. C.</i>												DATE, <i>Sunday</i>			
No.	Class.	Object.	R. A.	Dec.	Started.	Obs. H. A.	Obs. Dec.	Circle E. or W.	Lead.	Focus.	Film	Exp.	Sky at Start.	Stopped.	CF's, CF's, Dev.
64	M	Moon & Stars			9 20 0 0	11W	+21.2	E	95	8.0		-	0	9 30 0 0	0 0 -
65	M	Moon & Stars			9 32 0 0	23W	+21.2	E	95	8.0		-	0	9 43 0 0	0 0 -
					10 0 0 0		+90.0	E	95	8.0		-	0-?	12 5 0 0	0 0 -



TWEETS 219 FOLLOWING 44 FOLLOWERS 121 LIKES 219

Tweets Tweets & replies Media

Harvard Glass Plates Retweeted
Daina @DainaBouquin · Feb 3
Work by #CfALibrary & @DASCHDesk is being featured by @AstronomyMag! astronomy.com/news/2017/02/s... #DASCH #ProjectPHAEDRA #astronomy #womeninSTEM

Journal of Williamina Parsona Fleming
Creator of Astronomical Photographs, Harvard College Observatory.

<http://ocp.hul.harvard.edu/ww/fleming.html>

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Additional interesting passages from her diary

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“The United States of America is a large country, with a largehearted and liberal-minded people. Here they have made room for comers from all other countries, have welcomed them and have given them a fair open field and equal advantages in pursuing their labors or studies, as the case may be.

...

Women, therefore, who have taken up any branch of science, or indeed work of any kind, need not be discouraged in it even if one or two of the great mass which goes to make up the whole in their superior judgment refuse to give credit to their work.

~ *Williamina Fleming, “A Field for Women’s Work”,
Congress of Astronomy and Astro-Physics,
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1893 World’s Fair in Chicago spurred the Congress of Astronomy and Astrophysics to meet there

“At 1.30 decided to have lunch and got Miss Cannon interested. While waiting for water to boil on gas stove in the dark room, I was surprised to find Miss H. Stevens suffering from a fit of hysteria in the next room. This is the second attack she has had here within eight days. Last Tuesday she was quite ill, and I had to send her home in a carriage.”

~ *Journal of Williamina Fleming, March 7 1900*

“During the past three weeks, I have asked Miss Woods repeatedly regarding work on the ‘out of focus’ plates, and each time have been assured that the regions required for measurement have been satisfactorily photographed. On my return from the city I find that she has notified the Director of one or more incomplete regions. Just how she has overlooked them, or omitted to report them to me when I enquired again this morning, I cannot quite understand...”

~ *Journal of Williamina Fleming, March 9 1900*

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Typical issues that arise when supervising others... Nothing much has changed.

“My home life is necessarily different from that of other officers of the University since all housekeeping cares rest on me, in addition to those of providing the means to meet their expenses. My son Edward, now a junior in the Mass. Inst. of Technology, knows little or nothing of the value of money and, therefore, has the idea but that everything should be forthcoming on demand.”

~ *Journal of Williamina Fleming, March 1 1900*

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the more things change, the more they stay the same!