The first X-ray diffraction experiment

In 1912 Laue exposed a crystal to a beam of X-rays. The experiment confirmed that X-rays have very short wavelengths and revealed the periodicity of the crystals.

Max von Laue

Using the crystal to understand the X-rays

In his discussions with Ewald, a thesis student at the time, Laue had an inspiration. He imagined that by exposing a crystal to X-rays he could provoke the phenomenon of diffraction and separation of light beams known as interference.

Diffraction of X-rays by crystals

Continuing with Laue's idea, in April 1912 Friedrich and Knipping exposed a crystal to X-rays and observed a number of spots on the photographic plate behind it. Laue interpreted these spots as being due to interference: i.e. the diffraction of the X-rays by the regular periodic lattice of atoms within the crystal. In 1914 Laue was awarded the Nobel prize for physics for his discovery, which revealed that X-rays are waves, just like light, but with a wavelength a thousand times smaller (similar to the distance between atoms).

Using X-rays to understand crystals

The experiment carried out to reveal the nature of the X-ray beam also established the frequency of order in the crystals (periodicity) and opened up the extraordinary possibility of determining their atomic arrangement.

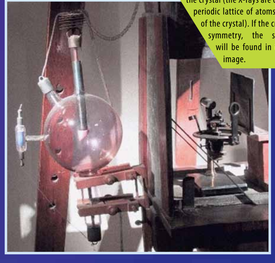
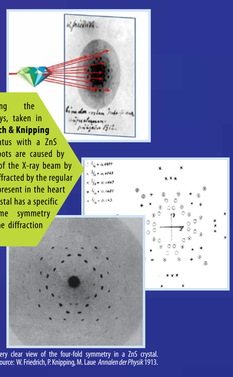


Image showing the diffraction of X-rays, taken in April 1912 by **Friedrich & Knipping** on home-made apparatus with a ZnS sphalerite crystal. The spots are caused by the deviation and division of the X-ray beam by the crystal (the X-rays are diffracted by the regular periodic lattice of atoms present in the heart of the crystal). If the crystal has a specific symmetry, the same symmetry will be found in the diffraction image.



Very clear view of the four-fold symmetry in a ZnS crystal. Source: W. Friedrich, P. Knipping, M. Laue *Annalen der Physik* 1913.

Exchanging views...

Munich was a key town for physics at the start of the 20th century, with three different laboratories situated not far from each other…
- the Institute for theoretical physics, directed by **A. Sommerfeld**
- the Institute for experimental physics, directed by **W.C. Röntgen**
- the Institute for mineralogy and crystallography, directed by **P. Groth**

… with the Hofgarten's Café Lutz as the favourite location for informal discussions.

Following an exchange with **P. Ewald**, one of Sommerfeld's PhD students, **M. Laue** the theoretician imagined an x-ray interference experiment with a crystal. Sommerfeld was not enthusiastic but Laue managed to convince the experimentalists Friedrich and Knipping to carry out the experiment

Scientific discussions with a few good beers at the café. Laue is the first on the left, W. Friedrich is at the end of the table in a dark jacket and P.P. Ewald is the last on the right. Source : Deutsches Museum, Munich.