1.47: Friedel's law

Friedel's law, or rule, states that the intensities of the *h, k, l* and $\bar{h}, \bar{k}, \bar{l}$ reflections are equal. This is true either if the crystal is centrosymmetric or if no resonant scattering is present. It is in that case not possible to tell by diffraction whether an inversion center is present or not. The apparent symmetry of the crystal is then one of the eleven Laue classes.

The reason for Friedel's rule is that the diffracted intensity is proportional to the square of the modulus of the structure factor, $|F_h|^2$, according to the geometrical, or kinematical theory of diffraction. It depends similarly on the modulus of the structure factor according to the dynamical theory of diffraction. The structure factor is given by:

$$F_h = \Sigma_j f_j \exp - 2\pi \mathrm{i} \textcolor{red}{\backslash\mathrm{bold}} h . \textcolor{red}{\backslash\mathrm{bold}} r_j$$

where f_j is the atomic scattering factor of atom *j*, **h** the reflection vector and $\textcolor{red}{\backslash\mathrm{bold}} r_j$ the position vector of atom *j*. There comes:

$$|F_h|^2 = F_h F_h^* = F_h F_{\bar{h}} = |F_{\bar{h}}|^2$$

if the atomic scattering factor, f_j, is real. The intensities of the *h, k, l* and $\bar{h}, \bar{k}, \bar{l}$ reflections are then equal. If the crystal is absorbing, however, due to resonant scattering, the atomic scattering factor is complex and

$$F_{\bar{h}} \neq F_h^*$$

The reflections *h, k, l* and $\bar{h}, \bar{k}, \bar{l}$ are called a Friedel pair. They are used in the resolution of the phase problem for the solution of crystal structures and in the determination of absolute structure.

History

Friedel's law was stated by G. Friedel (1865-1933) in 1913 (Friedel G., 1913, *Sur les symétries cristallines que peut révéler la diffraction des rayons X.*, *C.R. Acad. Sci. Paris*, **157**, 1533-1536.

See also

Absolute structure
Section 3.1 of *International Tables of crystallography, Volume A*