MS47 New horizons in teaching crystallography in the 21st century

MS47-05

Ducks in space groups! Grasping arrangements of symmetry elements with 3D models

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Abstract

Symmetry considerations are vital in chemistry and even more so in crystallography.[1,2] In a typical chemistry curriculum, students are taught symmetry on a molecular basis. Learning and teaching about symmetry naturally requires spatial imagination. To develop and refine this ability, molceular models and model kits are of outmost importance and are readily available for a broad range of purposes[3]. Moving on to the solide state though, the variety of available or reported models becomces smaller. The description of crystalline matter from a crystallographer's point of view necessitates translational symmetry to be considered. From our teaching experience the introduction of translational symmetry components is difficult and something students struggle with. These difficulties culminate when it comes to the assembly of symmetry elements to give space groups.

We herein present large scale (i. e. typically 50 x 50 x 50 cm), physical 3D models of complete space groups (Fig. 1) to promote student's spatial imagination and to help understanding the construction of space groups by symmetry elements.[4] The models were designed and built to fulfil three basic requirements: (1) to be accurate space group representations containing conventional symbols to depict symmetry elements, (2) to visually resemble the conventional 2D space group notation used in the International Tables of Crystallography, Section A[5] if viewed along the respective crystallographic axis and, (3) to allow students to assemble asymmetric units within the unit cell by themselves. These models allow to connect conventional 2D depictions to a 3D representation, which can be moved and inspected by students. Furthermore being able to assemble objects freely within the models underlines the governing role of symmetry in solid-state structures.

While physical models have their benefits in face-to-face teaching, they are usually only available during a lecture. In order to create a digital version of the developed models that can be used by students outside the classroom (e.g. for revision at home), a virtual reality approach is pursued. The VR environment allows to keep the design principles and interactivity of the physical models, but makes them available at any time. First results of this work will be outlined.

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Figure 1: Model of space group P21/c.