



Some of the Harvard Observatory 'computers' in 1925. Annie Jump Cannon is seated fifth from left; Cecilia Payne is at the drafting table.

HISTORY

Women who read the stars

Sue Nelson delights in Dava Sobel's account of a rare band of human computers.

There are half a million photographic plates in the Harvard College Observatory collection, all unique. They date to the mid-1880s, and each can display the light from 50,000 stars. These fragments of the cosmos furthered our understanding of the Universe. They also reflect the dedication and intelligence of extraordinary women whose stories are more than astronomical history: they reveal lives of ambition, aspiration and brilliance. It takes a talented writer to interweave professional achievement with personal insight. By the time I finished *The Glass Universe*, Dava Sobel's wonderful, meticulous account, it had moved me to tears.

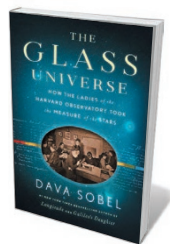
In the nineteenth century, US women had no vote (that would come in 1920). The careers open to the vast majority were in domestic service, farms, factories, schools or offices. Fortunately, Maria Mitchell, the first woman in the United States to discover a comet, left a guiding light. In 1865, she became the first professor of astronomy at Vassar College in Poughkeepsie, New York, a new institute of higher education for women.

Yet change was slow. When Edward Pickering became director of the Harvard Observatory in Cambridge, Massachusetts, in 1877, being a 'computer' was still predominantly a man's job. This low-paid but essential work involved noting a star's brightness, or

magnitude, on the photographic plates and computing its location in the sky. Pickering was especially interested in variable stars, whose light would brighten and fade over a specific period. These fluctuations, captured on the plates, required constant observation, but he couldn't afford extra staff.

Some years later, opportunity arrived in the form of the wealthy Anna Palmer Draper, widow of amateur astronomer and physician Henry Draper. She set up a memorial to fund his great ambition: to photograph the night sky and create a spectral catalogue of the stars. When starlight is split by a prism or spectroscope at the end of a telescope, it can produce a tiny grey smudge, millimetres long, on a photographic plate. The separated light, on closer examination, reveals vertical black spectral lines. This stellar barcode provides a star's chemical composition, colour and temperature.

By 1883, six women were already working



The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars

DAVA SOBEL
Viking: 2016

as computers at Harvard, a practice unique to the university. Within five years, the number of paid female computers, from a range of backgrounds, had risen to 14. Their efforts would be boosted by philanthropist Catherine Wolfe Bruce, who in 1889 donated US\$50,000 to the observatory, convinced that the introduction of photography and spectroscopy would advance the field.

The Glass Universe concentrates on a few of the Harvard computers. Williamina Fleming, a Scottish school teacher, arrived at the observatory in 1879, pregnant and abandoned by her husband. Pickering employed her as a maid and housekeeper before promoting her to computer in 1881. Fleming discovered more than 300 variable stars and, in 1899, became Harvard's first curator of astronomical photographs. She and Pickering revised the classification of stars using their spectral lines, labelling them alphabetically from the bluest, hottest stars to the coolest red stars.

Henrietta Swan Leavitt, who studied at another women's institution, Radcliffe College in Cambridge, began as a volunteer in 1895, gaining a permanent post in 1903. Five years later, she determined the relationship between luminosity and period of fluctuation for a class of pulsing variable stars called Cepheids. That enabled astronomers to calculate a star's distance from Earth, and ▶

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► in 1918 allowed Harlow Shapley, who would become Pickering's successor, to extend the boundaries of the Milky Way. Leavitt's work also laid the foundation for Edwin Hubble's finding, in 1925, that our Galaxy was not a lone 'island Universe' but one of billions. In 1929, Hubble used Leavitt's work and spectral shifts to show that this populous Universe is also expanding.

Annie Jump Cannon arrived in 1896, following studies in mathematics, physics and astronomy at another women's college, Wellesley, in the Massachusetts town of the same name. She refined and simplified the Pickering–Fleming system of stellar classification by proving that most stars were of a similar type. The International Astronomical Union adopted her system in 1922, three years after Pickering's death.

Cecilia Payne, educated at the University of Cambridge, UK, came to the observatory on a fellowship in 1923, under Shapley. As part of her PhD, she determined correctly that stars were predominantly composed of hydrogen and helium. In 1956, she became Harvard's first female professor of astronomy.

Payne provides some of the book's most touching passages. Sobel describes, for instance, Payne's distress at the untimely death of her friend and fellow computer Adelaide Ames in 1932, and her whirlwind romance with the astronomer and Russian émigré Sergei Gaposchkin, whom she married in 1934. Later that year, Payne won the inaugural Annie Jump Cannon Prize for contributions to astronomy, receiving \$50 and a gold pin, designed by Cannon, in the form of a spiral nebula.

These personal touches flesh out the women's lives. We are shown Payne, for instance, pawning her violin and jewellery to fund her research, and combining motherhood with astronomy. The low wages were a sticking point with many of them — Fleming often mentions it in her diaries. Yet, as Sobel shows, they clearly liked and admired Pickering and Shapley, who encouraged their work and facilitated their professional progress.

One of the last computers in the twentieth century, Radcliffe alumna Ellen Dorrit Hoffleit, gets a brief mention towards the end. She joined the observatory in 1928. In 2004, I met her at Yale University in New Haven, Connecticut, when I was making a radio documentary for the BBC on the Harvard computers. An energetic 96, Hoffleit was working on a paper about meteors. Like all of this band of remarkable women, she was unforgettable, as is this book. ■

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POLITICS

Life at the divide

Alison Abbott hails a memoir from Italian senator and biologist Elena Cattaneo, scourge of pseudoscience.

One hot day in August 2013, the phone rang in the laboratory of neuroscientist Elena Cattaneo at the University of Milan. The then-president of Italy, Giorgio Napolitano, wished to speak to her in Rome as soon as possible.

Cattaneo was already a minor national figure, known for her opposition to all forms of pseudoscience, however powerful the perpetrators. In one of her first public fights, in 2009, she criticized the Vatican for condemning the use of human embryonic stem cells in research. At the time of the call, she was in the middle of a battle to stop the government supporting a clinical trial of an unproven stem-cell 'therapy' run by the maverick Stamina Foundation in Brescia. The call made her wonder whether she had overstepped some mark.

Napolitano had something quite different to discuss at his residence in Rome, the baroque Quirinal Palace. He told Cattaneo, then aged just 51, that he wanted her to become a senator for life: what did she think?

"It was as if my every atom had been paralysed by the question," she recalls in her book *Ogni giorno: Tra scienza e politica (Every Day: Between Science and Politics)*. "Seconds passed without me being able to line up a meaningful sentence. The President realised, and touching my arm as if to shake me, he jokingly said: 'Professor, can I get you a cordial?'"

Cattaneo works on Huntington's disease, an incurable genetic disorder in which brain

Ogni giorno: Tra scienza e politica (Every Day: Between Science and Politics)

ELENA CATTANEO
Mondadori: 2016.

cells progressively die. Stem-cell research has provided new insights into the disease, which is why she had fought so hard for the right to do it responsibly.

Those battles stole precious time and energy. Would being a senator for life — with the inevitable widening of her repertoire of fights — drain too much from her scientific life?

Ogni giorno is a fascinating account of how a scientist entered the messy business of politics (arguably more so in Italy than in other rich countries) and learnt to survive. Cattaneo accepted the position. As one of only a few appointed by the president, the role signifies a person's importance to national culture. But she set boundaries. She would not give up her lab, and in the Senate she would engage mainly with themes relating to science. She would apply the same rigour to evidence supporting a political hypothesis as she would to that supporting a scientific one. She would not vote if such evidence were missing, and she would vote only according to her conscience, never along any party lines.

In August that year, she was sworn in along with conductor Claudio Abbado (who died five months later), architect Renzo Piano and Nobel-prizewinning physicist Carlo Rubbia. She threw herself into action, appointing a small team to help with research and administration, and organized a series of workshops with invited scientists from around the world. The aim was to educate parliamentarians in themes such as science, health and innovation, neuroscience and cell therapy.

She quickly learnt about Senate investigations and organized one into the Stamina debacle, a process that took more than a year. Published in February 2015, the report assigns responsibility for every step in the affair that allowed public hospitals to host the treatment, the government to support it and numerous courts to rule that patients had the right to it — even though it had been condemned as dangerous by the Italian health authorities.

Her repertoire of battles, as anticipated, did expand and she found herself on steep learning curves. One of these was genetically modified (GM) crops. In 2015, Italy's parliament debated the sensitive issue of whether each European Union member state should have the right to ban cultivation in their territories



Elena Cattaneo.

ANTONIO SCATTOLINO/CONTRASTO/EVINE