

The X-Ray diffraction and the discovery of the structure of DNA

By Gaia Marana

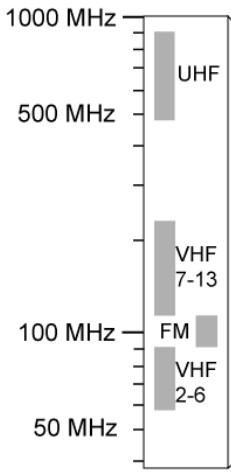
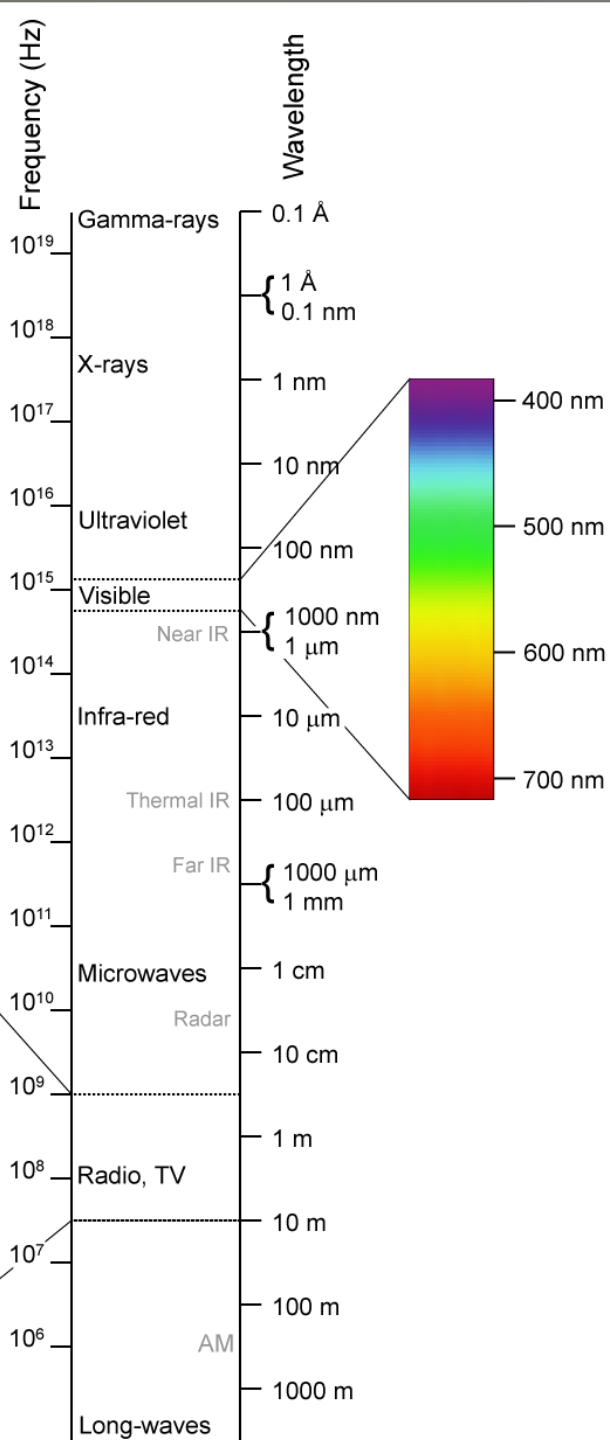




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Electromagnetic Spectrum

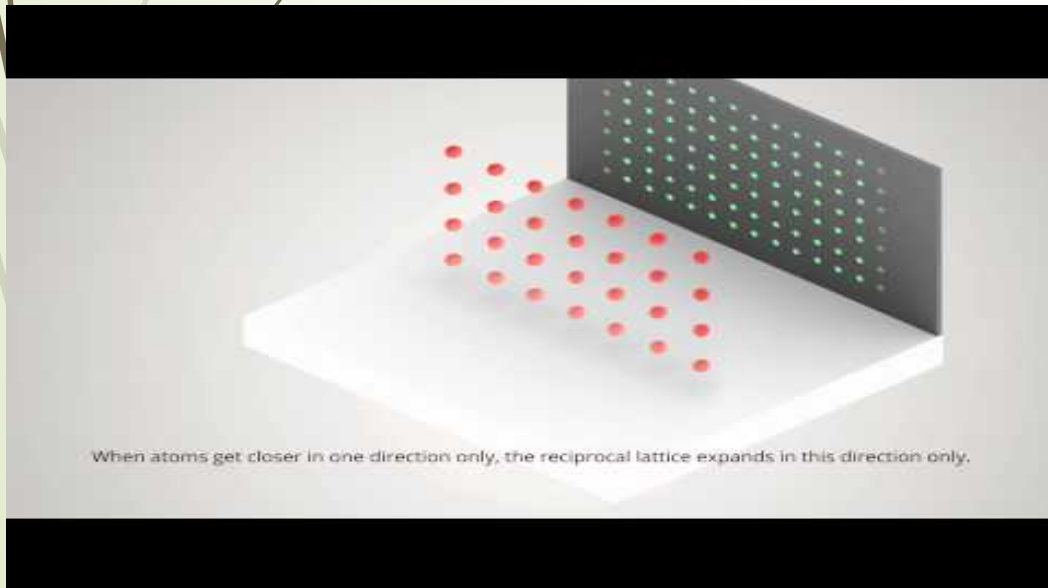


What are the X-Rays

- X-rays are types of **electromagnetic radiation**, mostly known for their ability to see through people's skin.
- X-Rays are roughly classified into **soft X-rays** and **hard X-rays**. The first one have relatively short wavelengths of about 10 nanometers; while the second one have wavelengths of about 100 picometers.
- These electromagnetic waves **occupy the same region of the EM spectrum as gamma-rays**. The only difference between them is their source: X-rays are produced by accelerating electrons, whereas gamma-rays are produced by atomic nuclei, in one of four nuclear reactions.
- X-rays have a **similar nature to visible light rays**, but have a much shorter wavelength.

How does the X-Ray diffraction works:

The X-Ray diffraction or X-Ray crystallography is a **scientific method for the determination of the precise positions of atoms** in a lattice where beams of X-ray strikes a crystal and causes the beam of light to diffract into many specific directions. This particular phenomenon was discovered by **Wilhelm Röntgen** in **1895**.



- After the discovery of the diffraction of X-rays by crystals, in 1912 **William H. Bragg** and his son, **William L.**, derived the **Bragg's law**, which relates the wavelength of X rays to the glancing angle of reflection.

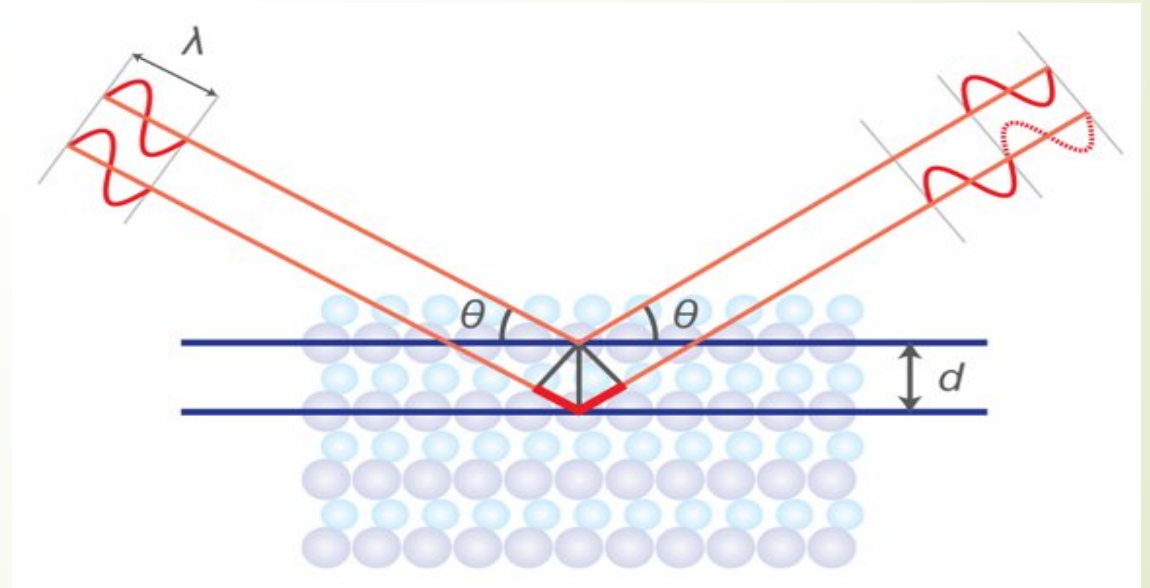
$$n\lambda = 2d \cdot \sin\theta$$

n = integer determined by the order given;

λ = wavelength of x-rays;

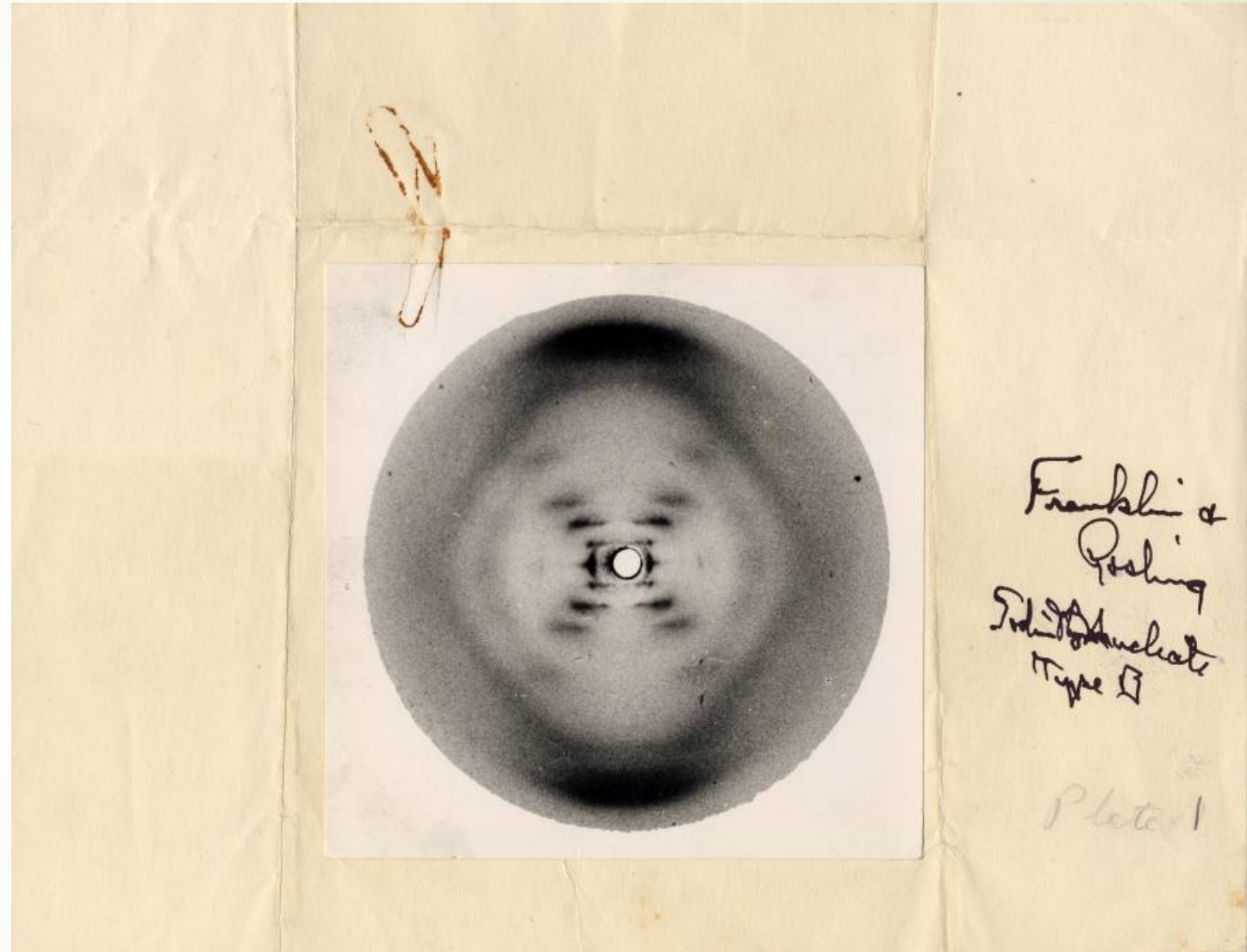
d = space between the planes in the atomic lattice;

θ = angle between the incident ray and the scattering planes.



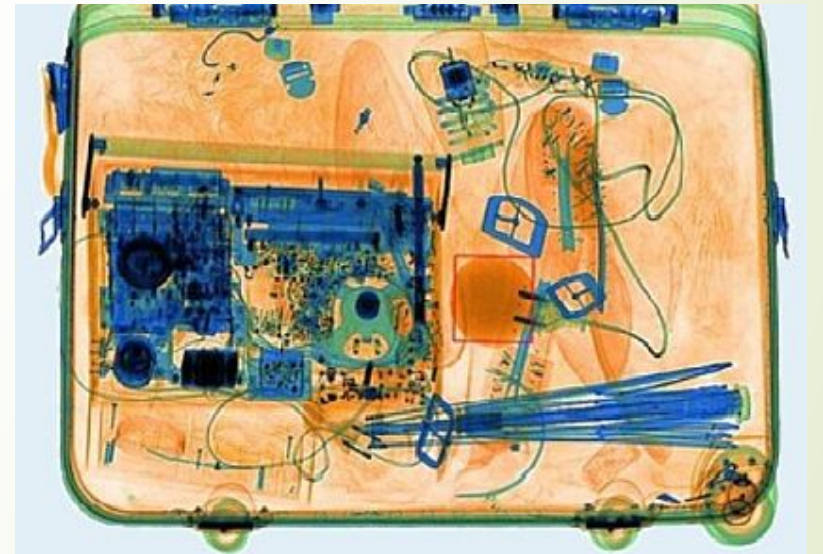
The discovery of the structure of DNA

- The most famous use of the X-Ray crystallography was for the **study of the structure of DNA** which unlocked the door to understanding many aspects of DNA's function.
- The X-Ray diffraction was used firstly for the study of **myoglobin** and then it was a woman called **Rosalind Franklin** and **Raymond Gosling** to use this method for the determination of DNA's structure. With the help of **Maurice Wilkins** (who prepare DNA samples in a perfect parallel regularity), Rosalind managed to take the picture who helped **J. Watson** and **F. Crick**. to understand the structure of DNA and, sequently, won the Nobel Prize in Medicine in 1962.



Modern application of X-Rays:

- ▶ **MEDICINE:** X rays are widely used for diagnostic purposes like the observation of the broken bones and torn ligaments moreover lately researcher started to study x-ray to understand if there is the possibility to kill tumoral and cancer cells.
- ▶ **SECURITY:** The science of X-rays in security systems makes possible to see into the passengers' luggage, and ascertain the presence of dangerous or forbidden objects.





Sitography:

- <https://www.livescience.com/32344-what-are-x-rays.html>
- https://www.leeds.ac.uk/heritage/Astbury/X_ray_diffraction/index.html
- <https://www.youtube.com/watch?v=DFFU39A3fPY>
- <http://scarc.library.oregonstate.edu/coll/pauling/dna/pictures/sci9.001.5-large.html>
- http://www.chem.ucla.edu/~harding/ec_tutorials/tutorial73.pdf
- [https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_\(Materials_Science\)/Electronic_Properties/X-ray_diffraction%2C_Bragg's_law_and_Laue_equation](https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/X-ray_diffraction%2C_Bragg's_law_and_Laue_equation)
- <https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-discovery-and-structure-of-dna/a/discovery-of-the-structure-of-dna>
- <http://ebook.scuola.zanichelli.it/sadavabiologia/section-4/il-contributo-di-franklin-e-wilkins-fu-decisivo-per-la-scoperta-della-struttura-del-dna>
- <https://www.gilardoni.it/en/security/x-ray-solutions/>
- <http://science.jrank.org/pages/7433/X-Rays-Applications-x-rays.html>
- <https://ntbxray.com/application/application.html>
- *FISICA Modelli teorici e problem solving 2*, James S. Walker, Linx, Pearson