



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

7th Anniversary of #FEBRUARY11  
Global Movement (2022)

# The International Day of Women & Girls in Science



**Elisabetta Rossi**

PhD student in Historical Studies

TACITROOTS research group

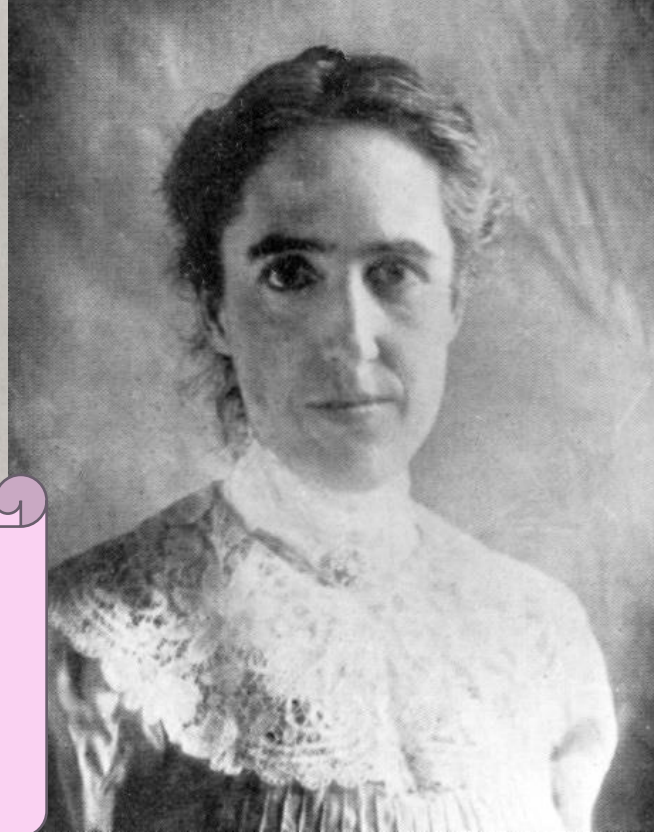
<https://sites.unimi.it/tacitroots/>



Elisabetta.Rossi1@unimi.it



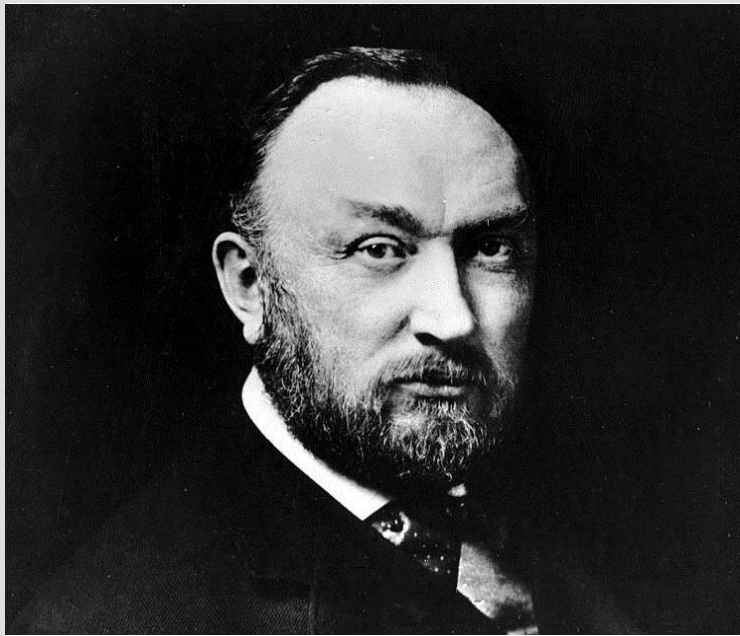
UNIVERSITÀ DEGLI STUDI DI MILANO



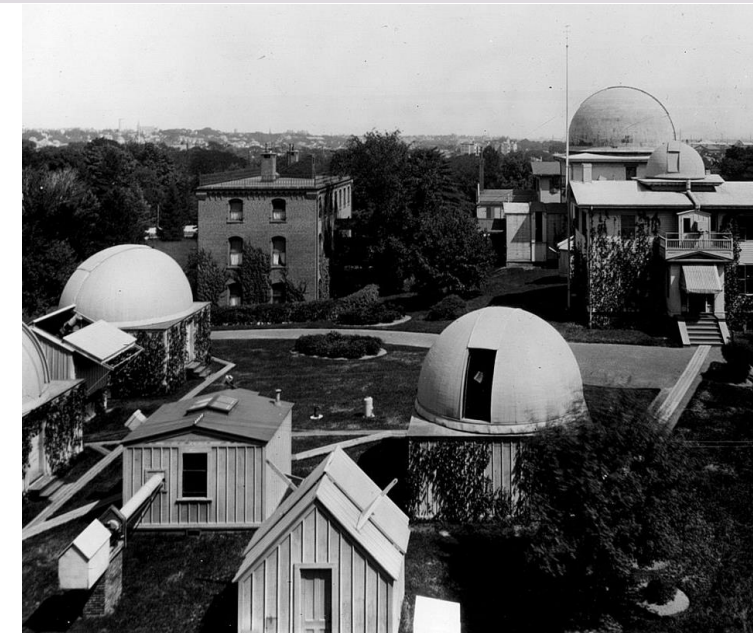
*L'altra metà del cielo:  
due secoli di astrofisica al femminile*







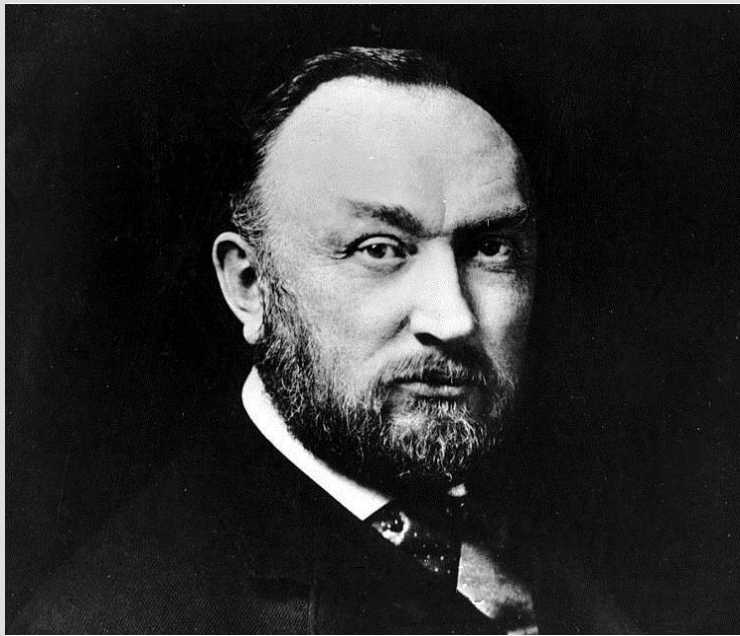
# Pickering's Harem at the Harvard College Observatory (1839)



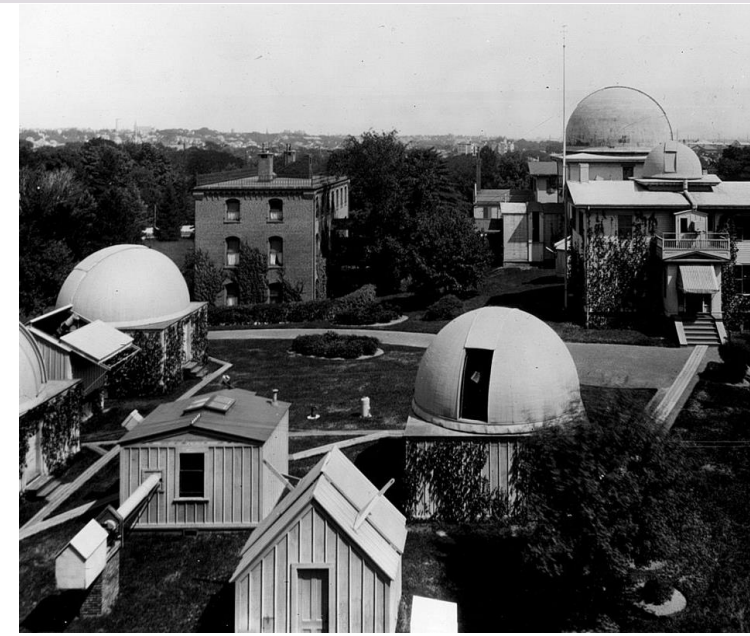
**Edward Charles Pickering**  
(1846, Boston - 1919, Cambridge, U.S.)



Harvard University, Harvard University Archives, W432043\_1



## Pickering's Harem at the Harvard College Observatory (1839)



*"Molte signore si interessano di Astronomia e possiedono telescopi ma, salvo due o tre eccezioni degne di nota, i loro contributi alla scienza sono stati pressoché nulli. Molte di loro hanno il tempo e l'inclinazione per simili mansioni e, soprattutto tra le laureate dei college femminili, ve ne sono molte che hanno ricevuto un addestramento più che sufficiente per essere eccellenti osservatrici. (...)*

*non sembra esservi ragione per cui non debbano mettere a frutto la loro conoscenza"*







Caroline was the first woman to be awarded the Gold Medal of the UK's Royal Astronomical Society in 1838.

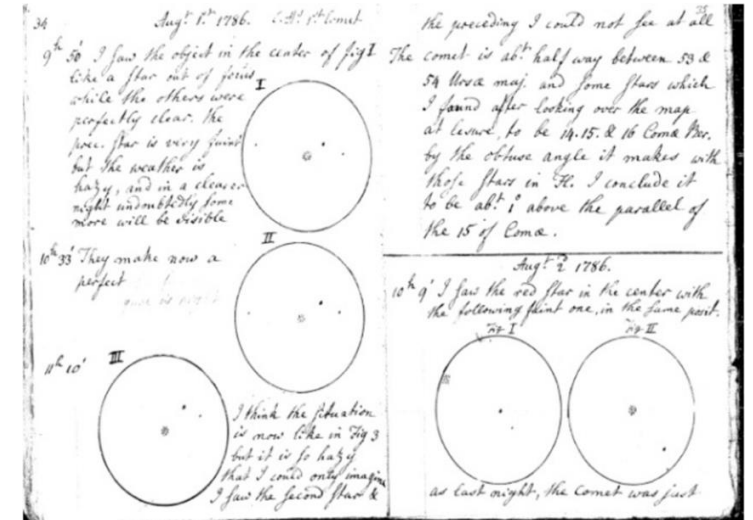
*Caroline Herschel medal to honour women in astronomy.* [Michael Banks 2021 Phys. World 34 (9) 10ii]

# CAROLINE LUCRETIA HERSCHEL

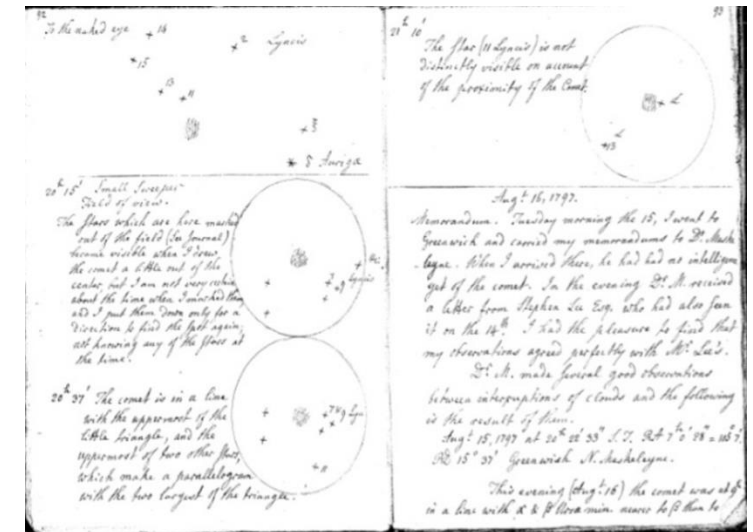
(1750 - 1848)



A portrait of Caroline Herschel with an illustration of planets in the solar system. Credits: RAS / SPL.

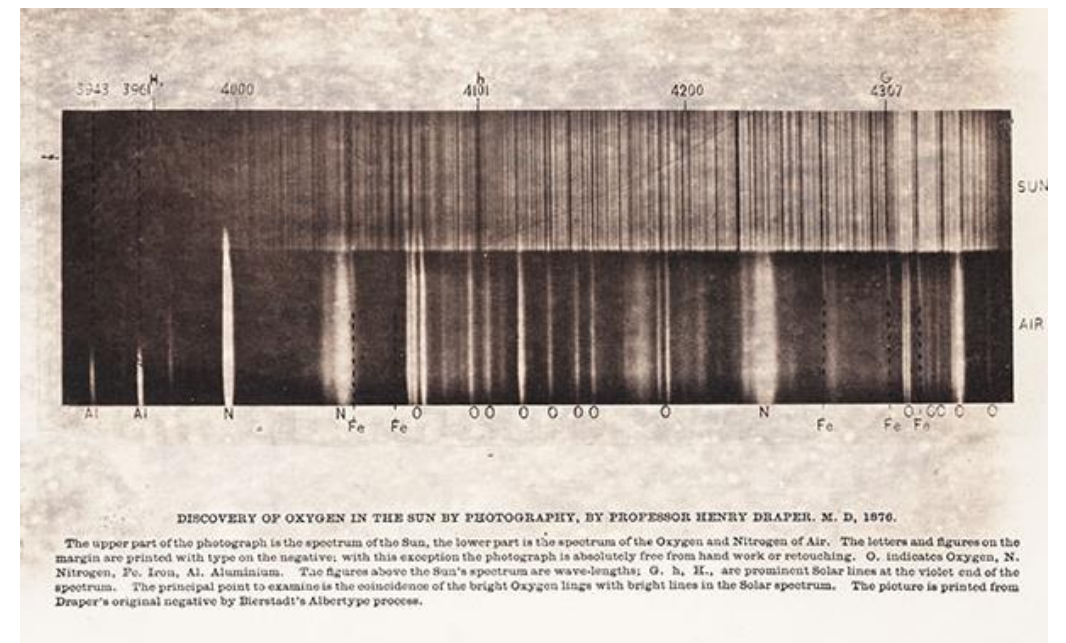
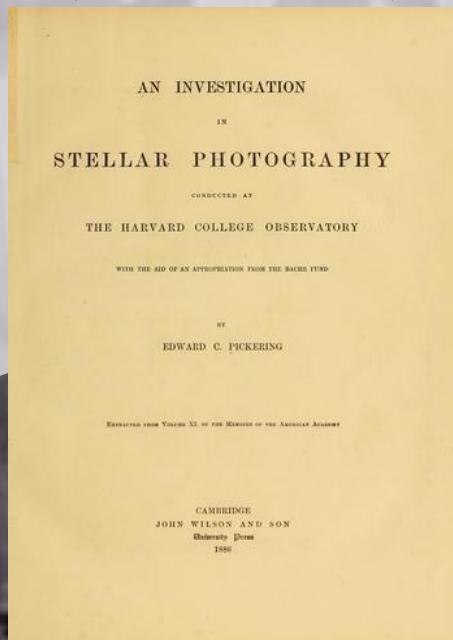


Caroline Herschel, Comet C/1786 P1 (Herschel), MS. RAS C.1/1.1, 34-35, 1786, Royal Astronomical Society, London

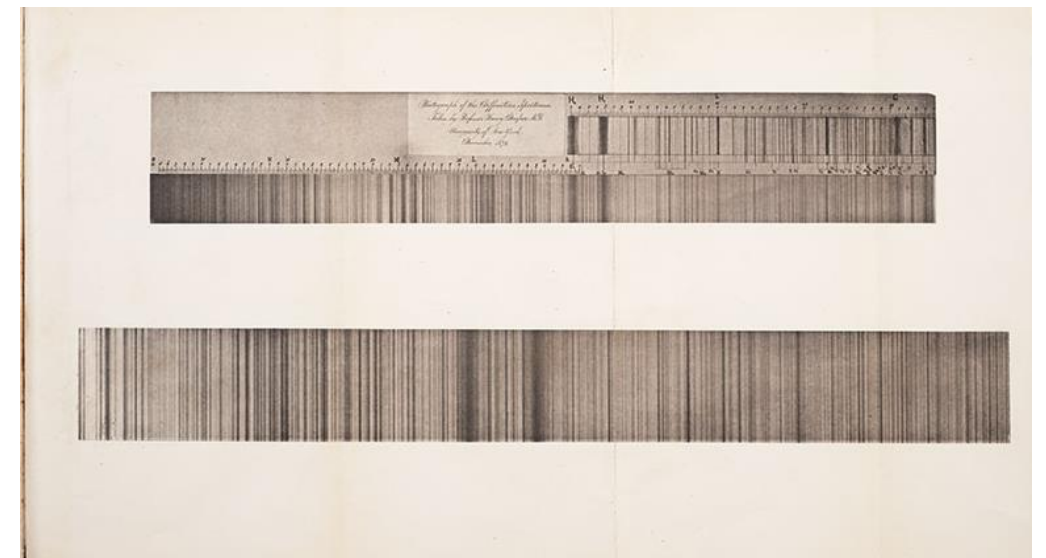


Caroline Herschel, Comet C/1797 P1 (Bouvard-Herschel), MS. RAS C.1/1.2, 92-93, 1795, Royal Astronomical Society, London

SPECTROGRAPHY:  
A PRACTICE  
PIONEERED BY DR.  
HENRY DRAPER  
(1837-1882)



Photograph of spectrum of oxygen compared with a solar spectrum, by Henry Draper, 1877 (Linda Hall Library).



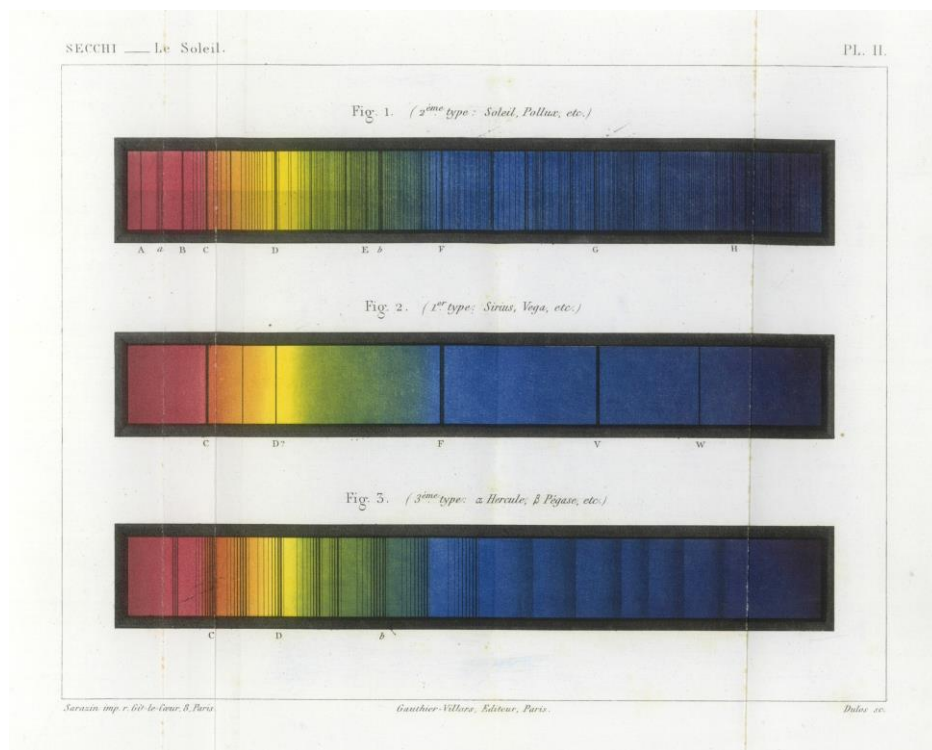
Complete solar spectrum, photograph, with detail below, by Henry Draper, 1873 (Linda Hall Library).



The first "COMPUTER WOMAN":

Williamina Paton

Stevens Fleming (1857-1911)



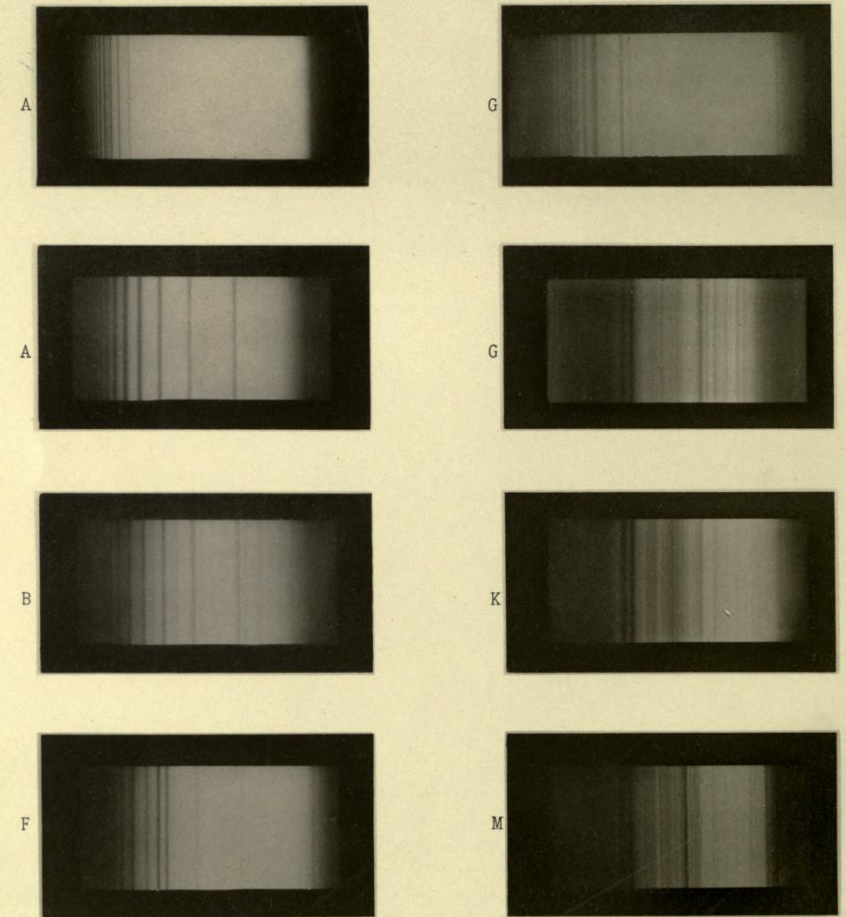
Reproduction of a table from Angelo Secchi's *Le Soleil* (1870).



# Williamina Fleming (1857-1911)



Williamina Fleming examining a star plate in 1891. Image: Observatory [analysis of stellar spectra], 1891. HUV 1210(9-6).

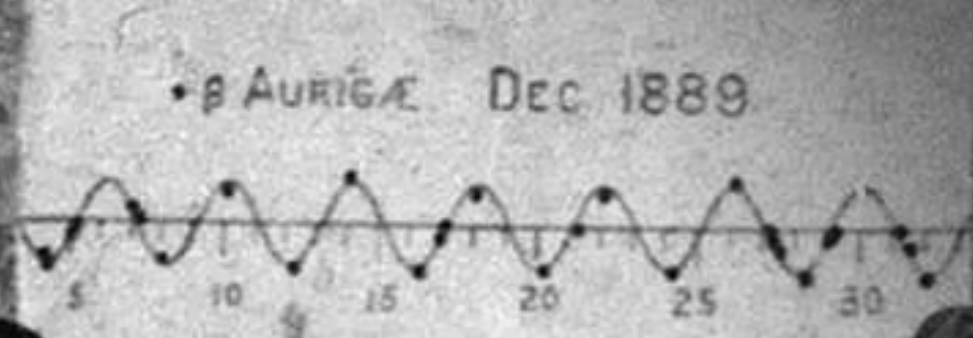


TYPES OF STELLAR SPECTRA.

Some of Williamina Fleming's alphabetical classification of the spectra of stars, from the *Draper Catalogue of Stellar Spectra*, 1890.



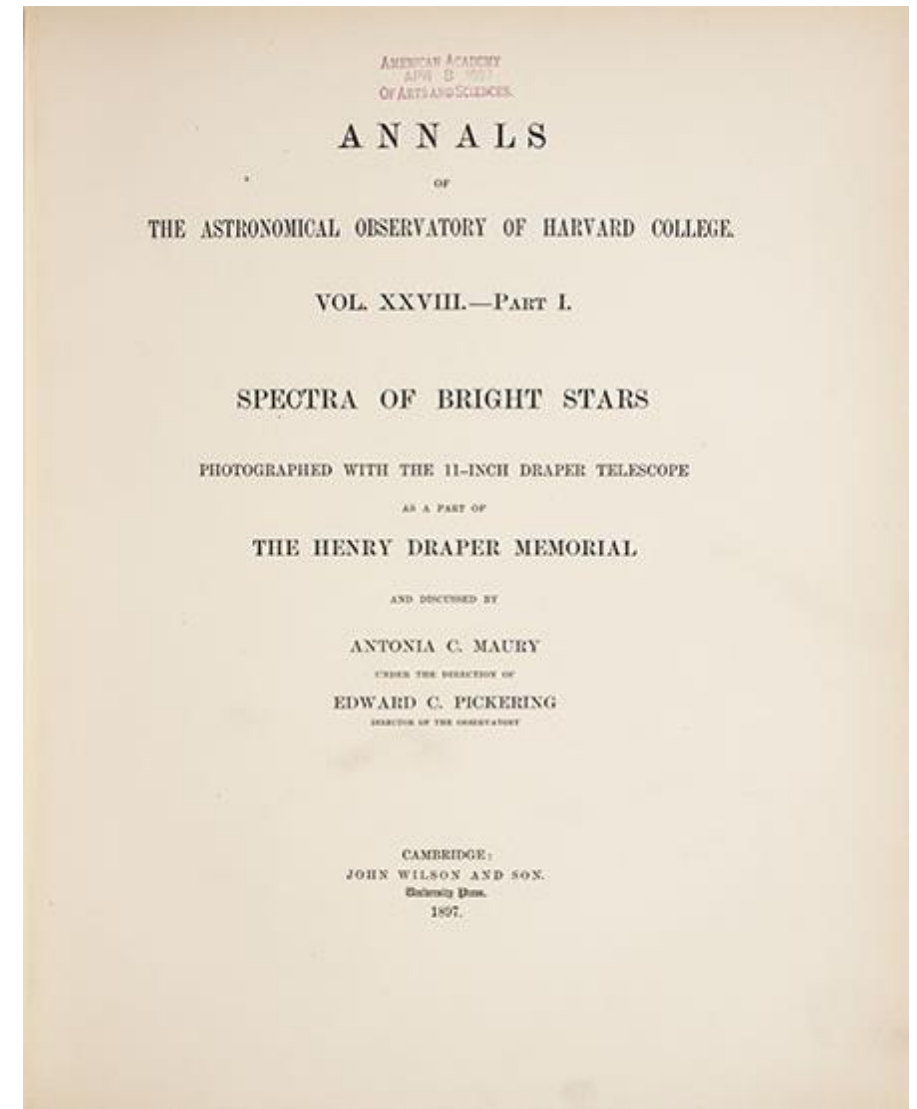
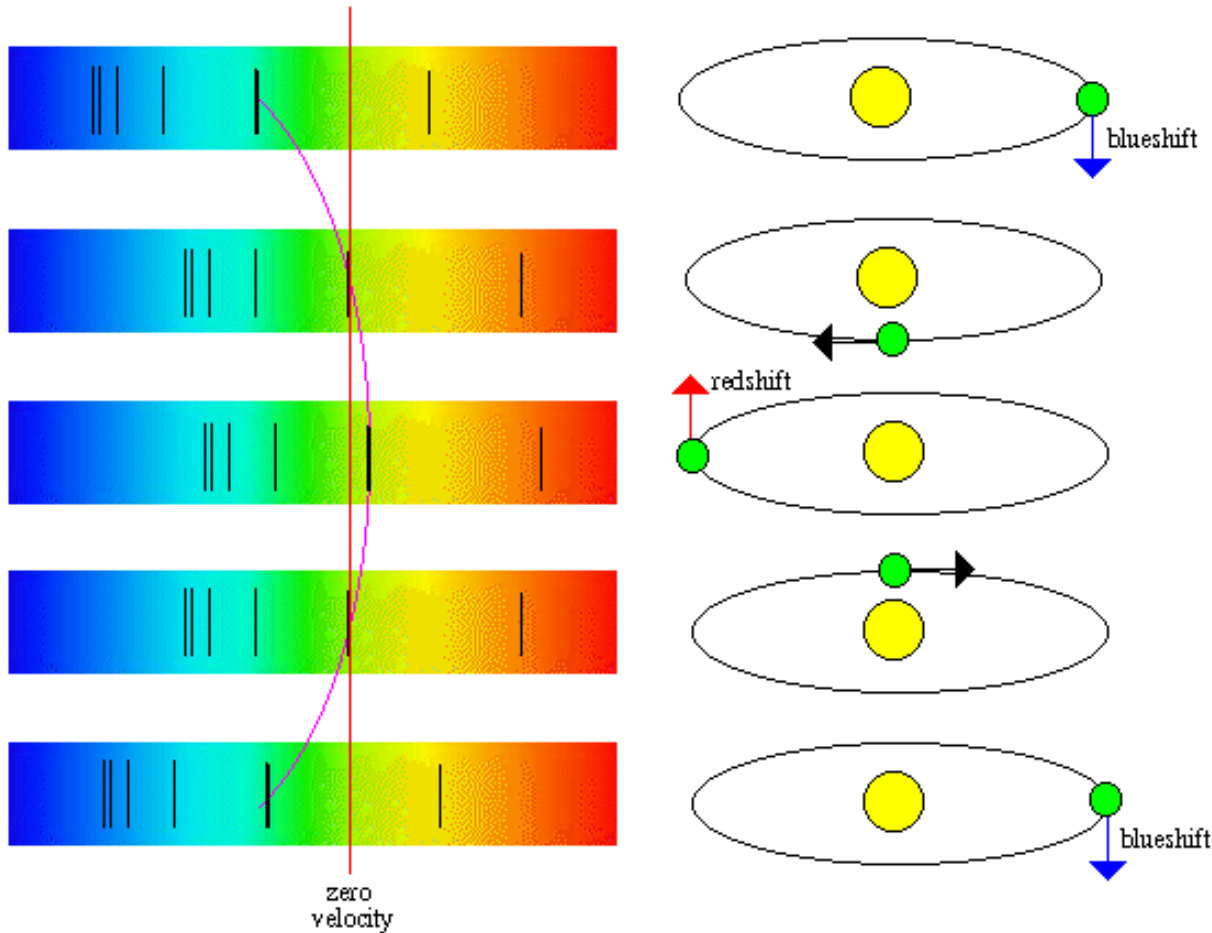
*"... the line appeared hazy, as if the components were slightly separated, while at other times the line appears to be well defined and single. (...)  
The line is double at intervals of 52 days."*



ANTONIA PEREIRA MAURY (1866-1952)

# SPECTROSCOPY BINARY

A spectroscopic binary is where there is evidence of orbital motion in the spectral features due to the Doppler effect



Maury A (1897) *Spectra of Bright Stars*. *Annals of Harvard College Observatory*, vol. 28, Linda Hall Library.





*"Quantunque non si possa affermare che la donna sia in ogni cosa uguale all'uomo, per molti versi la sua pazienza, perseveranza e logica la rendono superiore.*

*Speriamo pertanto che nell'astronomia, dove ora si aprono grandi possibilità per il lavoro e la competenza delle donne, ella possa, come è accaduto in altre scienze, almeno dimostrarsi sua pari."*





*Annie Jump Cannon & Henrietta Swan Leavitt*

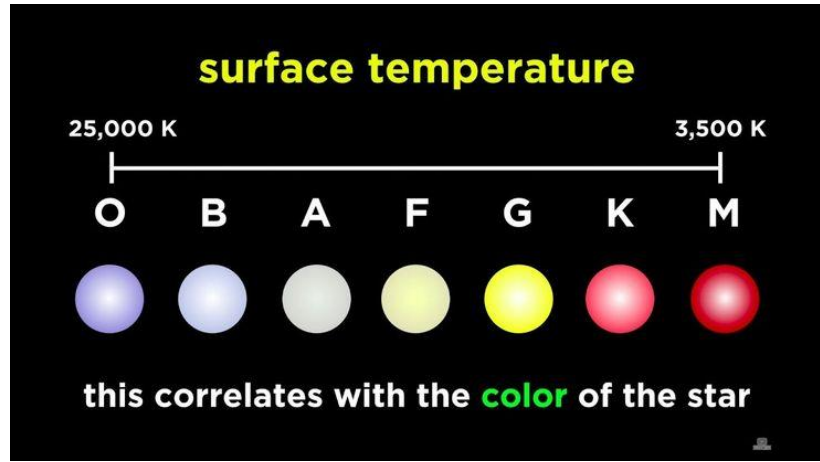
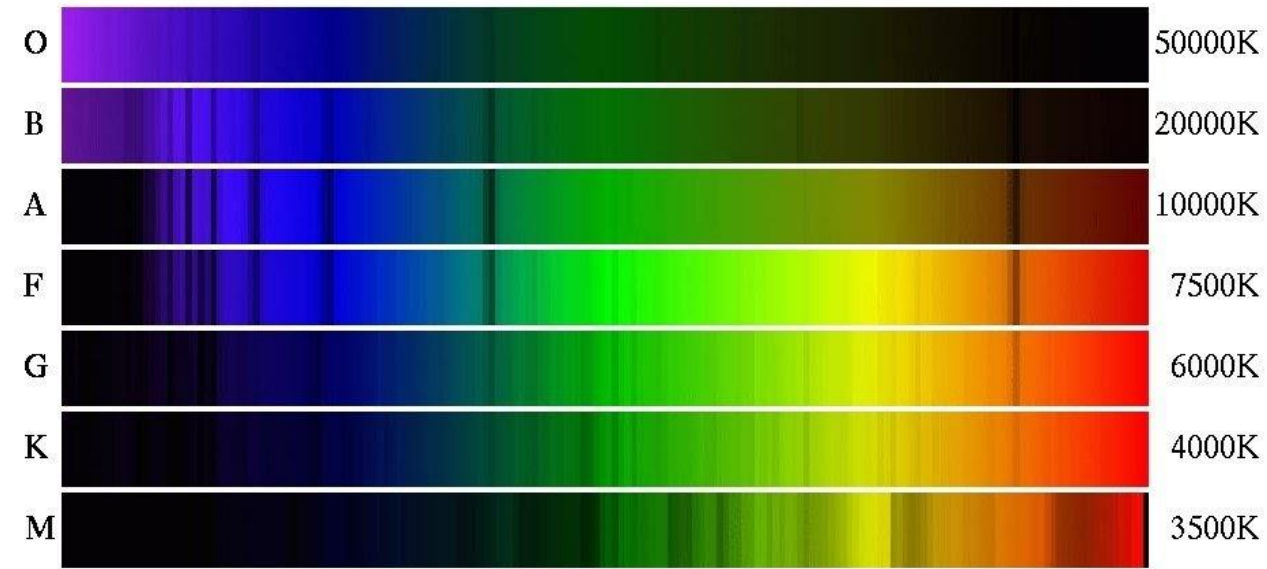






ANNIE JUMP  
CANNON  
(1863-1941)







*"The first medal ever bestowed on a woman (...) and one of the highest honors attainable by astronomers of any sex, race, religion, or political preference (...)"*

Harlow Shapley on Annie Jump Cannon winning the Henry Draper Medal, 1931



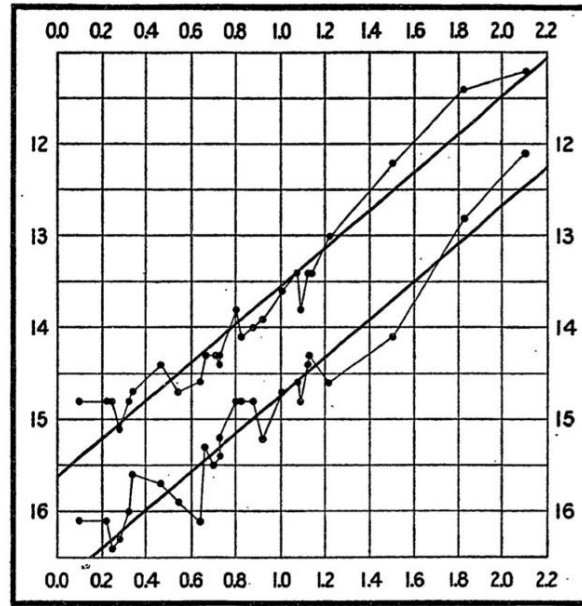
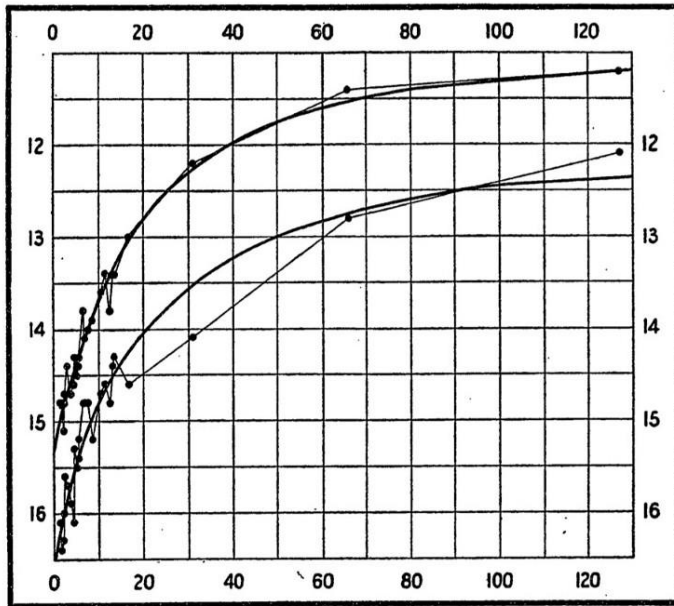
O B A F G K M



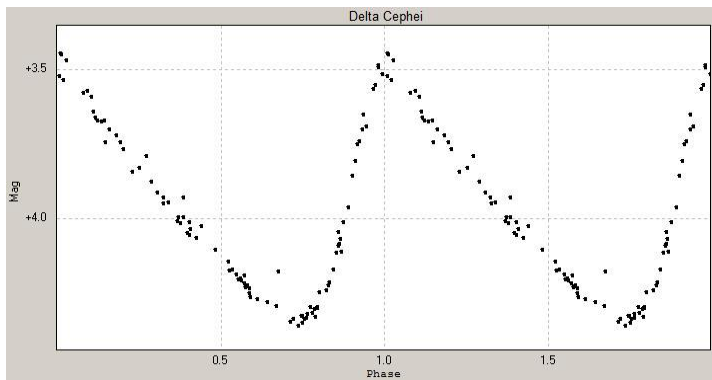
HENRIETTA SWAN LEAVITT (1868-1921)





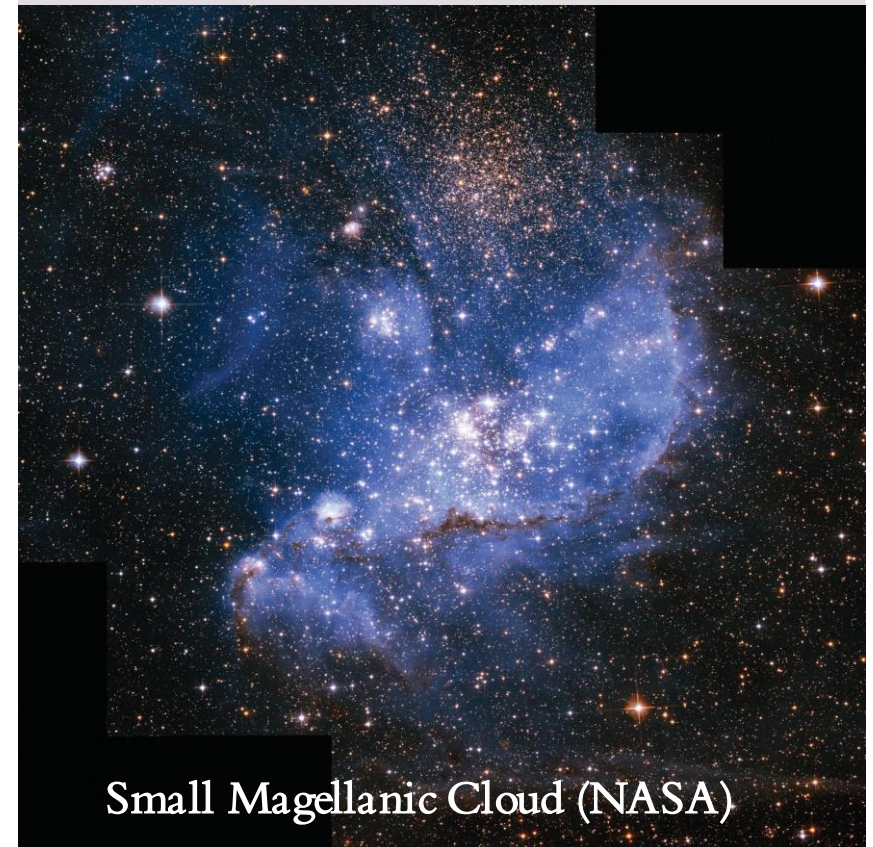


Leavitt H (1912) *Periods of 25 Variable Stars in the SMC.*



$$L = 4\pi D^2 f$$

# THE P-L RELATION



Small Magellanic Cloud (NASA)

# Henrietta's legacy



Ejnar Hertzsprung (1873–1967) was the first to calibrate Leavitt's report and to give an estimation of the distance of a group of Cepheids in our Galaxy (1913, article published in *Astronomische Nachrichten*).



Henry Norris Russell (1877–1957) worked on these objects (and devised with Hertzsprung around 1910 the well-known HR diagram).



The P-L relation was recalibrated correctly in 1952 by Walter Baade (1893–1960) who identified the two classes of pulsators.



In 1918 Harlow Shapley (1885–1972) elaborated the first model of our Galaxy by studying what he believed to be Cepheids in a GC (they turned out to be RR-Lyrae stars).






# Unveiling the size of the Universe

By the end of 1924 **Edwin Hubble** (1889-1953) had found 36 variable stars in Andromeda, 12 of which were Cepheids. He obtained a distance of 900,000 light-years (measurements now place it at 2 million light-years away)


**The Great Debate**  
April 26, 1920

A galaxy is an island universes!

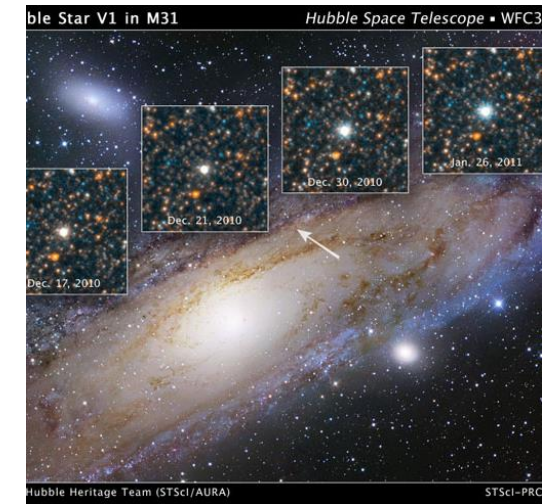
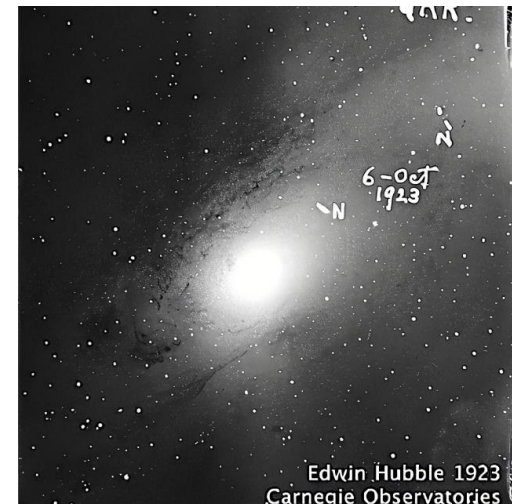


Harlow Shapley

A galaxy is a nebula within the Milky Way!



Hebert Curtis



# THE LOSS OF THE NOBEL PRIZE IN PHYSICS - 1926

*"Honoured Miss Leavitt, what my friend and colleague Professor von Zaipel of Uppsala has told me about your admirable discovery of the empirical law touching the connection between magnitude and period-length for the Cepheid-variables of the Little Magellan's Cloud, has impressed me so deeply that I feel seriously inclined to nominate you to the Nobel prize in physics for 1926".*

1925 Gosta Mittag-Leffler







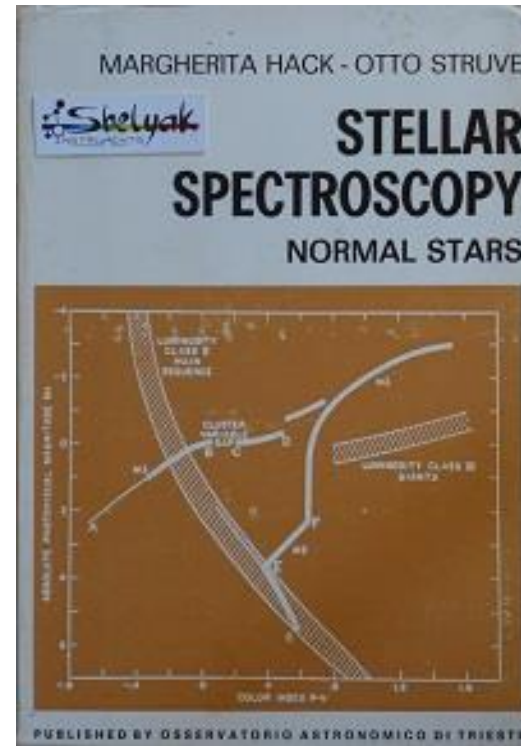
Margherita Hack  
(1922, Firenze  
– 2013, Trieste)



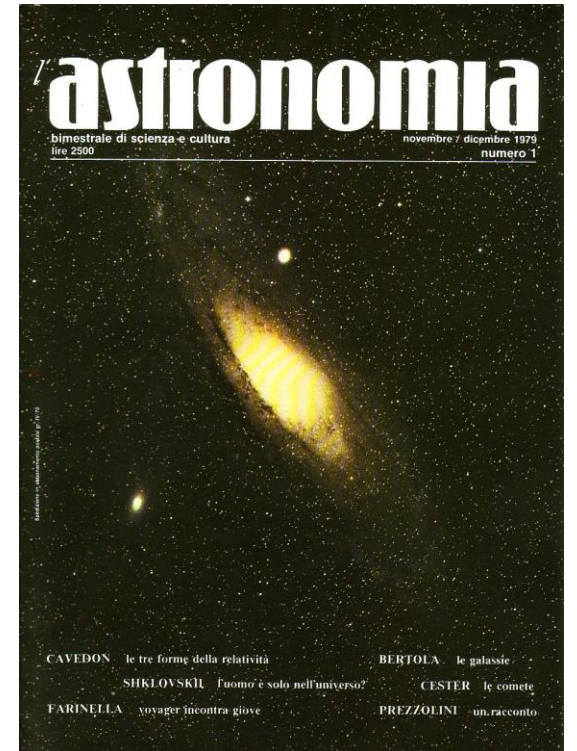
The 100th birth anniversary  
this year



# Astrophysicist & scientific disseminator



1959



1978





HACK



MARGHERITA HACK CI MOSTRA  
CHE L'UNICA MANA NON È UNA SCELTA  
RISULTA AL INDIRIZZO  
NOI SECONDO IL CORPO DAL TITOLO  
MA È UNO SCENIO



TAV  
SCULTURE  
DIPINZI

"SGUARDO FISICO"



# VERA FLORENCE COOPER RUBIN

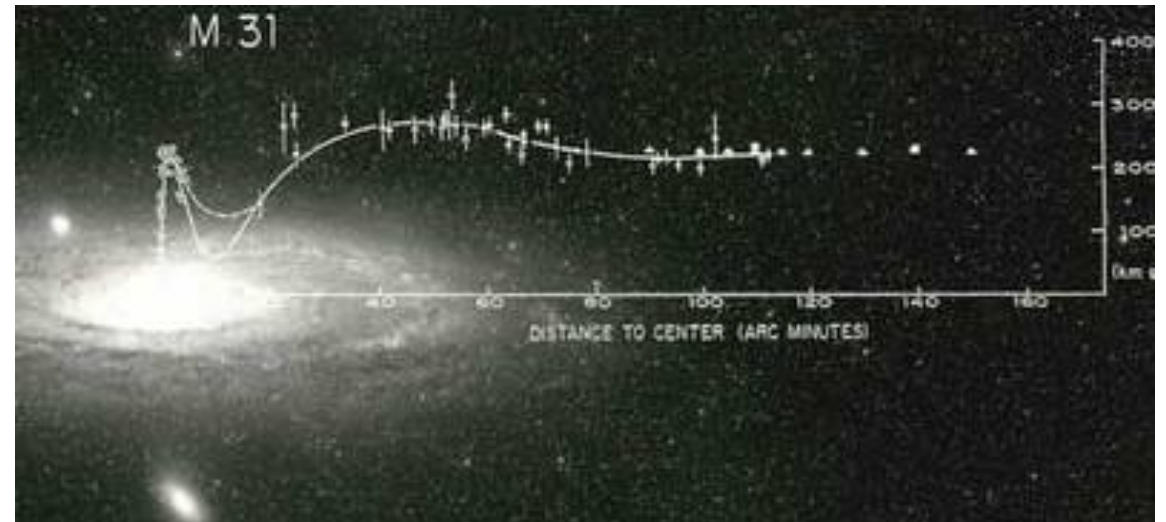
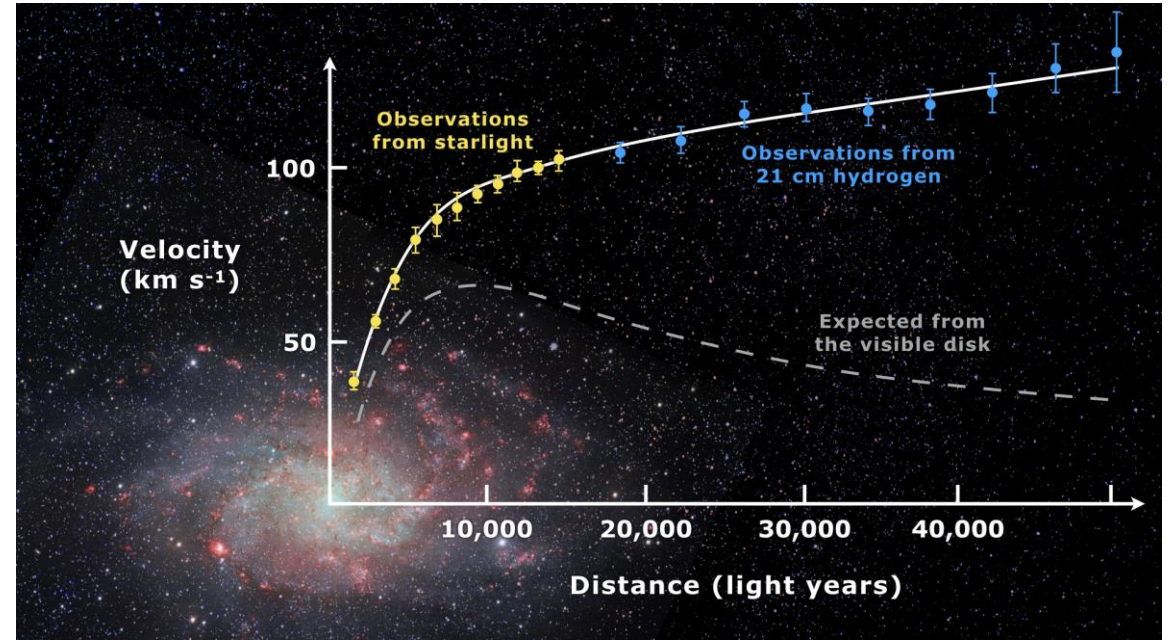
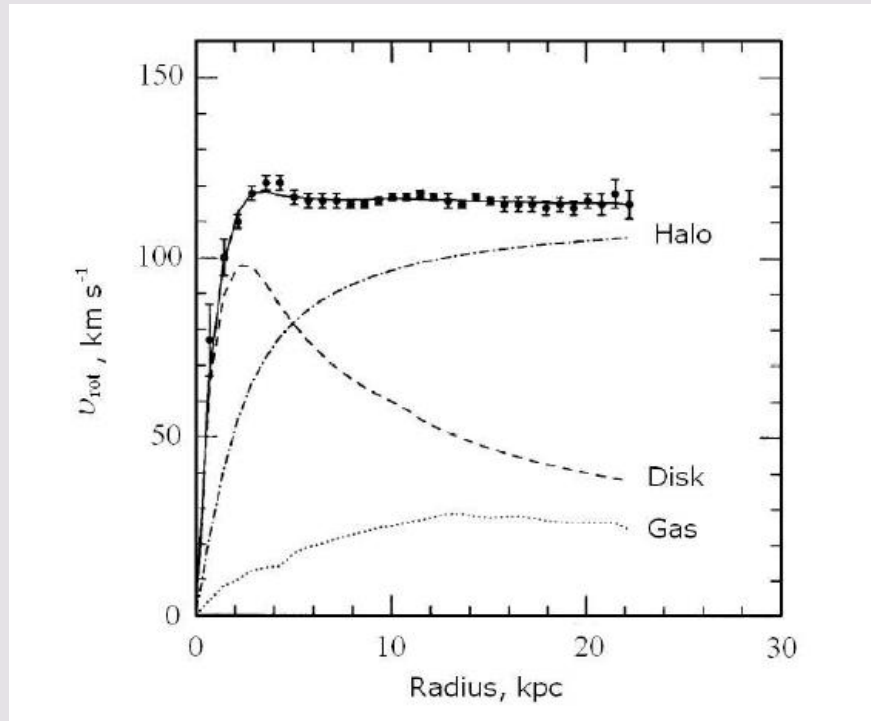
(1928, PHILADELPHIA, PENNSYLVANIA –  
2016, PRINCETON, NEW JERSEY)



Rubin VC 2011 Ann. Rev. Astron. Astrophys. 49 2  
(autobiographical article)



# GALAXY ROTATION RATE



Mitton J (2021) How Vera Rubin encountered dark matter. *Astronomy & Geophysics*, Vo. 62, Issue 2, pp. 2.22–2.28.





## Vera C. Rubin Observatory

The Vera C. Rubin Observatory, previously referred to as the Large Synoptic Survey Telescope (LSST), is an astronomical observatory currently under construction in Chile.

The name honors Rubin and her colleagues' legacy to probe the nature of dark matter by mapping billions of galaxies.

*"The telescope will produce the deepest, widest, image of the Universe."*

<https://www.lsst.org>



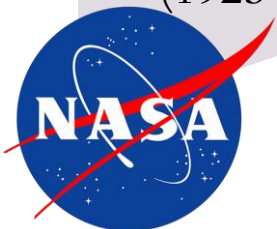


# Nancy Grace Roman (Space Telescope)

The Roman Space Telescope is a NASA observatory designed to settle essential questions in the areas of dark energy, exoplanets, and infrared astrophysics.

The telescope has a primary mirror that is 2.4 meters in diameter, and is the same size as the Hubble Space Telescope's primary mirror. The Roman Space Telescope will have two instruments, the Wide Field Instrument, and the Coronagraph Instrument.

It is named after **Nancy Grace Roman** (1925-2018).



<https://roman.gsfc.nasa.gov>

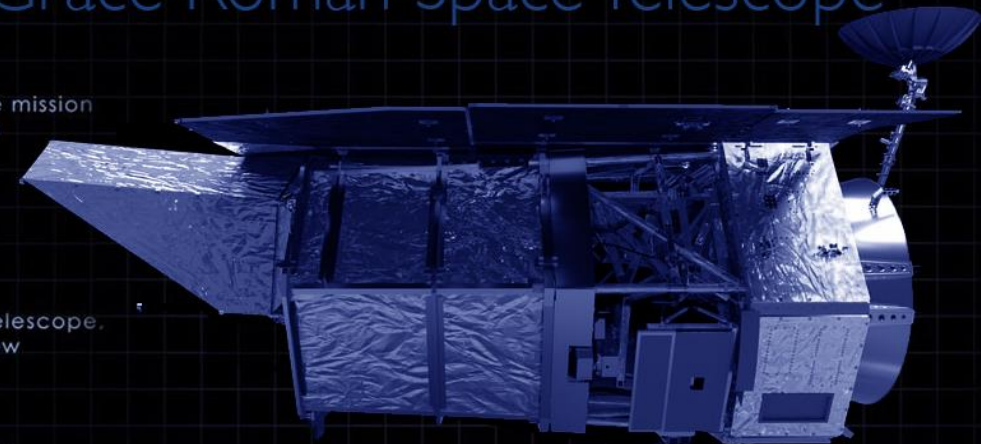


## Nancy Grace Roman Space Telescope

-Top ranked large space mission in NASA Decadal Survey to follow JWST

-Hubble-class infrared telescope, with 100x the field of view

-Will study exoplanets, dark energy and galaxies





Susan Jocelyn  
Bell Burnell

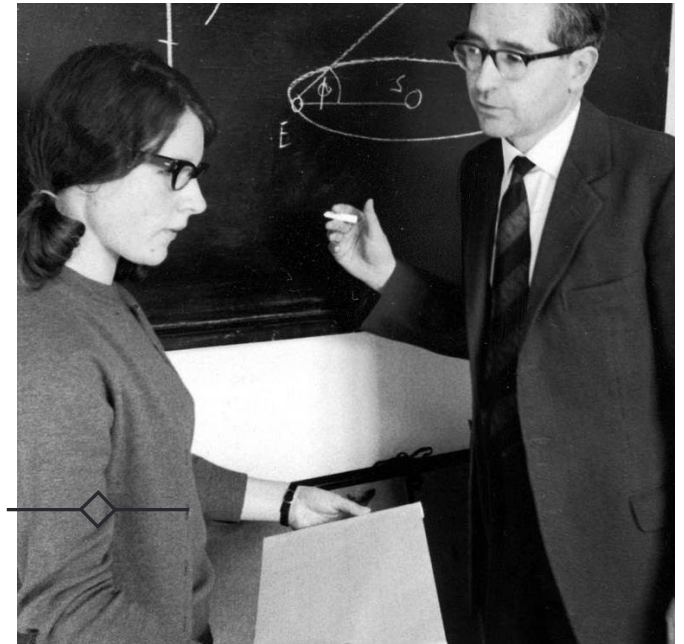
(1943, Belfast, Northern Ireland)

*"I knew I wanted to be an astronomer  
but at that stage,  
there weren't any women role models  
I knew of."*





# Radioastronomer



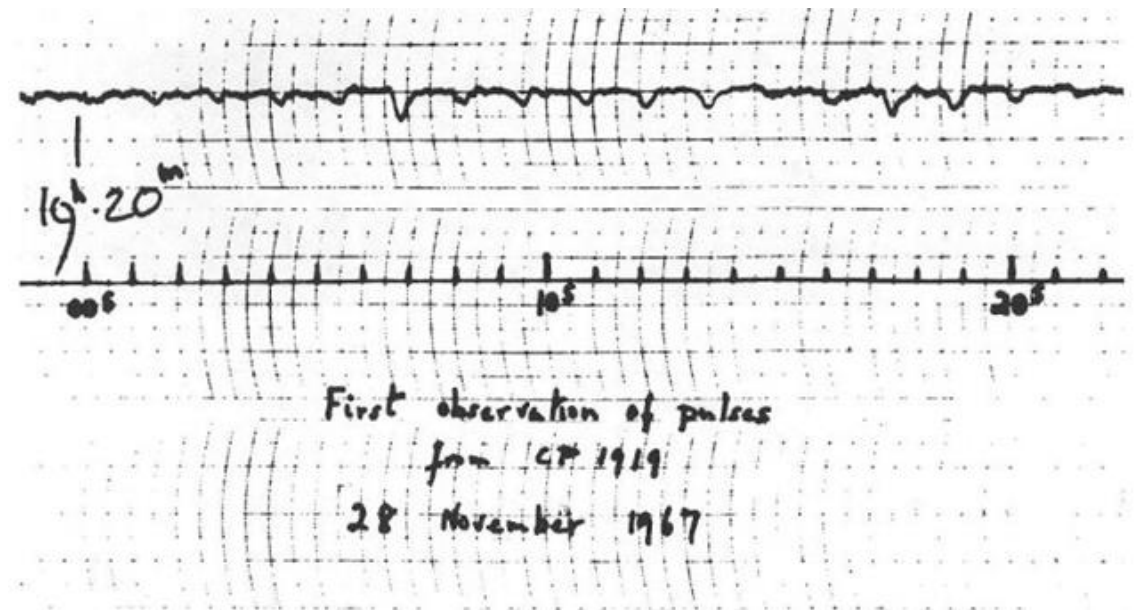
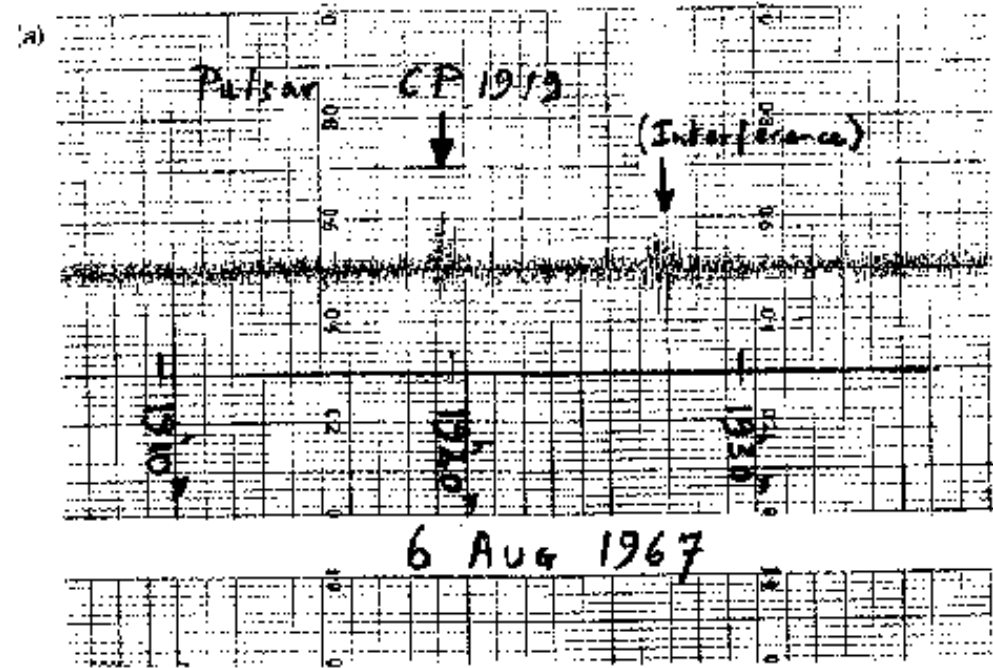
# The discovery of pulsars



PSR B1919+21 has a period of 1.3373 seconds, a pulse width of 0.04 seconds. Discovered by Jocelyn Bell and Antony Hewish on November 28, 1967.

Nature 217, 709-713 (24 February 1968)  
Observation of a Rapidly Pulsating Radio Source. A.  
HEWISH, S. J. BELL, J. D. H. PILKINGTON, P. F.  
SCOTT & R. A. COLLINS.

*“A string of pulses,  
one and a third seconds apart.”*





# Pulsating radio stars

Pulsars are rapidly spinning neutron stars, which are the small dense remnant of much more massive stars.

They can rotate up to 40,000 times a minute and have incredibly strong magnetic fields that drive powerful beams of electromagnetic radiation.

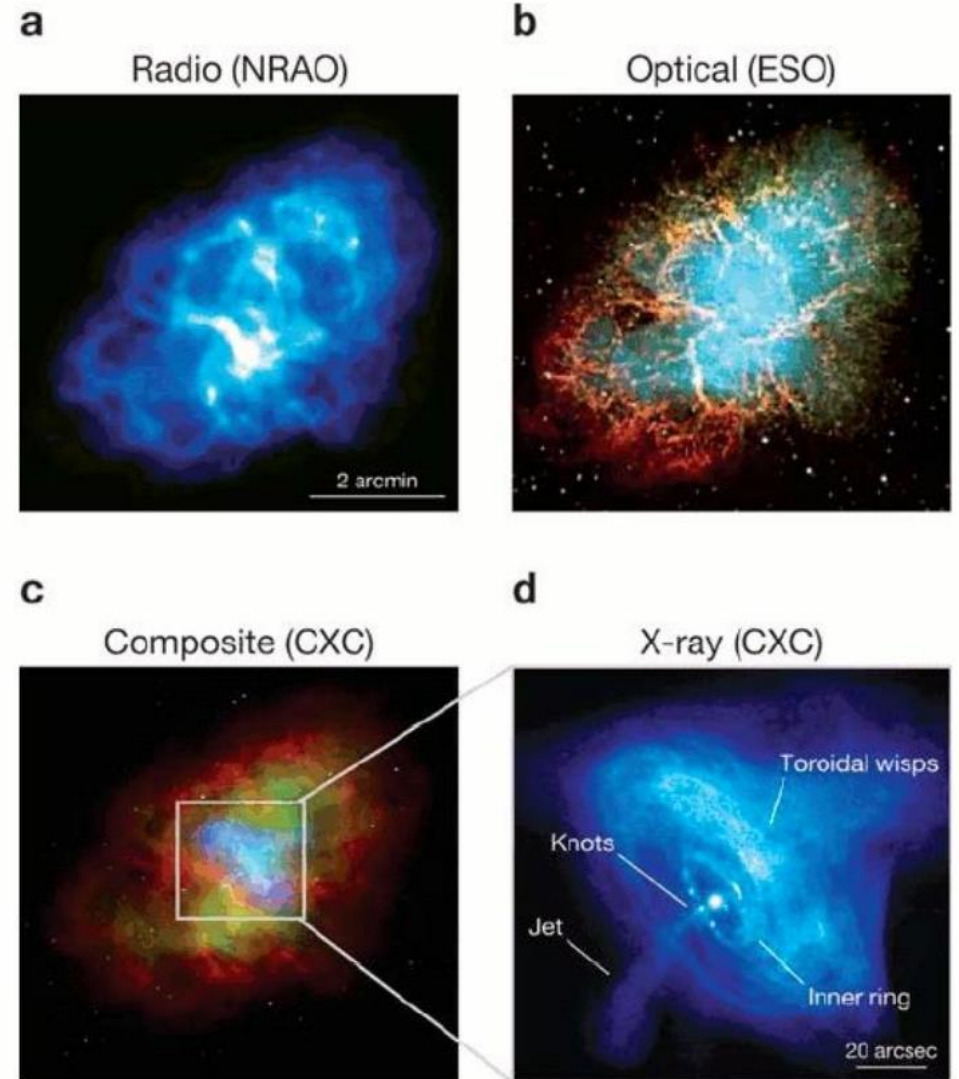
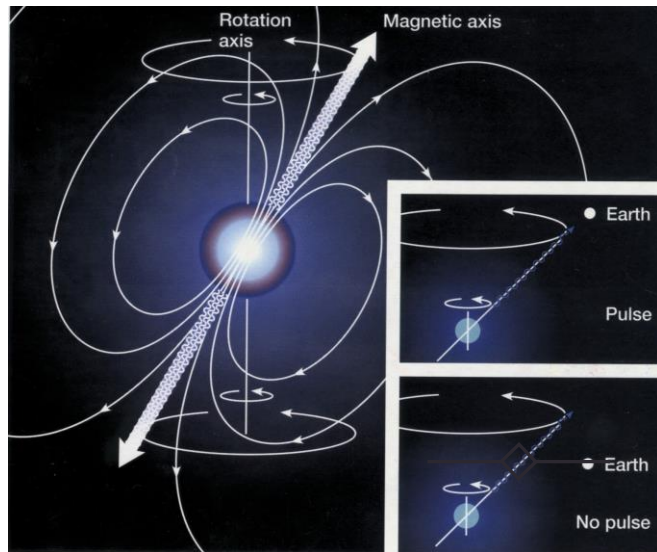




Photo from the Nobel  
Foundation archive.

**Antony Hewish**

Prize share: 1/2

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## THE LOSS OF THE NOBEL PRIZE IN PHYSICS - 1974



The Nobel Prize in Physics 1974 was awarded jointly to Sir Martin Ryle and Antony Hewish "for their pioneering research in radio astrophysics:

Ryle for his observations and inventions, in particular of the aperture synthesis technique, and Hewish for his decisive role in the discovery of pulsars."

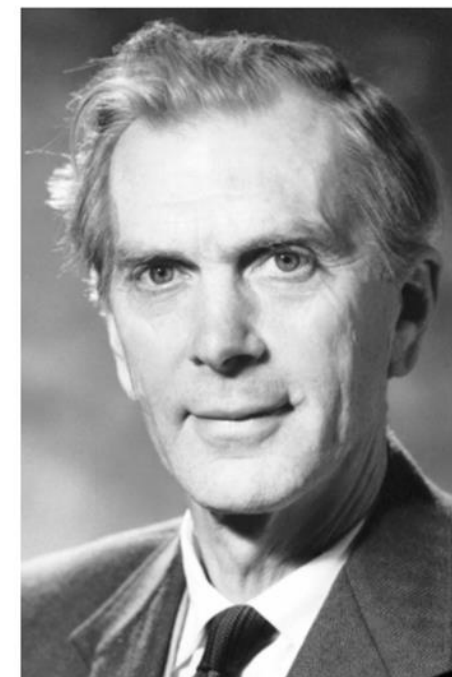


Photo from the Nobel  
Foundation archive.

**Sir Martin Ryle**

Prize share: 1/2

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*“I do think it’s important  
that there are role model for young women.  
So, ok, I’ll be it”*

SPECIAL  
BREAKTHROUGH PRIZE  
IN FUNDAMENTAL  
PHYSICS



Breakthrough Prize Recognizes Bell  
Burnell’s 1967 Detection of Radio Signals  
from Rapidly Spinning, Super-Dense  
Neutron Stars and a Lifetime of Inspiring  
Scientific Leadership.

## THE MONSTER IN THE MIDDLE

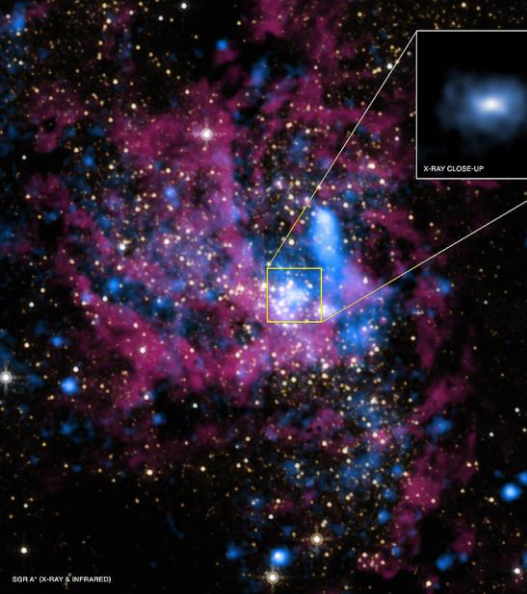
By tracking stars near the mysterious object at the centre of the Milky Way, astronomers have shown that they move in years-long orbits. 8 examples are shown here. These orbits prove that the object packs the mass of 4.1 million Suns into a space smaller than the Solar System, and can only be a black hole.



## THE BLACK HOLE



## THE MILKY WAY



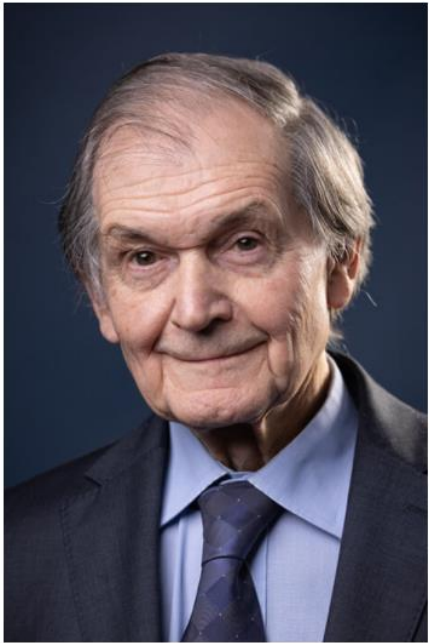
SDR 'A' (X-RAY & INFRARED)

# ANDREA MIA GHEZ

(1965, NEW YORK)







© Nobel Prize Outreach. Photo:  
Fergus Kennedy  
**Roger Penrose**  
Prize share: 1/2



© Nobel Prize Outreach. Photo:  
Bernhard Ludewig  
**Reinhard Genzel**  
Prize share: 1/4



© Nobel Prize Outreach. Photo:  
Annette Buhl  
**Andrea Ghez**  
Prize share: 1/4

## (FINALLY) WINNING THE NOBEL PRIZE IN PHYSICS -2020





# Nobel Prize awarded women

58 women in total have been awarded the Nobel Prize between 1901 and 2021 (only Marie Curie, has been honoured twice)

## Nobel Prize in Physics awarded women:

- **1903: Marie Curie** “in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel”
- **1963: Maria Goeppert Mayer:** “for their discoveries concerning nuclear shell structure”
- **2018: Donna Strickland:** “for groundbreaking inventions in the field of laser physics”, “for their method of generating high-intensity, ultra-short optical pulses.”
- **2020: Andrea Ghez:** “for the discovery of a supermassive compact object at the centre of our galaxy”







THANK YOU

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February 21st, 2022

Bologna



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