

Precise Absolute-Structure Determination in Light-Atom Crystals, Simon Parsons^{*a} and Howard Flack^b,
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Absolute-structure determination (*e.g.* for absolute-configuration determination from enantiopure crystals) may be ambiguous, particularly in the case of 'organic' or 'light-atom' structures. The cause of the ambiguity lies in the weakness of the resonant scattering (anomalous dispersion) producing the intensity differences between Friedel opposites that may be analysed to reveal information on absolute structure. The magnitude of these differences depends on the wavelength of the X-rays used to collect the diffraction data and the atomic composition of the crystal. Specifically, it is the imaginary contribution (f'') to the scattering factor which must be significant if the absolute structure is to be determined with acceptable precision.

In an absolute-structure determination one absolute structure is refined competitively against the alternative. The result is expressed by the Flack (1983) parameter $x(u)$ which for absolute-configuration determination can be interpreted as the mole fraction of the alternative enantiomer in the crystal. The physical range of x is 0 to 1 and even if the bulk material is known to be enantiopure the standard uncertainty (u) should be less than 0.08 before any firm conclusions regarding the absolute structure can be drawn. This criterion has proved to be extremely demanding for light-atom structures.

It is possible to record the intensities of Friedel opposites in a way that systematic errors such as absorption and extinction are identical for the two measurements. One procedure involves measuring the intensity $I(\mathbf{h})$ of one reflection at setting angles 2θ , ω , χ and ϕ , and the intensity of its Friedel opposite $I(-\mathbf{h})$ at -2θ , $-\omega$, χ and ϕ . These measurements can be combined in the form:

$$D_{obs}(\mathbf{h}) = \frac{I(\mathbf{h}) - I(-\mathbf{h})}{I(\mathbf{h}) + I(-\mathbf{h})} \cong (1 - 2x) \frac{|F(\mathbf{h})|^2 - |F(-\mathbf{h})|^2}{|F(\mathbf{h})|^2 + |F(-\mathbf{h})|^2}$$

and the quantities $D_{obs}(\mathbf{h})$ which are thus free from systematic errors are used as observations (restraints) in a least-squares refinement along with the conventional intensity data and including all the usual parameters.

Symmetry-equivalent measurements of $I(\mathbf{h})$ and $I(-\mathbf{h})$ were carried out for six inversion-sensitive reflections of L-alanine and the mean values of $D_{obs}(\mathbf{h})$ were applied as restraints. Whereas the unrestrained absolute-structure refinement converged to $x = -0.1(2)$, application of restraints yielded $x = -0.03(7)$, an improvement in precision by a factor of three. This determination has strong inversion-distinguishing power, and enables a positive statement to be made about the absolute configuration of the molecule studied.

Flack, H.D. (1983). *Acta Cryst.* **A39**, 876-881.