Acta Cryst
C
STRUCTURAL CHEMISTRY

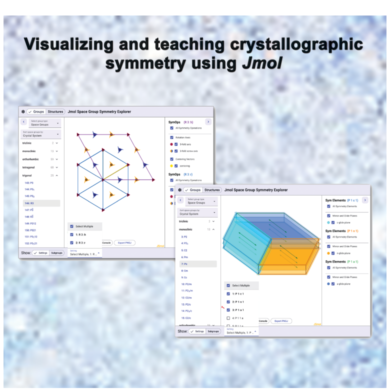
ISSN 2053-2296

Making symmetry visible: an interactive visualizer for teaching crystallography

Gemma de la Flor*

Institute of Applied Geosciences, Karlsruhe Institute of Technology, Karlsruhe, Germany. *Correspondence e-mail: gemma.delaflor@kit.edu

Keywords: Jmol; Space Group Symmetry Visualizer; crystallographic symmetry; visualization.



Symmetry is one of the foundational concepts of crystallography, but it is also one of the topics that students often find most difficult to understand. Space-group symbols, symmetry diagrams, Wyckoff positions, site symmetries, space-group settings and group–subgroup relations provide a compact and rigorous description of symmetry. The difficulty is that students must connect this formal description with three-dimensional relationships and translational periodicity, often through static two-dimensional diagrams.

In their contribution to the *Best practice in crystallography* series in *Acta Crystallographica Section C: Structural Chemistry*, Johnston & Hanson (2026) present the *Jmol* **Space Group Symmetry Visualizer** (https://spacegroups.symotter.org/) as a web-based resource for the visualization and teaching of crystallographic symmetry. The tool is built around the crystallographic capabilities of *Jmol* (Hanson, 2010*a*; Hanson, 2010*b*; Hanson, 2017) and provides interactive representations not only of space groups, but also of lower-dimensional and subperiodic symmetry groups, including frieze, plane, rod and layer groups. It also allows users to explore Wyckoff positions, symmetry elements, alternative settings, group–subgroup relations and the symmetry of real crystal structures.

The importance of this contribution lies not simply in the availability of another visualization resource, but in the way in which it connects crystallographic formalism with visual understanding. Many crystallographic concepts are easier to grasp when the relationships they describe can be followed directly: a Wyckoff position is not only an entry in a table, but a constrained condition governed by site symmetry and by the operations of the selected symmetry group. Similarly, a screw axis or glide plane is not simply a graphical symbol or algebraic operation, it generates symmetry-related positions whose relationships become clearer when they can be seen, manipulated and compared. By allowing users to add pseudoatoms, drag them interactively and observe the corresponding symmetry-related positions update in real time, the visualizer turns abstract symmetry relations into dynamic geometrical objects.

This is particularly valuable in education. Interactive visualization can reduce the barrier between formal crystallographic descriptions and three-dimensional understanding without simplifying the underlying crystallography. Frieze, plane, rod and layer groups can serve as stepping stones towards three-dimensional space groups. The modular structure of the website therefore supports different levels of teaching, from introductory demonstrations of symmetry operations to more advanced exploration of crystallographic symmetry. In this context, the tool can also serve as a valuable companion to Volumes A, A1 and E of the *International Tables for Crystallography* (Aroyo, 2016; Wondratschek & Müller, 2010; Kopský & Litvin, 2010), helping students and researchers move from tabulated symmetry information to visual and interactive representations.

The treatment of alternative settings and group-subgroup relations is especially useful. These are areas where static diagrams can quickly become difficult to interpret, particularly for students encountering crystallographic conventions for the first time. Being able to overlay settings, compare symmetry elements directly and visualize maximal subgroup relationships makes these conventions easier to inspect, explain and apply. This is not only useful in teaching, researchers working with phase transitions, structural relations or symmetry lowering may also benefit from such representations when checking or explaining structural relationships.

The structure–symmetry component broadens this relevance beyond teaching examples. By showing how symmetry elements and Wyckoff positions are expressed in real atomic arrangements, the visualizer helps connect crystallographic formalism with chemical and materials-science interpretation. The option to load local CIF files is particularly important. It means that the tool is not limited to preselected textbook examples but can be applied directly to structures that students or researchers are actually studying. This turns the website from a teaching demonstration into a practical exploratory environment.

Overall, the *Jmol* **Space Group Symmetry Visualizer** represents a valuable contribution to crystallographic education and practice. Its significance lies in making symmetry visible, manipulable and shareable in a browser-based environment. At a time when crystallography is used by increasingly diverse communities, including chemistry, physics, mineralogy, materials science and structural biology, such tools are important not only for crystallographic education, but also for supporting the correct and confident use of crystallographic concepts. Johnston and Hanson's work is therefore both a practical teaching resource and an example of how carefully designed interfaces can make crystallographic information easier to teach, inspect and use.

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