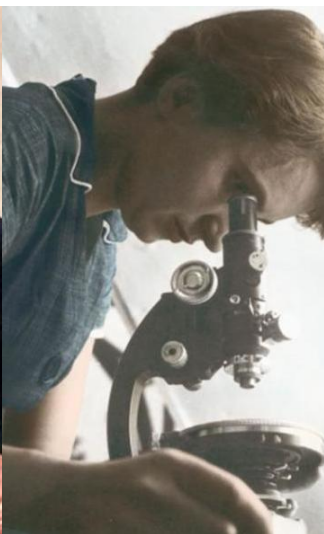


# Women in Science

March 8, 2018

Escuela Oficial de Idiomas de Gijón

John K. White







Ada Lovelace



Marie Curie



Lise Meitner



Maria Mayer



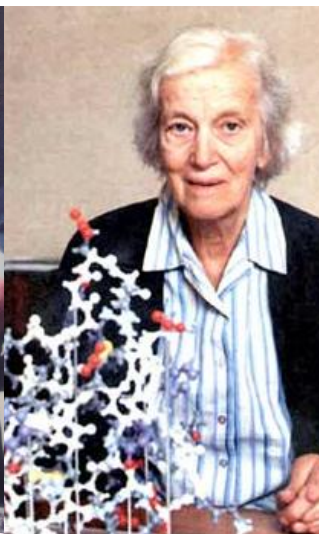
Cecilia Payne



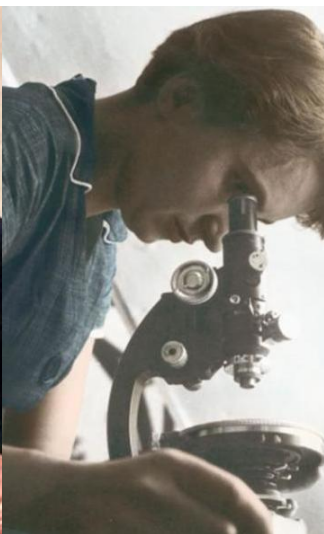
Rachel Carson



Mary Leakey



Dorothy Hodgkin

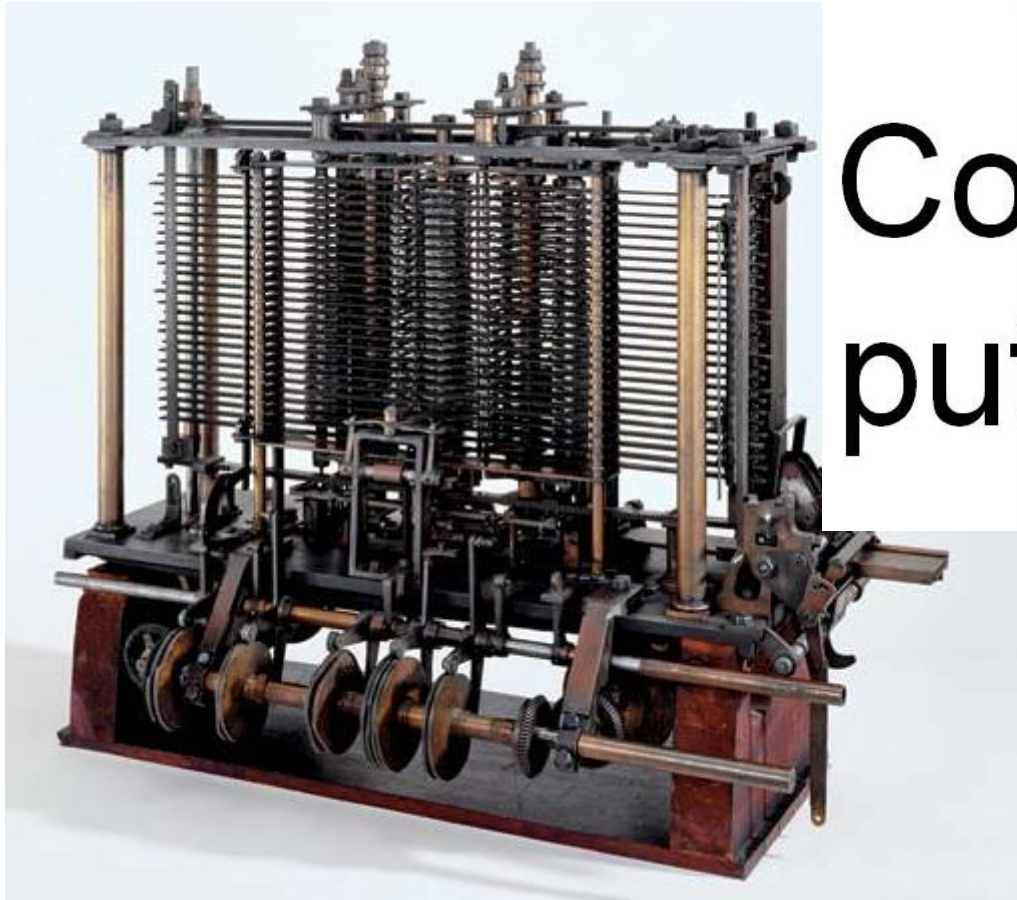


Rosalind Franklin



Jocelyn Bell

# Ada Lovelace (1815-1852)



Com  
puting

```
// Create data points.  
var numDataPoints = 30;  
var x = new Array(numDa  
for (i = 0; i < numData  
    x[i] = i;  
    y[i] = i*i;  
}  
for (i = 0; i < numData  
    data.addRow([ [x[  
    ]
```

# Marie Curie (1867-1934)



**1867** Daughter of a Warsaw physics teacher

**1891** Sorbonne physics

**1895** Married Pierre Curie

**1897** Daughter Irène born

**1898** Study of “radioactivity” using uranium salts

**1898** 2 new elements conjectured

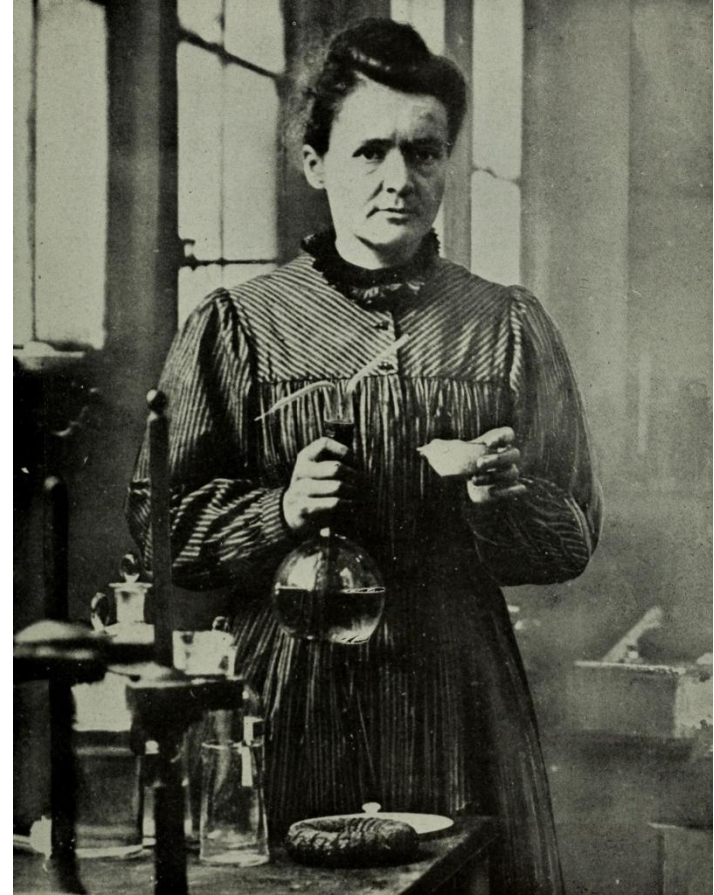
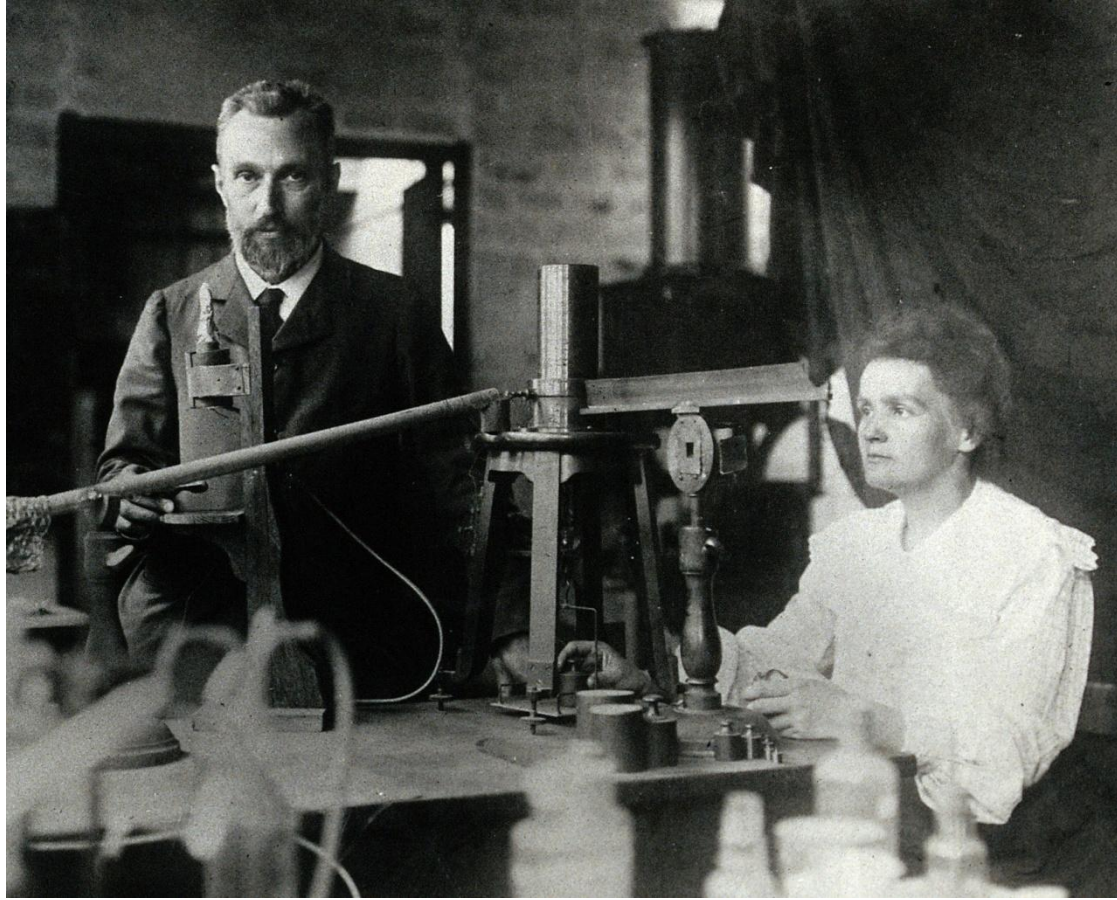
**1903** Nobel prize (number 1 -- physics)

**1906** Pierre dies by carriage accident

**1911** Nobel prize (number 2!! -- chemistry)



# Radioactivity



# Radioactivity



# Radioactivity

*“The study of this phenomenon seemed very attractive. ... I decided to undertake the study of it. ... In order to go beyond the results reached by Becquerel. It was necessary to employ a precise quantitative method.”*

*“Pitchblende and chalcite are much more active than uranium itself. This fact is very remarkable and leads one to believe that these minerals contain an element that is much more active than uranium.”*

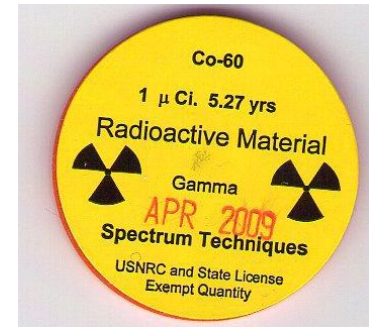
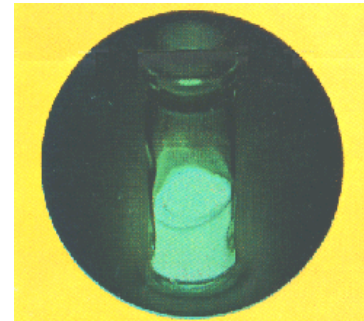
April **1898** polonium (400 times more active)


Dec **1898** radium (2 million times more active!)

Marie Curie is the founder of radio chemistry



# Radium extraction



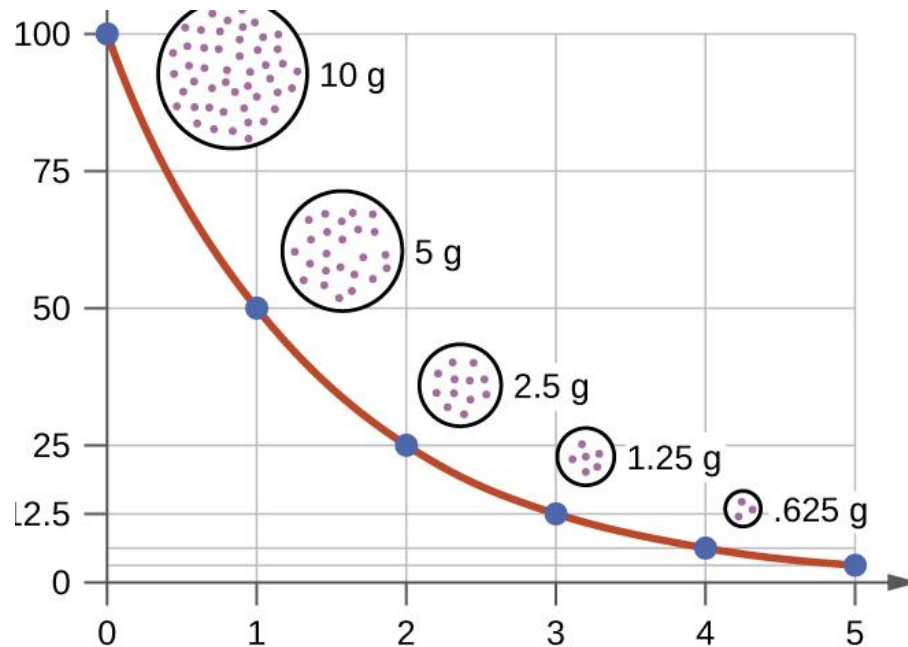
**WITHIN THIS BORDER**  

is a minute quantity of actual  
**RADIUM**

Observe the radium on this card only in total darkness of night and remain in darkness until eyes are accustomed. Use a magnifying glass. If not previously exposed to any light, thousands of alpha rays may be seen like vivid sparks. If accidentally exposed to the light you will not see the sparks until it ceases to glow.

Theoretically, this Radium should lose only half of its fiery energy in 1680 years.

# Radiation



Uranium 4.5 billion years

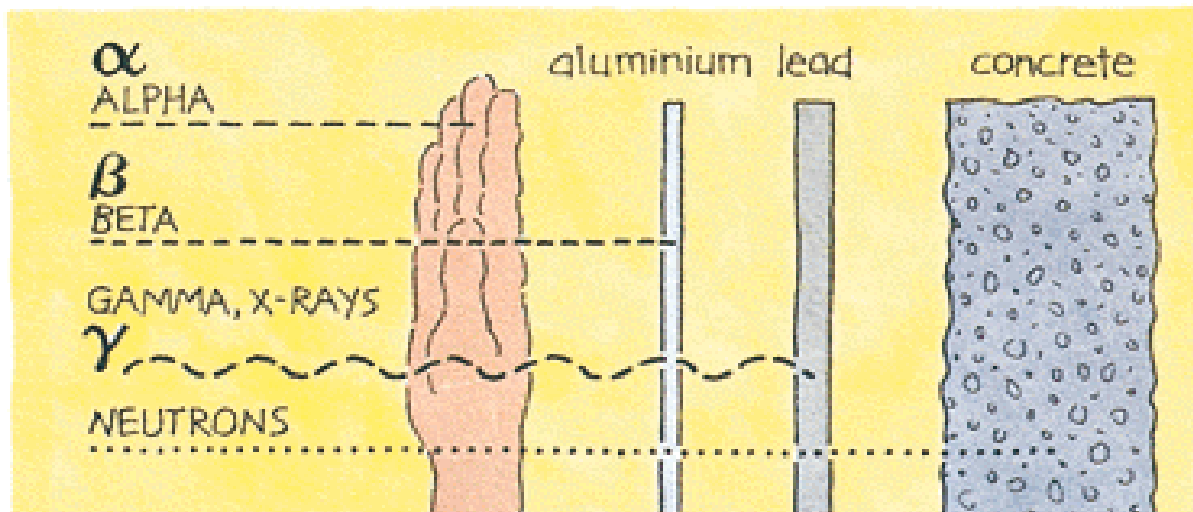
Radium 1,600 years

Carbon-14 5,730 years

Cobalt 5.3 years

Polonium 138 days

Radon 3.8 days



# 1903 Nobel Physics Prize

***in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel***

“The discoverers of radium have ... not profited financially from the work as greatly as might have been expected, and their admirers throughout the world will be delighted to hear of this windfall for them.” *The New York Times*

# 1911 Nobel Chemistry Prize

***in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element***

[www.nobelprize.org/nobel\\_prizes/physics/laureates/1903/marie-curie-facts.html](http://www.nobelprize.org/nobel_prizes/physics/laureates/1903/marie-curie-facts.html)



# Solvay Conference 1911



# Marie Curie legacy



World War I – x-ray development

Radium therapy (curiethérapie)

70 papers, 2 Nobel prizes

1 curie =  $3.7 \times 10^{10}$  disintegrations/second

Irène Joliot-Curie (1935)

EU Marie Curie awards

# RADIUM    THERAPY

The only scientific apparatus for the preparation of radio-active water in the hospital or in the patient's own home.

This apparatus gives a high and measured dosage of radio-active drinking water for the treatment of gout, rheumatism, arthritis, neuralgia, sciatica, tabes dorsalis, catarrh of the antrum and frontal sinus, arterio-sclerosis, diabetes and glycosuria, and nephritis, as described in

Dr. Saubermann's lecture before the Roentgen Society, printed in this number of the "Archives."

## DESCRIPTION.

The perforated earthenware "activator" in the glass jar contains an insoluble preparation impregnated with radium. It continuously emits radium emanation at a fixed rate, and keeps the water in the jar always charged to a fixed and measurable strength, from 5,000 to 10,000 Maché units per litre per diem.



SUPPLIED BY

**RADIUM LIMITED,**

93, MORTIMER STREET, LONDON, W.

Telephone: 676 MAYFAIR.



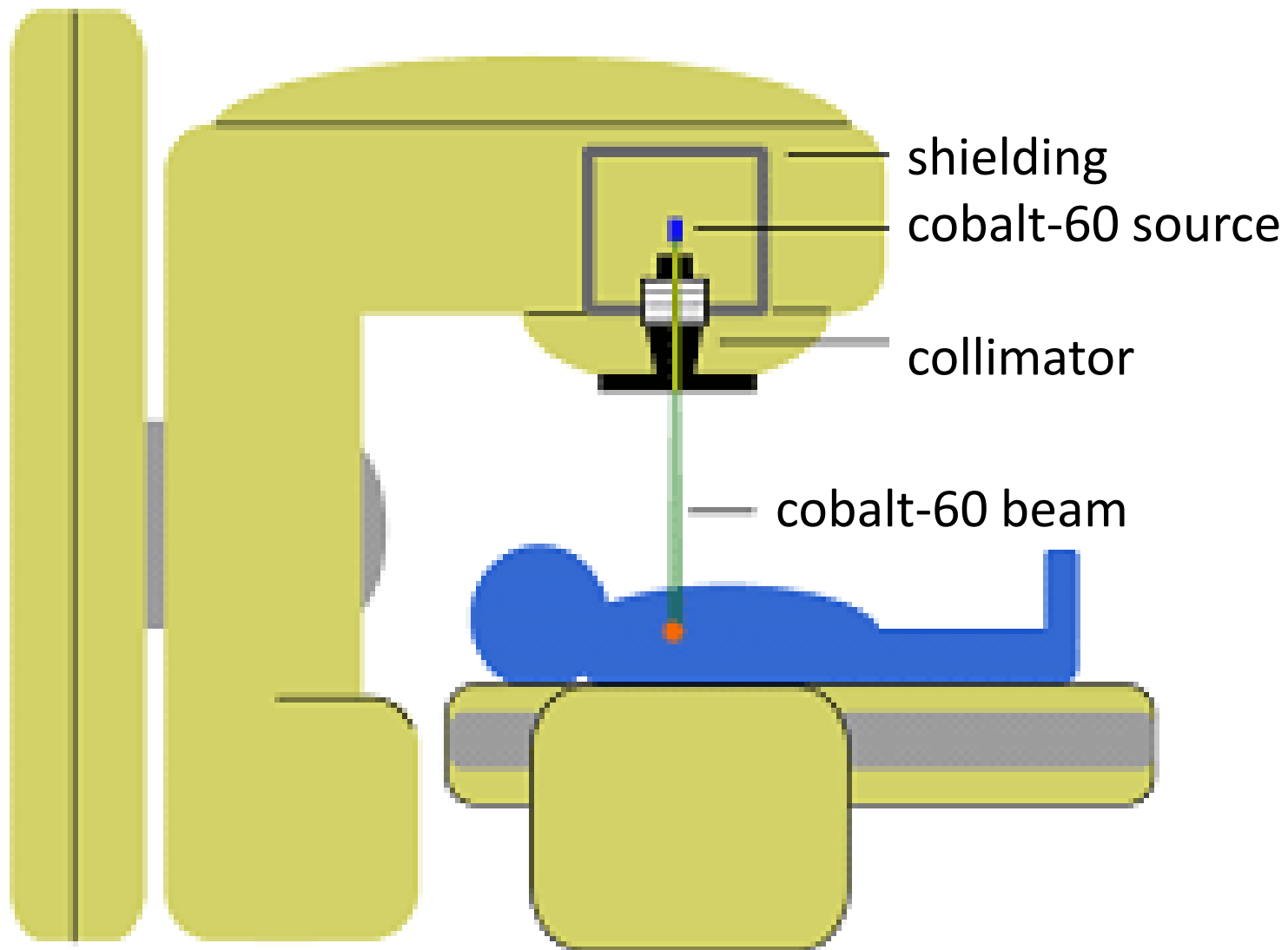
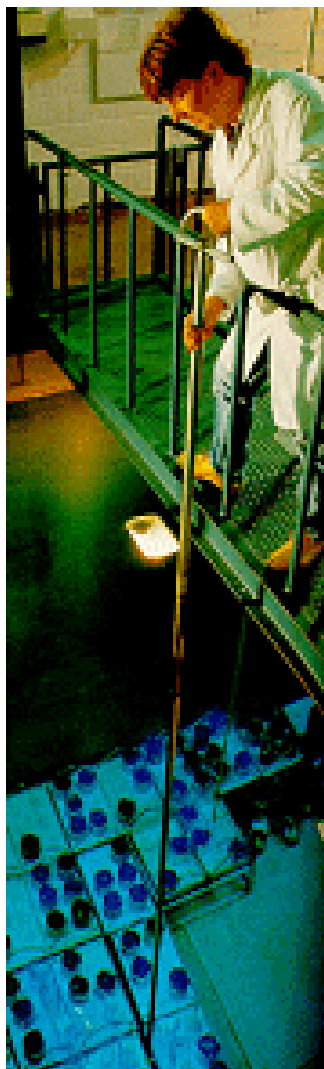
# Radium “girls”



# Radiation exposure

Radioactive source	$\mu\text{Sv/hr}$	x annual dose
Typical background	0.15	0.26
Hiroshima peace dome	0.3	0.53
Marie Curie office (door knob)	1.5	2.6
Jáchymov uranium mine	1.7	3.0
Los Alamos Trinity bomb site	0.8	1.4
Los Alamos trinitite mineral	2.1	3.7
airplane flight (33,000 feet)	> 2	> 3.5
Chernobyl reactor #4 exterior	5	8.8
Fukushima exclusion zone	10	18
astronaut	18	32
smoker's lung (polonium)	18	32
Chernobyl hospital basement	1,000	1,800

# Radiation therapy





# Radiation therapy



# Lise Meitner (1878-1968)



**1878** Daughter of a Jewish lawyer in Vienna

**1905** Physics PhD on heat conduction

**1918** Worked on radioactivity with Otto Hahn

**1923** Discovered the Auger effect

**1926** Head of physics at KWI for Chemistry

**1935** transuranium research

**1938** Moved to Sweden after Anschluss

**1939** Explains nuclear fission (January *Nature*)

**1944** Otto Hahn wins Nobel Chemistry Prize

What are the 4 fundamental forces?

Gravity

Electromagnetic

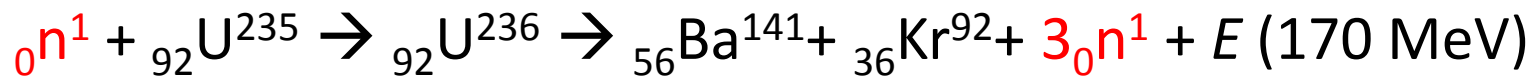
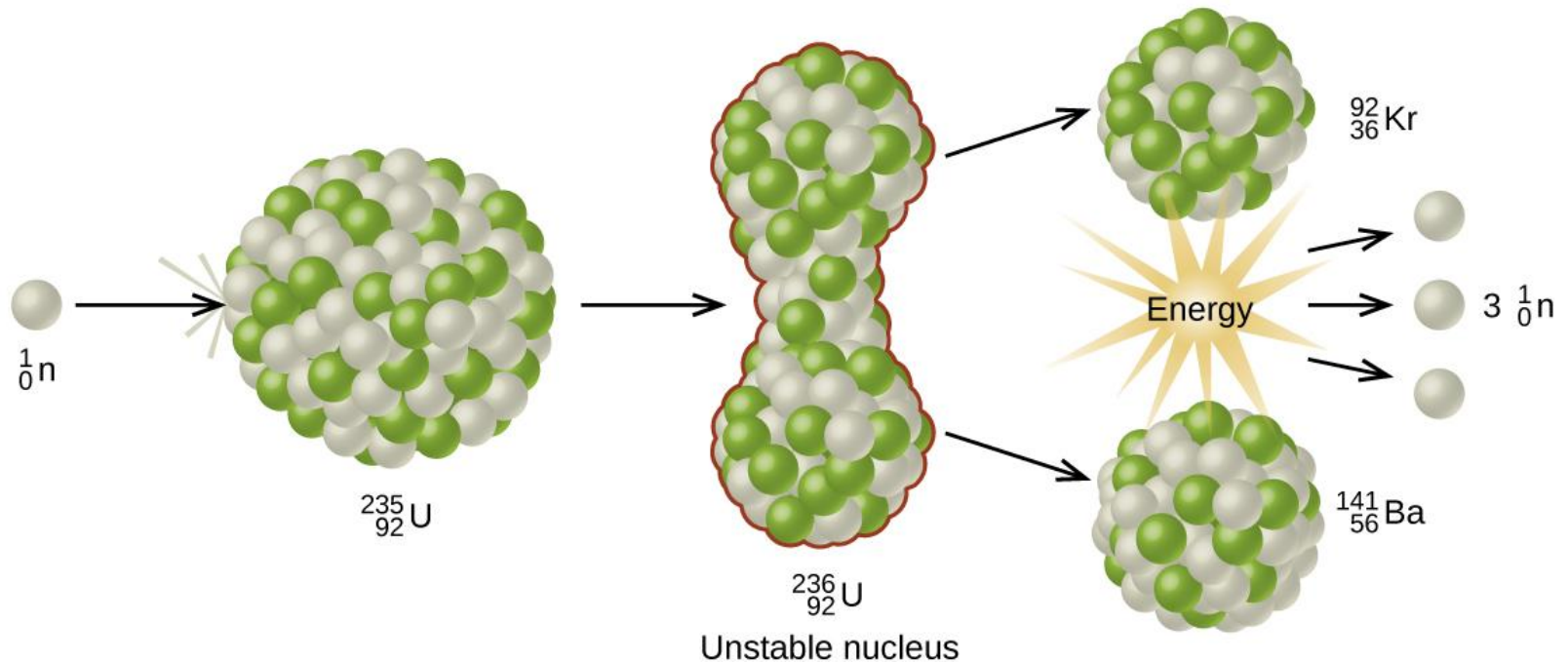
Weak nuclear

Strong nuclear

ALCHEMY

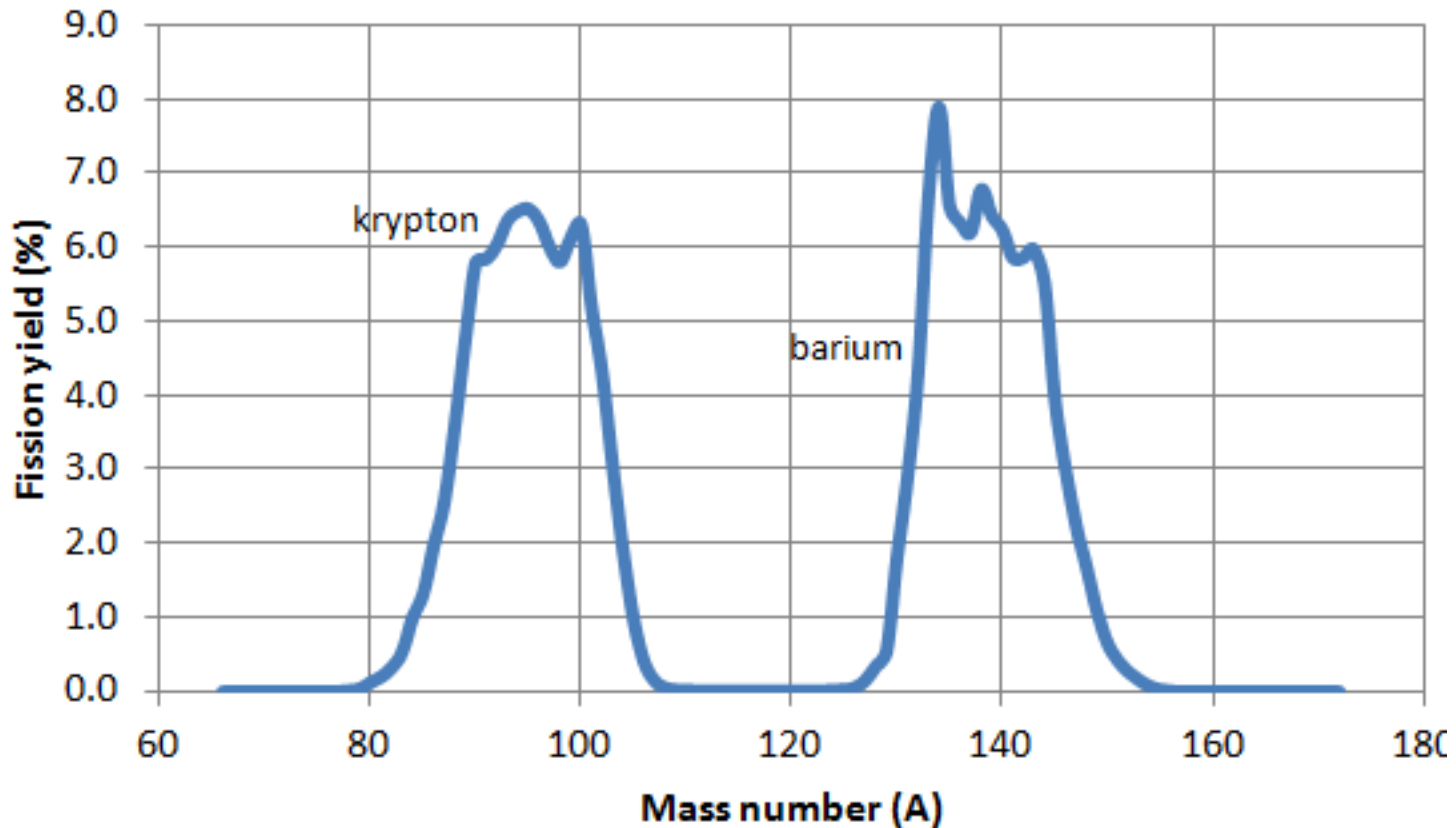


# Nuclear fission

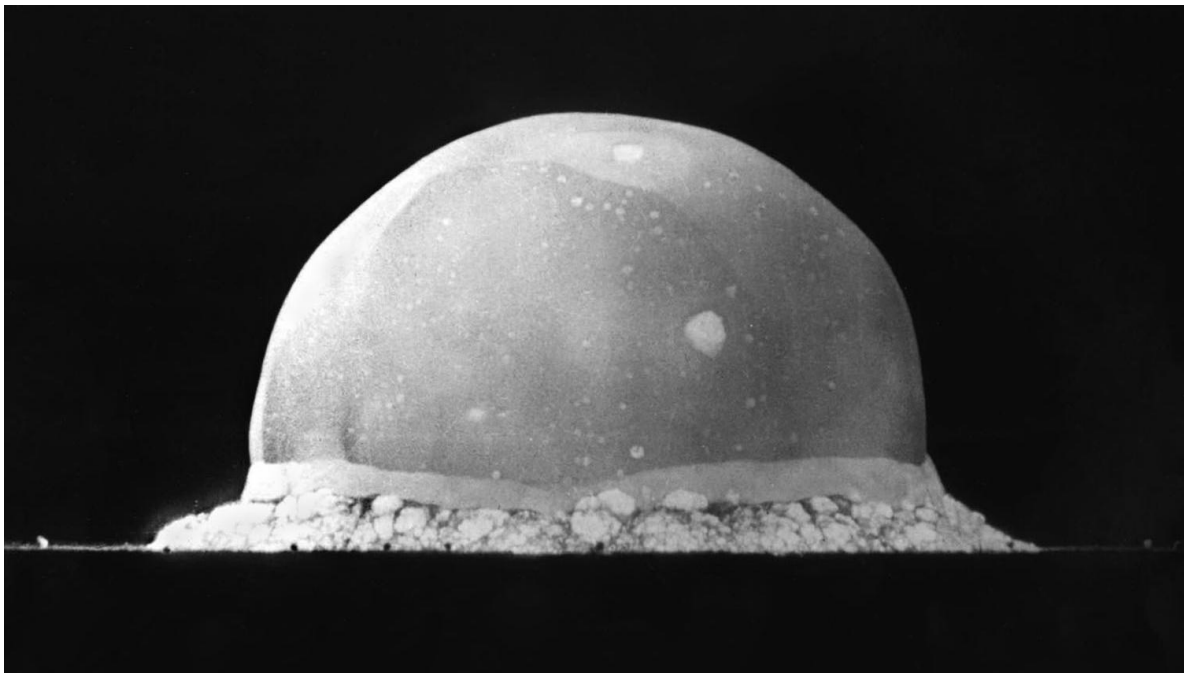


**200 million** times more energy in a nuclear reaction than a chemical reaction!

# Nuclear fission



“gradually the idea took shape that this was no chipping or cracking of the nucleus but rather a process to be explained by Bohr’s idea that the nucleus was like a **liquid drop**; such a liquid drop might elongate and divide itself.”



# Maria Goeppert Mayer (1906 -1972)



**1906** Daughter of a pediatrics professor in Katowice

**1930** PhD in physics at Göttingen

**1930** Marries American chemist Edward Mayer

**1939-** Isotope separation for the Manhattan Project

**1939-** two-photon absorption

**-1946** Johns Hopkins / Columbia / Chicago

**1948** MAGIC NUMBERS (2 8 20 28 50 82 114/126)

**1960** UCSD (La Jolla) professor

**1963** Wins Nobel Physics Prize (Wigner & Jensen)



# The nuclear shell model

*"It was like a jigsaw puzzle. I had many pieces (not only the "magic numbers"), so I could see a picture began to emerge. I felt that if I had only one more piece of the puzzle, everything would fall into place. I found the piece, and everything became clear."*



**Nobel prize in physics (1963)**

*for their discoveries concerning  
nuclear shell structure*

2 8 20 28 50 82 114/126

# CECILIA PAYNE-GAPOSCHKIN

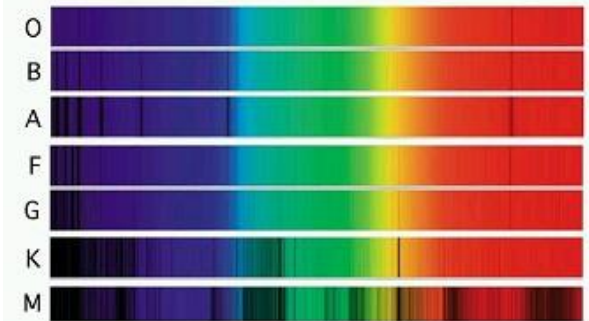
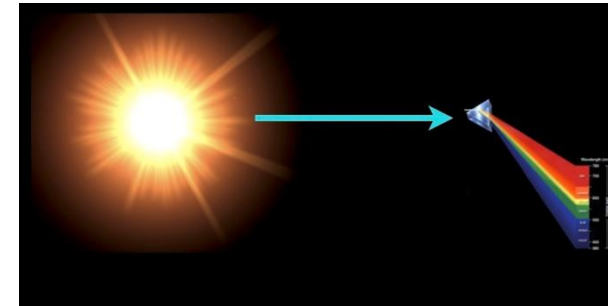
## THE WOMAN WHO DISCOVERED WHAT THE UNIVERSE IS MADE OF

In 1925, when astronomers believed stars to be made of heavy elements, a 25 year old student named Cecilia H. Payne wrote a revolutionary doctoral dissertation. She claimed that our Sun, all stars, and thus the universe itself, were composed mainly of hydrogen.

Henry Norris Russell, the leading contemporary expert on stellar spectra, dismissed the young woman's thesis as "impossible", but four years later published a paper *of his own* announcing the exact same conclusions.

While her name should be as well known as that of Galileo, Newton or Einstein, the patriarchal structure of institutional academia prevented her from achieving such status.

Today, all our science textbooks name hydrogen as the most abundant atom in the universe, but few acknowledge how we got to such an essential conclusion.

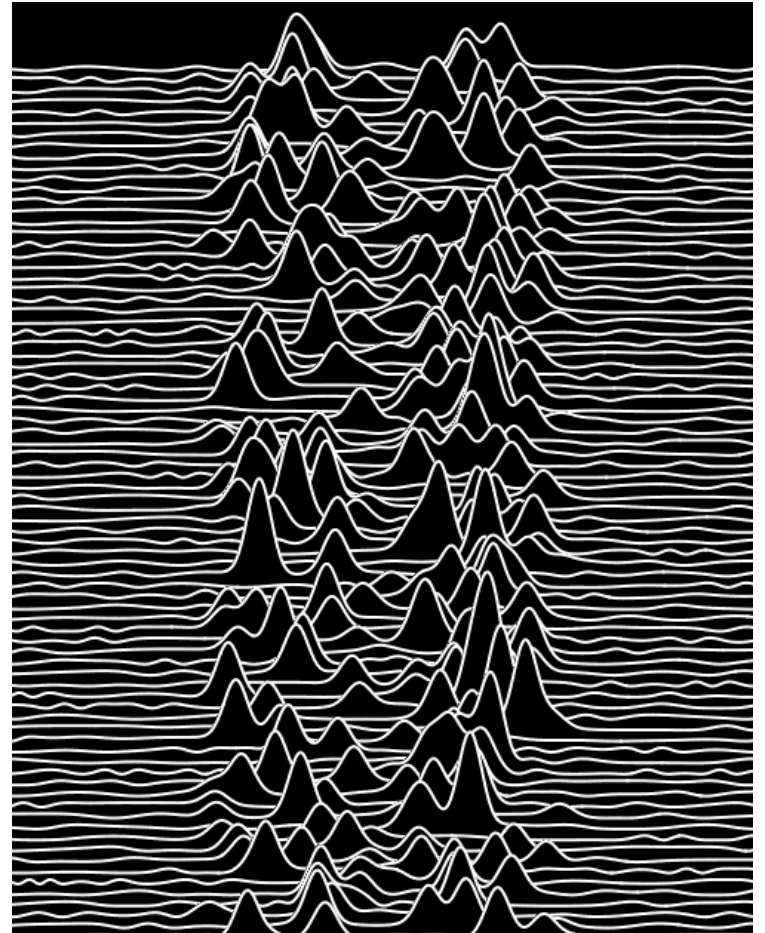


# Jocelyn Bell: pulsars

A pulsar is a highly magnetized, rotating neutron star or white dwarf, that emits a beam of electromagnetic radiation



**PSR B1919+21**

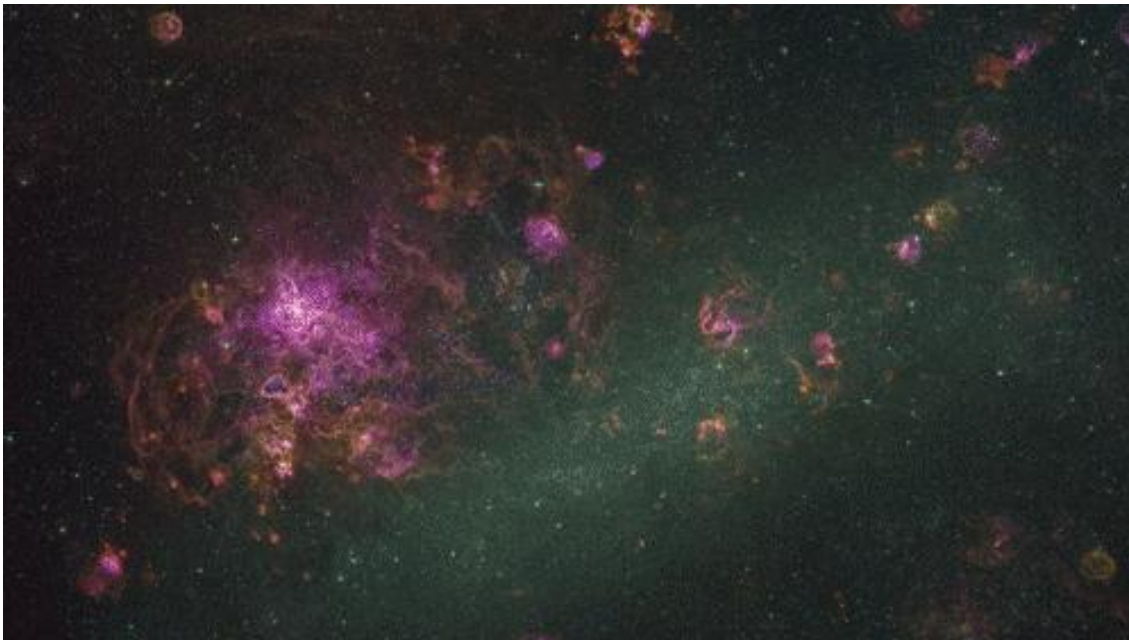






**PSR J1023+0038**

from radio to  
gamma radiation

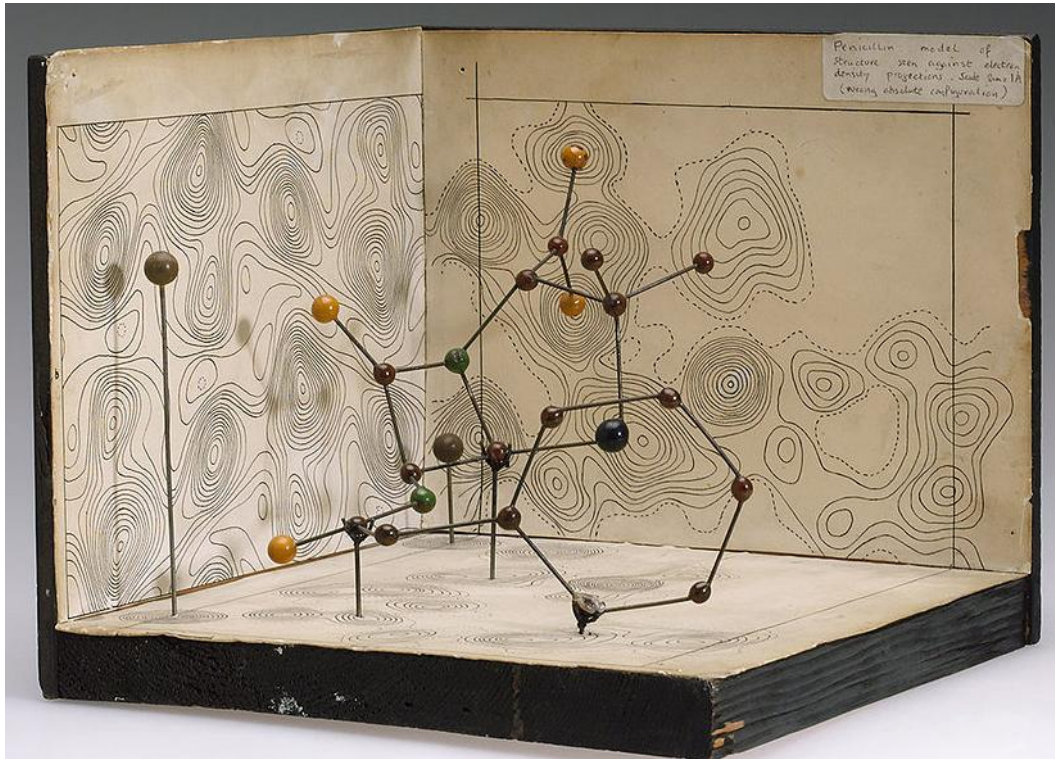


**PSR J0540-6919**

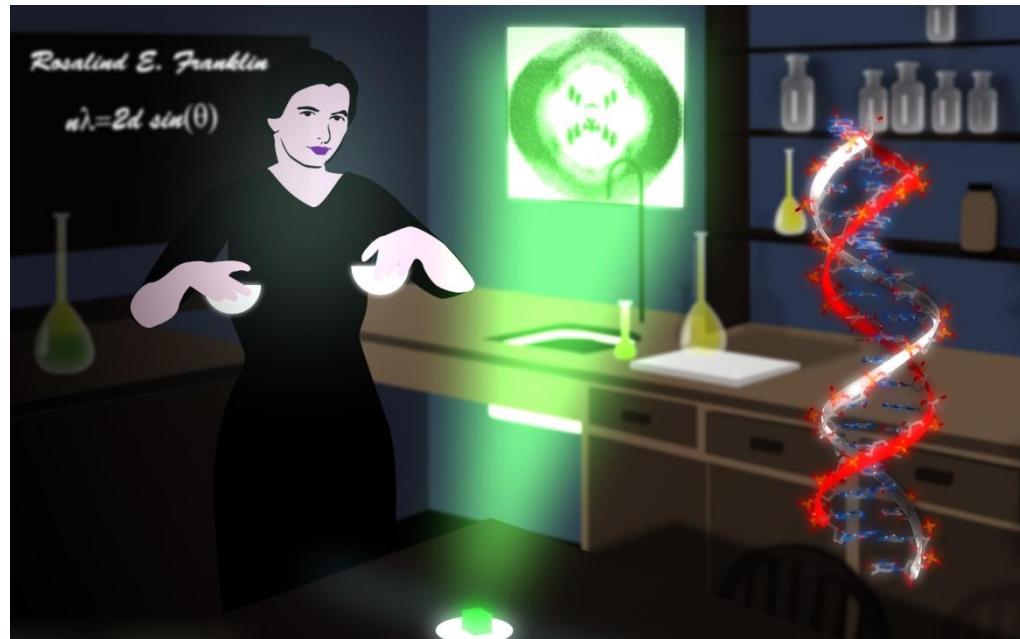
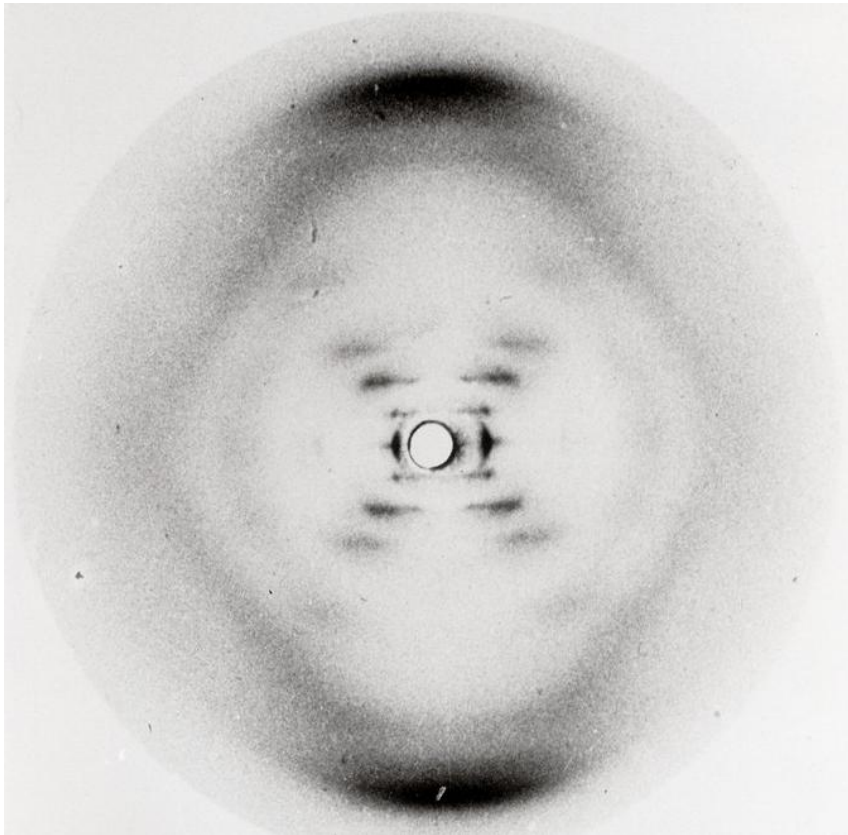
first gamma-ray pulsar  
beyond our own galaxy



# Science or Art?



# Science or Art?



# Women in Science



Marie Curie: The Courage of Knowledge



Lise Meitner: The Path to Nuclear Fission (PBS)



# Women in Science



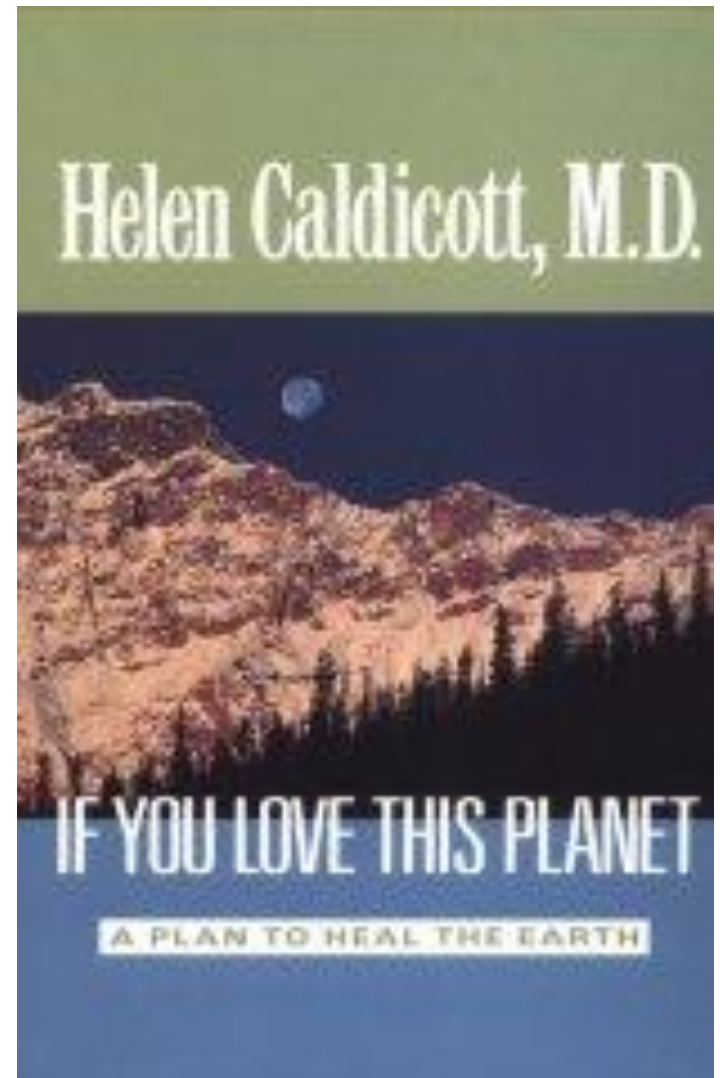
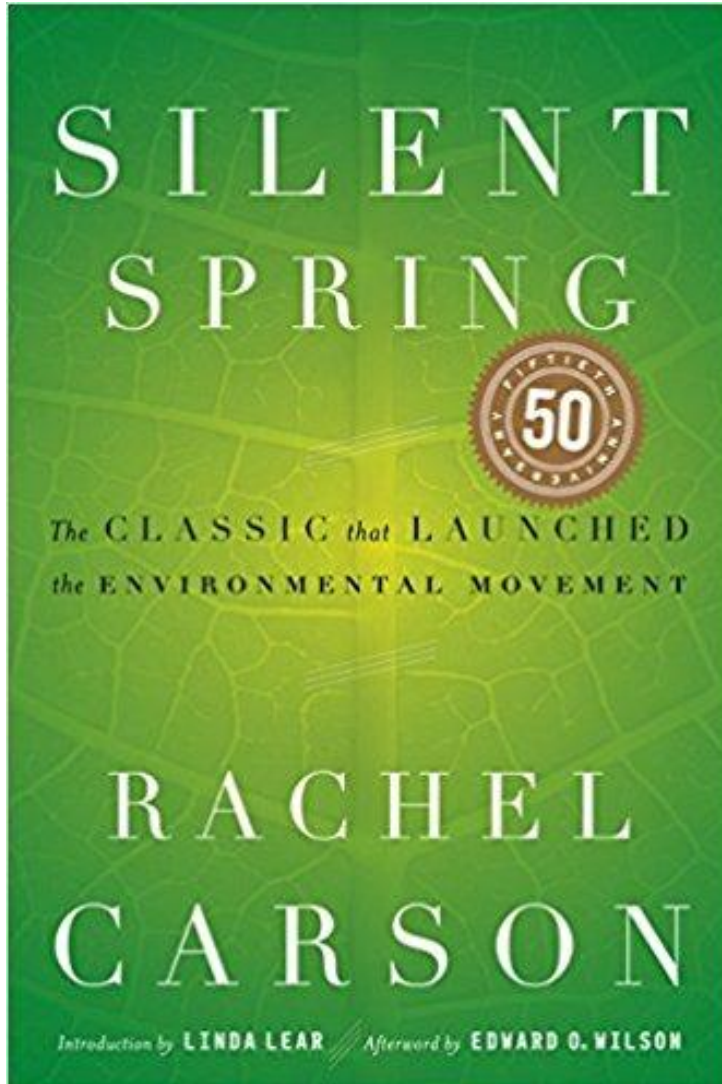
African-American women at NASA



Miss Goodall and the Wild Chimpanzees (NatGeo)



# Women in Science



# Proper representation?

## Nobel Prizes

Physics	2	48 women out of 880 Nobel laureates
Chemistry	4	
Medicine	12	
Literature	14	
Peace	16	

# *New Scientist* (May 2016)

More women in STEM than ever

Men still have better grant success

(~4% in biological, ~4% in physical, 2% medical sciences)

Decline in number of lead-authors in high-impact journals

Less pay, slower career advancement

## UK and Spanish numbers

Veterinarian science 77%

Anthropology 72%

Medical technology 69%

Microbiology 56%

Social sciences 60%

Engineering 26%

Architecture 26%

Chemistry/Physics ?

**A misogynistic culture?**

# The Periodic Table

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



# The Periodic Table

The Periodic Table

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	





# Women in Science



**"I WANT TO BE  
AN ENGINEER  
JUST LIKE MY  
MOM"**



Ontario  
Ministry of  
Labour

Western Region  
400 University Ave.  
Toronto, Ontario  
M5G 1Y7  
Telephone (416) 965-1001

Northern Office  
400 University Ave.  
Toronto, Ont. Ontario  
M5G 1Y7  
Telephone (416) 975-1001



**What it is  
is beautiful.**

**I WANT TO BE  
AN ENGINEER  
JUST LIKE MY MOM**

# جدول تناوبی عناصر

1	H	2	He	3	Li	4	Be	5	B	6	C	7	N	8	O	9	F	10	Ne																																												
11	Na	12	Mg	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar																																																
19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																												
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe																												
55	Cs	56	Ba	57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
87	Fr	88	Ra	89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Mn	102	Sg	103	Bh	104	Hs	105	Ds																										





ATRES  
PLAYER

#A3Boom

1.700

4.700

1:08:49

1.700€

ROSALIND FRANKLIN FUE UNA CIENTÍFICA BRITÁNICA  
QUE DESTACÓ EN EL CAMPO DE...

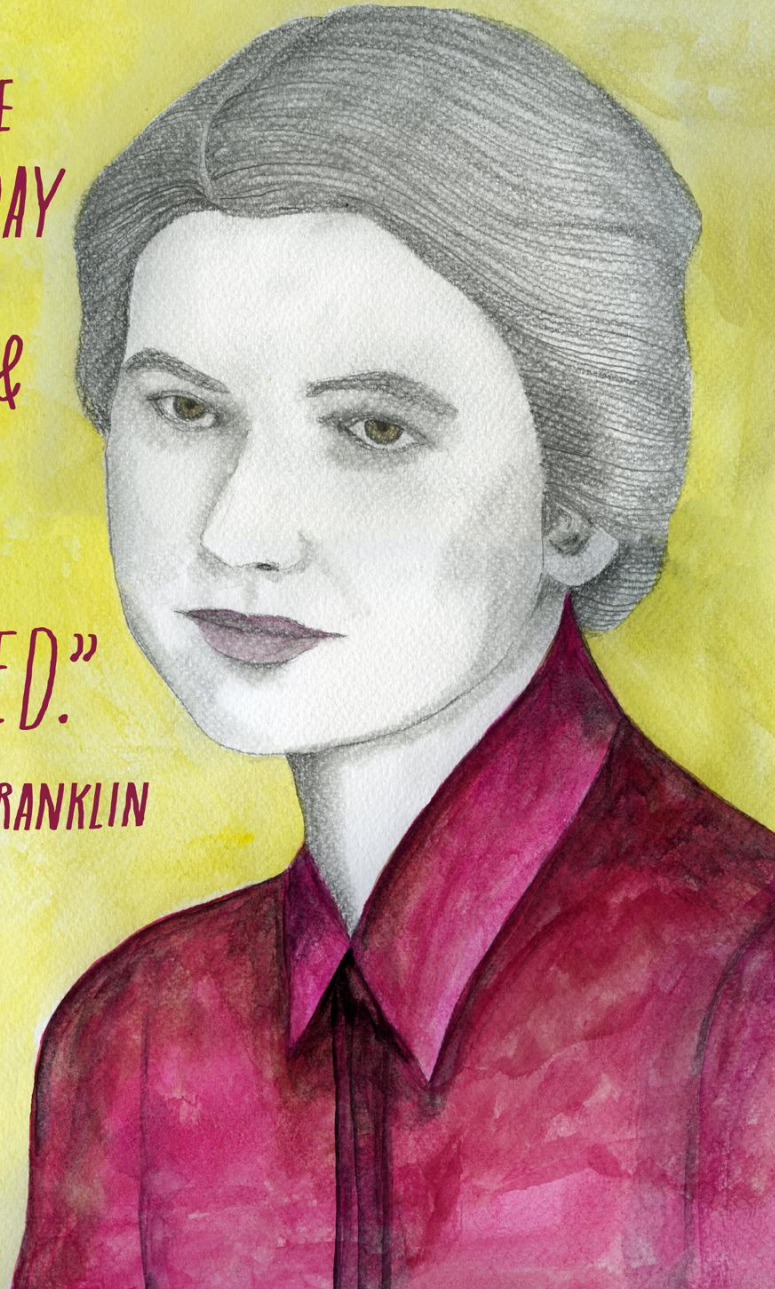
LA BIOLOGÍA

LAS MATEMÁTICAS

DIEGO

“SCIENCE  
& EVERYDAY  
LIFE  
CANNOT &  
SHOULD  
NOT BE  
SEPARATED.”

ROSALIND FRANKLIN





Nothing in life is  
to be feared, it is  
only to be  
understood.

– Marie Curie

