Crystals and X-rays : made for each other!

Laboratory of Wilhelm Conrad Röntgen.
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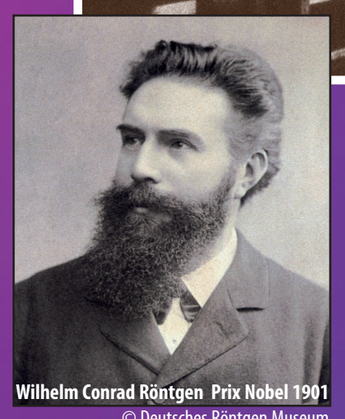

Wilhelm Conrad Röntgen Prix Nobel 1901
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1912, a breakthrough in Crystallography

Insight into the internal structure of crystals initially grew out of using crystals to understand what X-rays were; *insight often comes in unexpected ways!*.

X-rays …

In 1895, **Röntgen** discovered a new type of radiation but was unable to determine its precise nature. In the end, he gave up and called them X-rays. Invisible and able to pass through solid matter, these rays were studied by scientists from Australia, Britain, Germany and other countries who used crystals to understand their properties.

In 1912, **von Laue, Friedrich & Knipping** exposed a crystal to X-rays and evidenced that X-rays are waves with very short wavelengths. The experiment, now called **"diffraction"**, was initially carried out in order to understand the nature of the radiation; instead, its real importance was to reveal the regular order and symmetry of the crystals themselves. This led to the extraordinary possibility of determining the internal atomic arrangement of all crystals.

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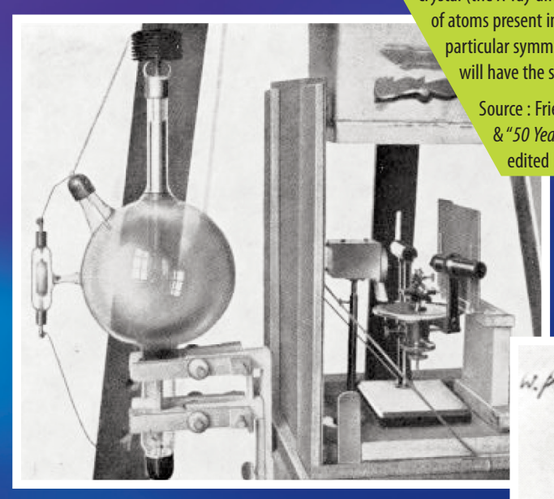
to explore the structure of crystals

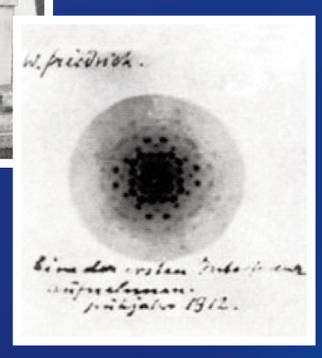
William Lawrence Bragg and his father**, William Henry Bragg**, realized that X-rays could be used to understand crystals, to "see" their inner structure and thus developed the new science of X-ray crystallography. W.L. Bragg is famous for his law on the diffraction of X-rays by crystals, made during his first year as a research student in 1912. The "diffraction" of X-rays thus changed from the status of being a physical phenomenon to that of a tool for exploring the arrangement of the atoms in crystals.

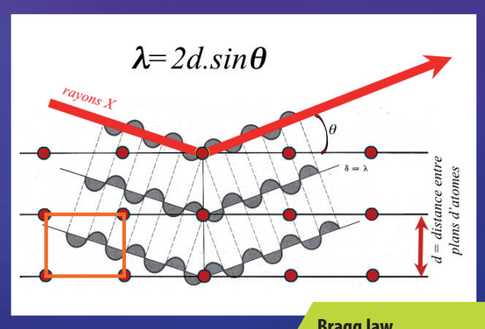
X-rays allow us to "look inside crystals", this discovery led to an intense period of research. Most of these pioneer scientists received Nobel prizes.

Max von Laue Prix Nobel 1914

X-ray diffraction pattern
obtained in April 1912 by **Friedrich & Knipping,** from a crystal of sphalerite ZnS, using a home-made device. The spots are due to a deviation and a division of the X-ray beam by the crystal (the X-ray diffraction by the periodic regular array of atoms present in the crystal). If the crystal has a particular symmetry then the diffraction pattern will have the same symmetry.
Source : Friedrich & Knipping & "*50 Years of X-ray Diffraction*", edited by P. P. Ewald

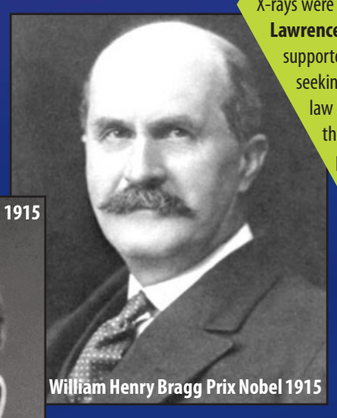




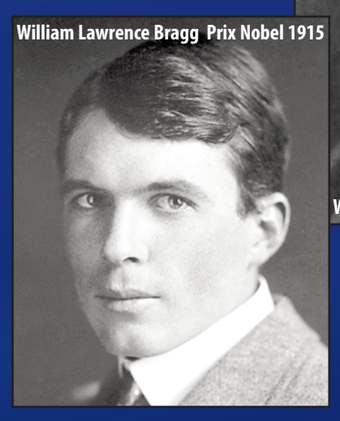


Bragg law
Source : «Voyage dans le Cristal»

William Henry Bragg, professor of physics, believed that X-rays were particles similar to electrons, but carrying no electric charge. But from the results of Laue, he understood that this experiment showed X-rays were behaving like a wave, like light. His son, **William Lawrence Bragg**, then aged 22, was an unconditional supporter of the view taken by his father and in seeking to prove this point he formulated Bragg's law **$\lambda = 2d.\sin\theta$** that connects the deviation of the beam with the distance between the planes formed by the atoms.



William Henry Bragg Prix Nobel 1915



William Lawrence Bragg Prix Nobel 1915

The Bragg **diffractometer** has a source that radiates at a known angle to the surface of a cleaved crystal and a detector oriented at an angle equal to the angle of incidence which registers the intensity of the diffracted beams.
This diffractometer was equipped with a gas detector which enabled direct measurement of the diffracted intensity as a function of the angle of diffraction.
Source :
Coll. Cavendish Laboratory