



CIENCIA EX AEQUO

CIMADEVILA

International Conference on Women in Physics

Wilfrid Laurier University,

Waterloo, Canada

2014

CIENCIA EX AEQUO

an exhibition of paintings on

WOMEN in SCIENCE

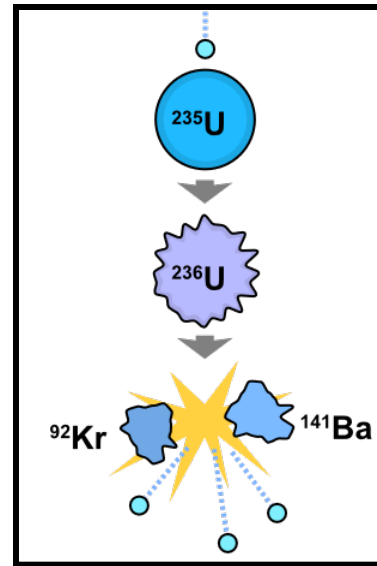




LISE MEITNER. Physicist. Austria(1878-1968)

She made the calculations leading to the discovery of **nuclear fission**. It was only her collaborator, who never mentioned her in his report to the Academy, who received the Nobel Prize for the discovery.

Nuclear fission happens when the nucleus of an atom splits into two or more smaller nuclei. The process releases a great amount of energy, but it is very difficult to control and the resulting products are highly radioactive.



Nuclear fission of Uranium 235 provoking Krypton, Bario, 3 neutrons and ENERGY.



LISE MEITNER. Nuclear fission



1s² 2s² p⁶ 3s² p⁶ d¹⁰ 4s² p⁶ d¹⁰ f¹⁴ 5s² p⁶ d⁵ 6s²

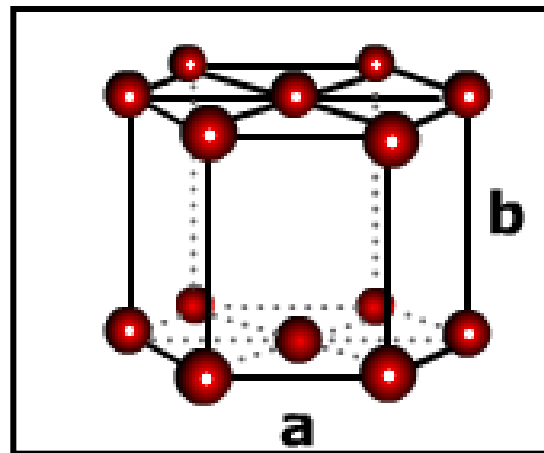
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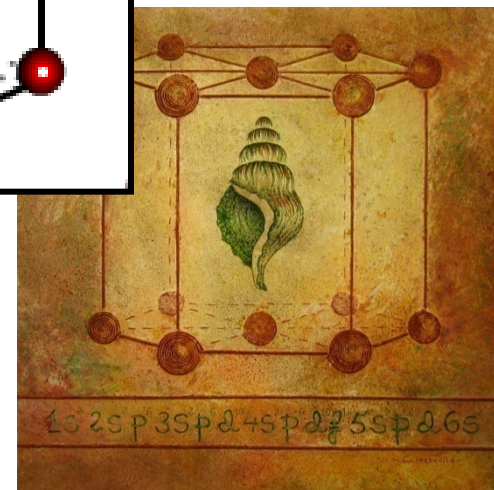
IDA TACKE. Chemist. Germany (1896-1978)

On her own, she discovered **Masurium**, now called Technetium, and together with her husband she discovered **Rhenium**. She put forward the existence of nuclear fission. She was nominated for the Nobel Prize on three occasions but she never got it.

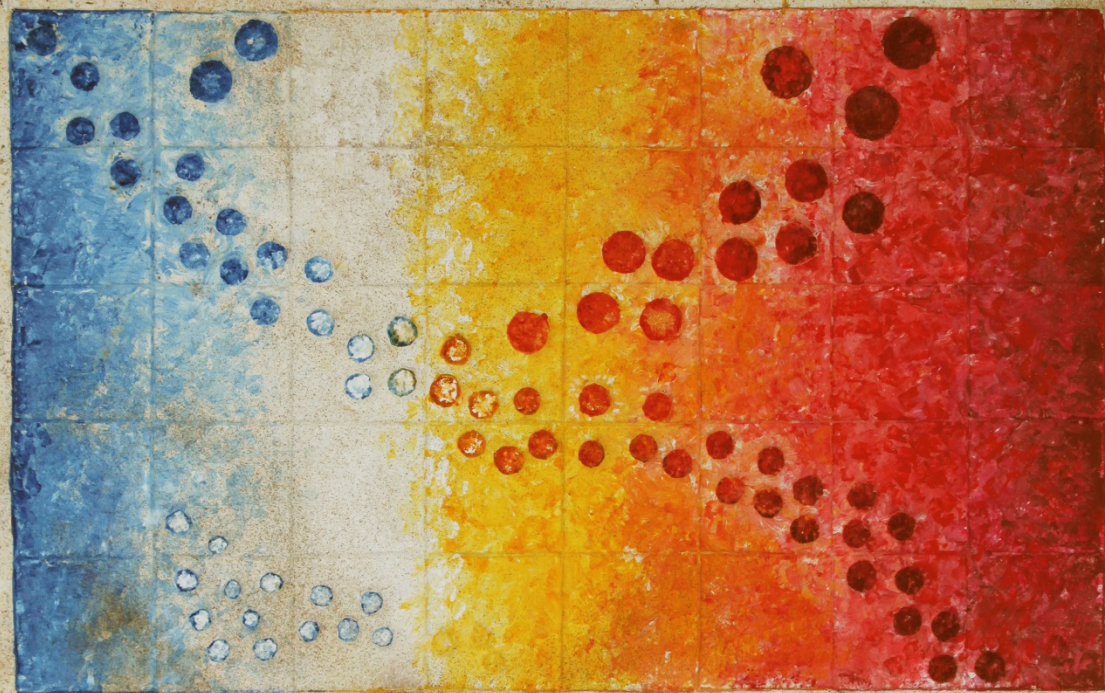
Rhenium is a rare, expensive silver white metal, very dense and with a high point of fusion. Its main use is as a catalyst and it is also used in thermo-elements and in switches. Its name comes from “Rhenus”, the Latin name of the Rhine.



Crystalline structure of Rhenium



IDA TACKE. Rhenium



O B A F G K M A C

estrellas, clases espectrales

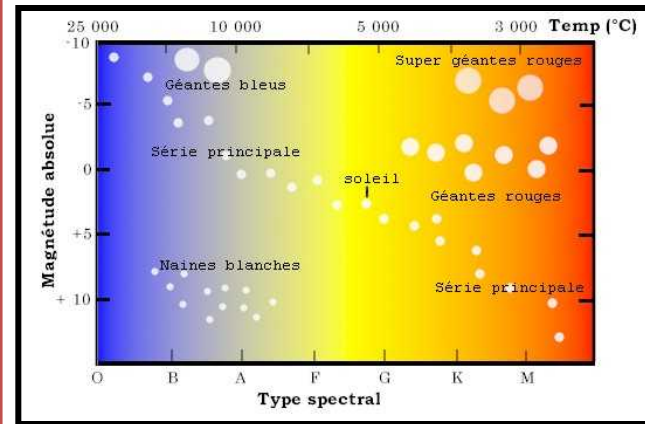
— C. IMDEVILLA —



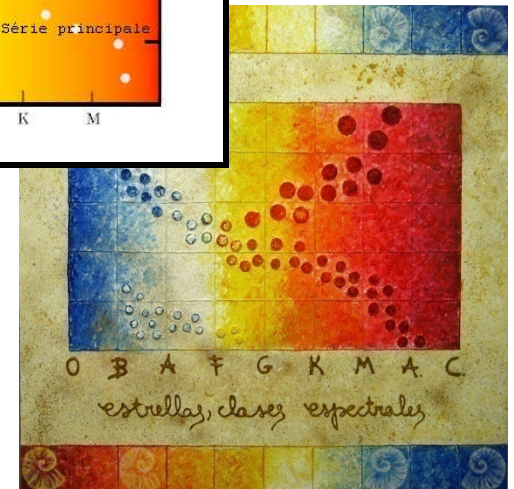
ANNIE CANNON. Astronomer. USA (1863-1941)

At the beginning of the 20th century, only women worked at the Harvard College Observatory because it was cheaper labour. Annie Cannon, continuing the work of other astronomers, catalogued thousands of stars compiled in a nine-volume catalogue in which does not even appear.

Annie Cannon developed a system of **classification of stars through spectral types** following the sequence OBAFGKM that was adopted as standard in the 1910 meeting of the International Astronomic Union.



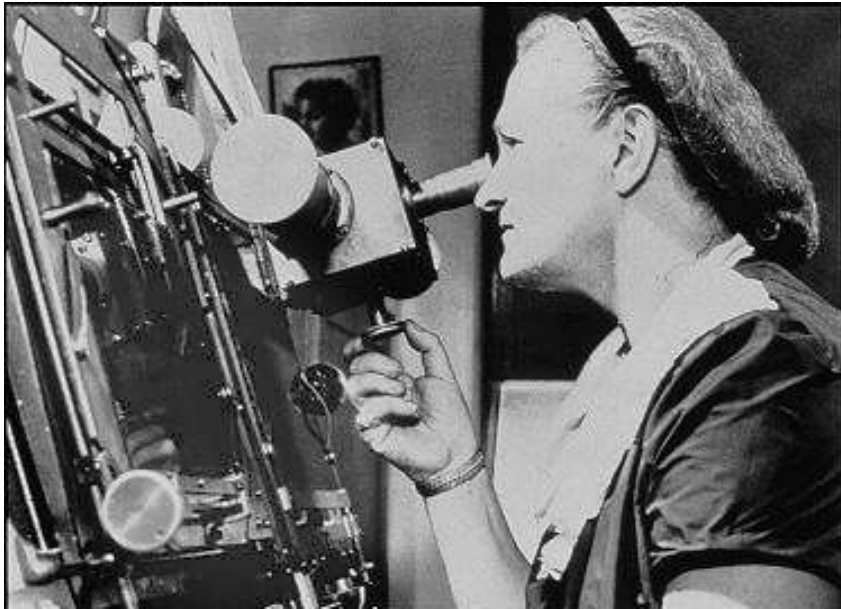
Classification of stars through spectral types



ANNIE CANNON. Stars spectral types



- CIMADEVILA



CECILIA PAYNE. Astrónoma. England (1900-1979)

In 1925, she put forward the theory that **stars were mainly composed of Hydrogen and Helium**. Astronomers at that time never took her theories into account until, four years after, one of them reached the same conclusions.

Nuclear fusion is the process that takes place in the sun and the stars. It is a chemical reaction in which atoms of hydrogen combine themselves to form helium and energy. The source of energy thus generated is clean and endless.

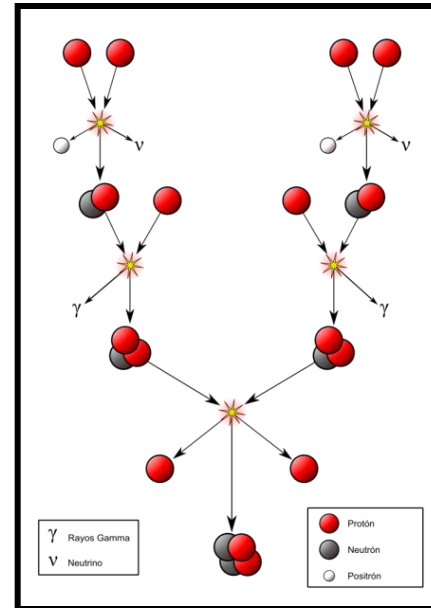
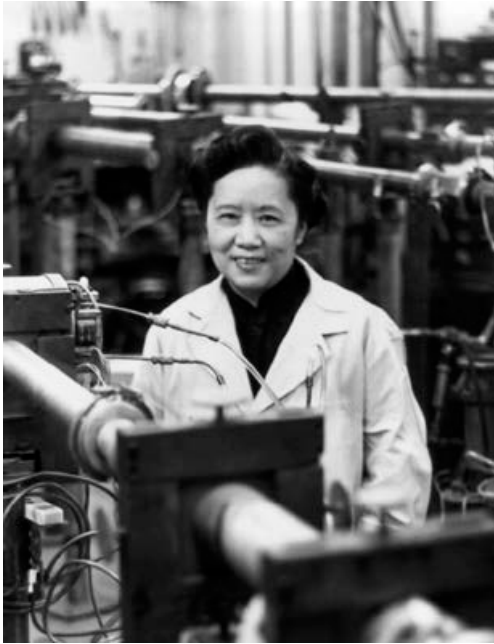


Diagram of nuclear fusion



CECILIA PAYNE. Stars of Hydrogen and Helium





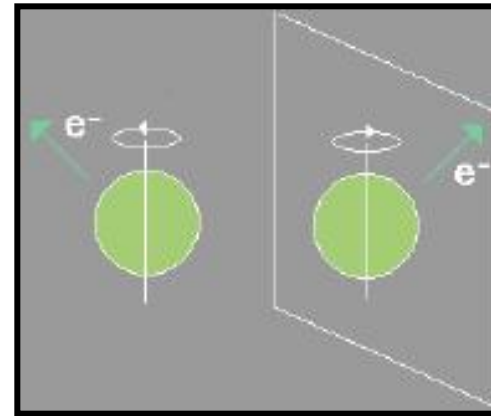
CHIEN-SHIUNG WU. Physicist. USA (1912-1997)

In 1957, Chien-Shiung Wu **proved experimentally that nature discerns between right and left** (no conservation of parity).
In spite of the fact she was the one to prove it, only the scientists who put forward the theory were awarded the Nobel Prize in 1957.

The experiment of Wu.

The radioactive atom of cobalt 60 emits an electron, the emission could be in the direction that the nucleus turns or in the opposite direction.

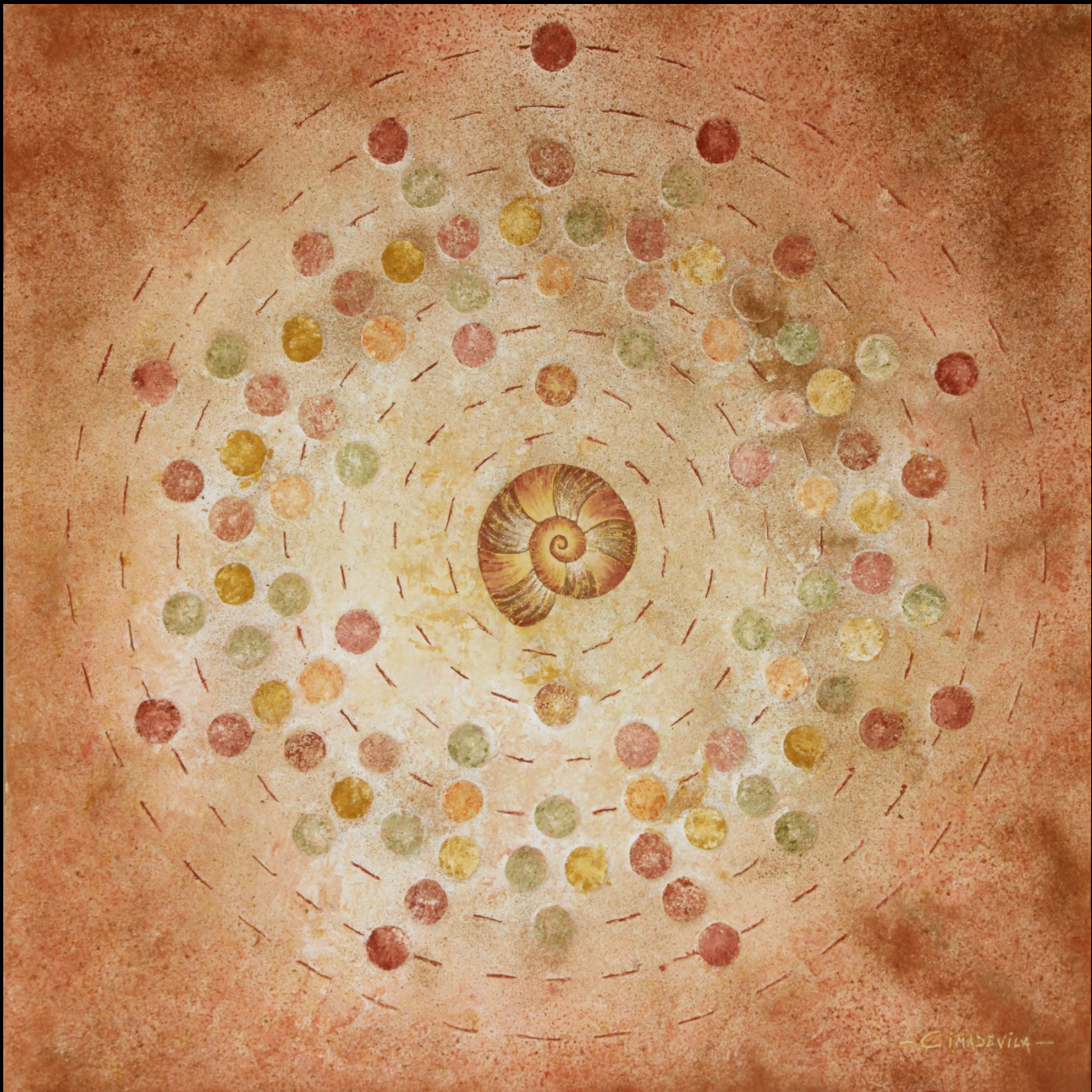
Wu proved the priority of the emission of the electron in the opposite direction to the turning and that both possibilities did not happen at 50% as it was believed up to then.



Conservation of parity



CHIEN-SHIUNG WU. No conservation of parity

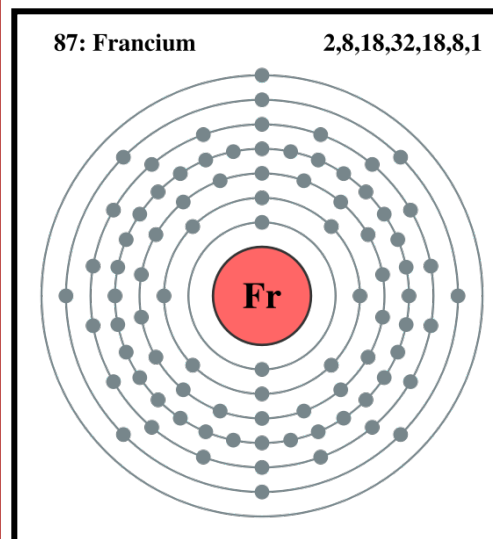




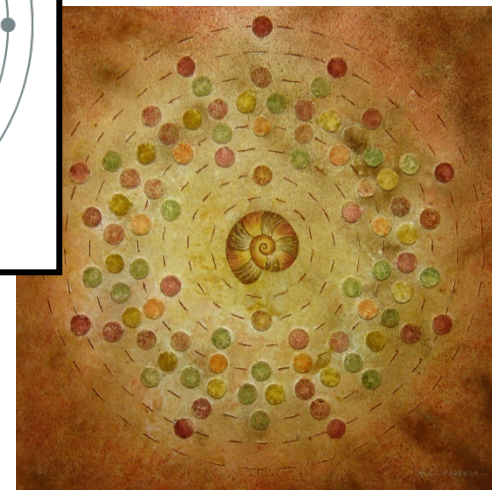
MARGUERITE PEREY
Chemist, Physicist, Biologist. France (1909-1975)

Chemical element 87 had been looked for since 1925. It was Marguerite Perey who discovered it in 1939, although she had to struggle hard to be recognized as the only author of the discovery which another scientist claimed.

Francium, atomic number 87, the number of its protons and electrons, is a natural radioactive chemical element named after the country it was discovered in. It is the most electropositive metal that exists and it has not got any known use apart from scientific research.



Francium has got 87 electrons in its shell



MARGUERITE PEREY. Francium



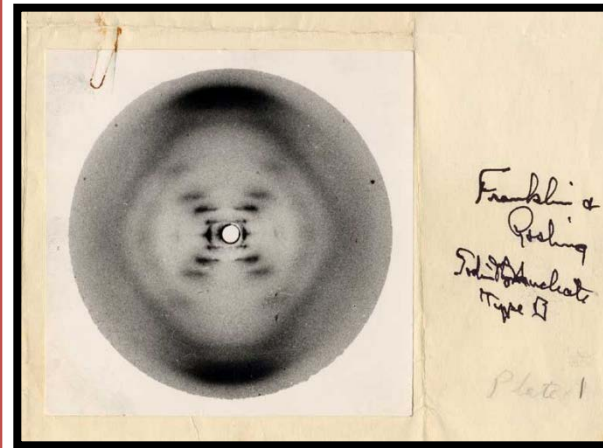
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ROSALIND FRANKLIN. Biochemist. England (1920-1958)

In the early 1950s she took the so called photograph 51 which unmistakably revealed the **helicoidal structure of DNA**. The awarding of the Nobel Prize to three scientists in 1958 without mentioning Rosalind Franklin has been very much questioned.

Considered to be the most important medical achievement in the 20th century, the model of the double helix of **DNA** opened the door to the understanding of molecular Biology and genetic functions that have allowed the establishing of the complete sequence of human genome.



Photograph 51



ROSALIND FRANKLIN. ADN, photograph 51



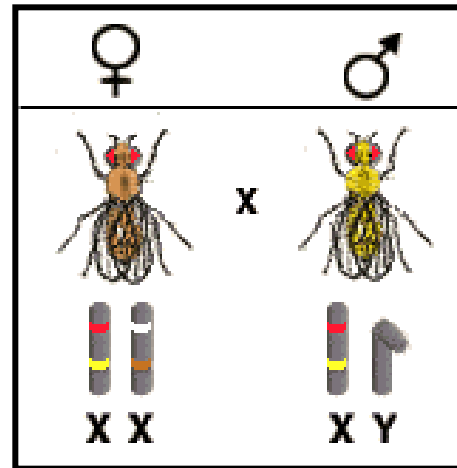
CIMDEVILA



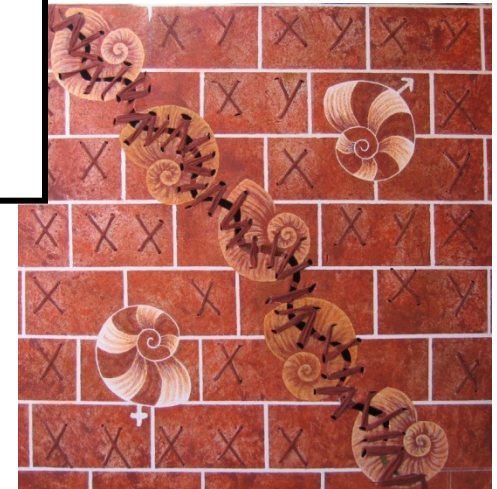
NETTIE STEVENS. Genetist. USA(1861-1912)

In 1905, she discovered that **chromosomes X, Y were responsible for the determination of sex**. Almost simultaneously, a highly reputed scientist published the same thing. Despite the fact that they both carried out a similar research, with the course of time the credit was only given to him, keeping her in an unfair oblivion and a painful second place.

Sexual chromosomes are one of the 23 pairs of human chromosomes. Each person has got a pair of sexual chromosomes in each cell. Women have two X chromosomes while men have one X chromosome and one Y chromosome.



Sex and chromosomes X, Y



NETTIE STEVENS. Chromosomes and sex



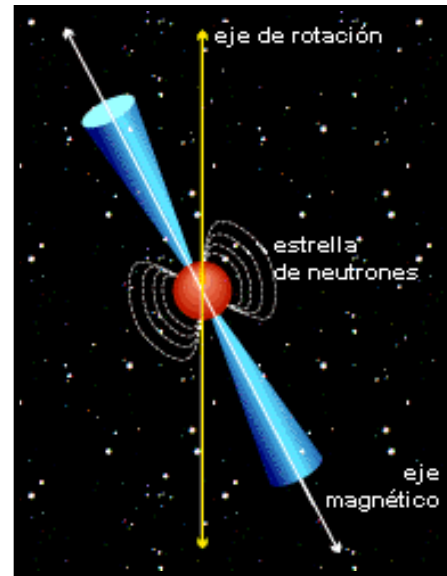
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JOCELYN BELL. Astrophysicist. Ireland.1943

While doing her doctoral thesis, she discovered the so-called **pulsars**. The director of her research project received for this reason the Nobel Prize in 1974. She was not even mentioned.

Pulsars are small stars of neutrons that, due to their high density and fast rotation, project beams of radiation through their magnetic poles. They emit light in a similar way to a lighthouse because the magnetic axis does not coincide with the axis of turning.



JOCELYN BELL. Pulsars



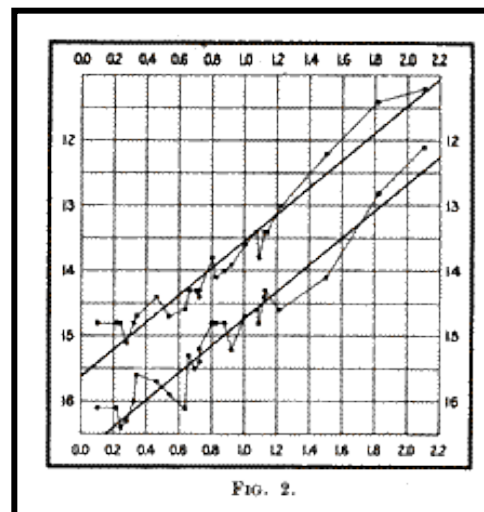
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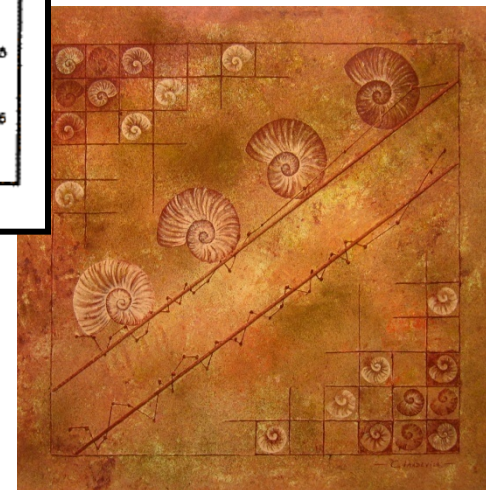
HENRIETTA LEAVITT. Astronomer. USA (1861-1921)

Her research on stars that change their brightness, variable, led her to give the first crucial step to determine **distances between galaxies and to establish dimensions in the Universe**. She was posthumously nominated for the Nobel Prize.

In 1908, Leavitt published a study, signed by her superior, in which she explained that cepheid variable stars palpitated with a regular rythm and had a higher intrinsic brightness the longer their period was.



Relationship between the logarithm of the period and brightness in cepheid variable stars



HENRIETTA LEAVITT. Period/ brightness in variable stars



- C. IMÁDEVILA -



EMMY NOETHER. Mathematician. Germany (1882-1935)

Although her fundamental field of study was algebra, she also worked on relativity. Her genius was recognized by the mathematical community of her time and her talent was praised, but she never received a decent wage and a great part of her work appeared in publications by her male colleagues and pupils.

If when acting upon a system this does not change, it is said to have symmetry. Thus, Noether's theorem proves that every symmetry in Physics implies a law of conservation. It was fundamental for the development of modern Physics.

Particular case of Noether's theorem

$$\frac{d}{dt} \left(L - \sum_{j=1}^n \frac{\partial L}{\partial \dot{q}_j} \dot{q}_j \right) = 0 \Rightarrow \frac{d}{dt} H = 0$$

The homogeneity in time, time passes and nothing changes, it involves the theorem of conservation of energy



EMMY NOETHER. Noether's theorem

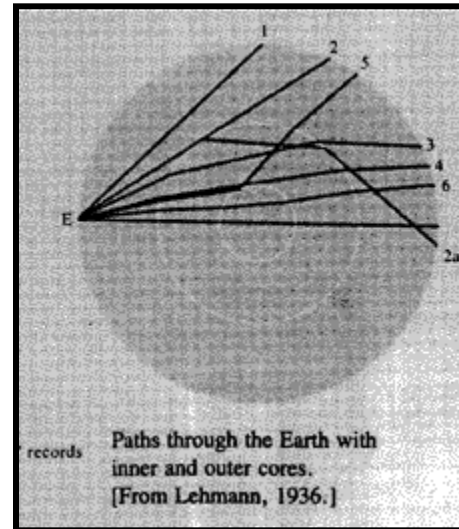




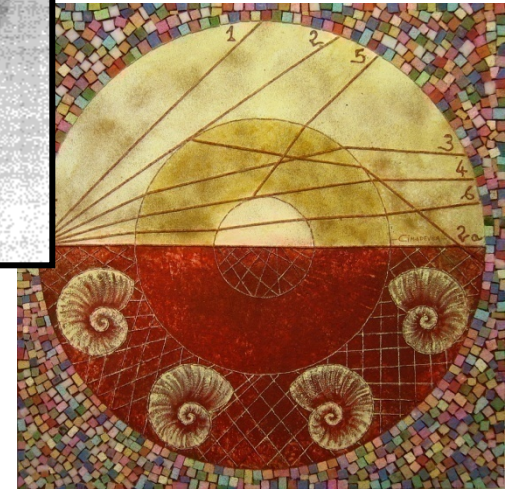
INGE LEHMANN. Seismologist. Denmark (1888-1993)

In 1936 she discovered the existence of the inner core and, in 1945 the area of separation between the solid and liquid core called **discontinuity of Lehmann**. She was a pioneer scientist and a recognized seismologist.

The inner part of our planet is formed by a liquid core which has inside a solid part called **inner core of the Earth**.



The deviation of P waves inside the Earth revealed the existence of a rigid inner core within the liquid core



INGE LEHMANN. Inner core of the Earth

Information



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