

LANDYNE

SPOGS

User Manual

Stereogram of Point Group Symmetry

Copyright 2011-2025 LANDYNE ©

All Right Reserve



Contents

1. Introduction.....	3
2. Theory background	3
2.1 Crystallographic point groups	3
2.2 Noncrystallographic point groups	3
2.3 Stereographic projection.....	4
3. Design and features.....	4
3.1 Graphic design	4
3.2 Function features.....	5
4. Usage.....	6
4.1 Input parameters	6
4.2 Adjustment.....	6
4.3 Stereogram	7
5. Related software components	8
5.1 SPICA.....	8
5.2 CRYSP	8
6. Software suite.....	8
6.1 Landyne suite.....	8
6.2 Installation	8
6.3 Licenses	9
7. References.....	9

1. Introduction

SPOGS is designed to use stereographic projections to illustrate the symmetric elements of the 32 crystallographic point groups, which is used to visualize and understand how symmetry elements (like rotation axes and mirror planes) affect the orientation of points in space. By projecting three-dimensional symmetry operations onto a plane, stereograms allow for a clear and concise representation of a point group's symmetry, making it easier to analyze and classify the symmetry of crystals and molecules. In SPOGS, we listed Hermann–Mauguin or Schoenflies symbols, presented their stereographic projections, and gives the Miller indices (hkl) of the equivalent crystal faces calculated by means of the matrix representations of their symmetry operations. The drawings of actual crystals, natural or synthetic were handled in SVAT. SPOGS can be considered as the extension or auxiliary of SPICA and CRYSP.

2. Theory background

2.1 Crystallographic point groups

A point group is a group of symmetrical operations, all of which leave at least one point unmoved. Thus, all operations containing translations are excluded. Point groups can be subdivided into crystallographic and noncrystallographic point groups. A crystallographic point group is a point group that maps a point lattice onto itself. Consequently, rotations and rotoinversions are restricted to the well-known crystallographic cases 1, 2, 3, 4, 6 and $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$, $\bar{6}$; No such restrictions apply to the noncrystallographic point groups.

The simplest crystallographic point groups are the rotation and rotoinversions listed above. The remaining 22 crystallographic point groups result from the combination of the previous 10 point groups. With the exception of point groups belonging to the cubic crystal system, only twofold rotation axes and/or mirror planes can be taken together with other rotation or rotary-inversion axes: Twofold axes can be combined perpendicular to other axes (e.g. point-group 422) while mirror planes can act either perpendicular (e.g. $2/m$) or parallel to another axis ($mm2$). A slash ("/") character before the symbol m indicates a mirror plane perpendicular to the main axis of rotation.

2.2 Noncrystallographic point groups

A symmetry operation that is not compatible with the periodicity of a crystal pattern (in two or three dimensions, E^n , $n = 2, 3$) is called a noncrystallographic symmetry. Rotations 5, 8, 10 and 12 are compatible with a translation in higher-dimensional (E^n , $n > 3$) spaces, but they are commonly considered noncrystallographic. They are often encountered in the study of molecules and quasicrystals, and as local symmetries within crystals.

The two point groups I_{235} and $I_h m\bar{3}5$ of the icosahedral system (orders 60 and 120) are of particular interest among the noncrystallographic groups because of the occurrence of fivefold axes and their increasing importance as symmetries of molecules (viruses), of quasicrystals, and as approximate local site symmetries in crystals (alloys, B_{12} icosahedron). Furthermore, they contain as special forms the two noncrystallographic *platonic solids*, the regular icosahedron (20 faces, 12 vertices) and its dual, the regular pentagon-dodecahedron (12 faces, 20 vertices). The

two icosahedral groups are in a form similar to the cubic point groups. Both groups are referred to a cubic coordinate system, with the coordinate axes along three twofold rotation axes and with four threefold axes along the body diagonals. The resulting indices h, k, l are irrational but can be approximated closely by rational (or integral) numbers. This explains the occurrence of almost regular icosahedra or pentagon-dodecahedra as crystal forms (for instance pyrite) or atomic groups (for instance B_{12} icosahedron).

Besides the two icosahedral, we present in the SPOGS the two sets of noncrystallographic points groups with one 5 or 10 rotation axes, in comparison to the cases with 3 or 6 rotation axes.

2.3 Stereographic projection

Stereograms are graphical representations of symmetry elements and poles (points) on a sphere, used to visualize these groups. The basic idea is to represent planes as points on some representative surface, which maintains the angular relationship of the points to each other. In the spherical projection, various structural features are expressed as points on a sphere. This sphere sits around the object being examined. Because lattice planes always maintain the same angular relationship to each other, planes can be represented by a plane normal. It is the plane normal which is used to produce the point on the sphere. This point is referred to as the ‘pole’ of the plane. More details are given in SPICA.

3. Design and features

3.1 Graphic design

SPOGS is designed to display the symmetry distribution of a point group in a stereogram. The graphic user interface (GUI) of SPOGS includes a drop-down menu, a menu bar, a display panel, and several operational dialogs. The drop-down menu provides access to all the operational panels, while the menu bar lists frequently used ones. Figure 1 shows the display panel with a menu bar. A control dialog of the crystal shape and other operational dialogs can be toggled on and off. The size of the SPOGS window, including the display panel, can be adjusted via the Auxiliary menu.

The menus and their functions are organized as follows:

- File Menu
 - i) The input interface of point group stereograms. The point groups O_{432} and I_{235} are available for demo practice.
 - ii) Exit the CRYSP application.
- Adjustment
 - i) Wulff and symmetric net.
 - ii) Symmetric symbols.
- Output Menu
 - i) Select a region of interest for output.
 - ii) Save the stereogram in various formats (JPG, PNG, GIF, TIF).
 - iii) Save index list.
- Auxiliary Menu
 - i) Adjust display panel size

projection plane and represent faces which intersect the positive c axis* (positive Miller index $l \geq 0$), those marked as disks lie below the projection plane (negative Miller index $l < 0$). In monoclinic system with its unique axis along b , circles are for positive Miller index $k \geq 0$ and disks for negative Miller index $k < 0$.

SPOGS is a user-friendly tool for teaching and application of Crystallography using along or in combination with SPICA or CRYSP. Key features of SPOGS include, but are not limited to:

- Interactive display point group stereogram with symbols and (hkl) poles.
- The symmetric symbols in a point group stereogram can be adjusted.
- Stereograms of 32 point group, extension to icosahedral and pentagonal and decagonal point groups.
- Pole distribution of single or multiple indices can be displayed.
- Save region of interest in common image formats: JPG, PNG, and TIF.

Here lists the treatment of SPOGS, (a) the three monoclinic point groups 2, m and $2/m$ can be presented in two settings, one with 'unique axis b ' and one with 'unique axis c '. Only 'unique axis b ' is applied in SPOGS. (b) The two point groups 4_2m and 6_2m are described for two orientations with respect to the crystal axes, as $4m2$ and 4_2m and as $6m2$ and 6_2m . Only the first choices are applied in SPOGS. (c) The five trigonal point groups 3, 3, 3_2 , $3m$ and $\bar{3}m$ can be treated with two axial systems, 'hexagonal axes' and 'rhombohedral axes'. Only the first choice is applied in SPOGS. (d) The hexagonal-axes description of the three trigonal point groups 3_2 , $3m$ and $\bar{3}m$ can be given for two orientations, as 3_21 and 3_12 , as $3m1$ and 3_1m , and as $\bar{3}m1$ and $\bar{3}_1m$; Only the first choice is applied in SPOGS. It is obvious that spots on a stereogram have an opposite handedness to the original when they are related by a mirror or an inversion or rotoinversion operations. SPOGS does not show the handedness.

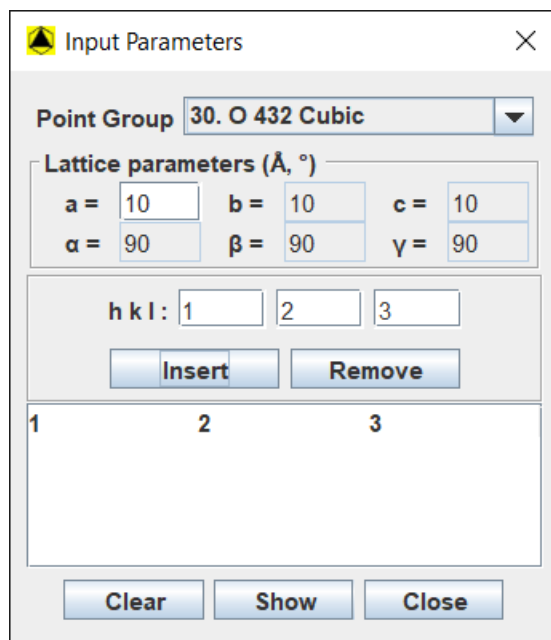
4. Usage

4.1 Input parameters

As shown in Figure 2, SPOGS allows users to select one of the 32 point groups or from the noncrystallographic extension, two icosahedral and five pentagonal and seven decagonal point groups. The lattice parameters according can be assigned according to the crystal systems. Single or multiple crystal plane(s) are allowed to edit in an input table. Once the parameters are assigned, a click on the show button to display the stereogram of the selected point group and symmetric equivalent indices.

4.2 Adjustment

A popout list has a choice of to show (a) a headline label, (b) the symmetric symbols, (c) the Wulff net or stereonet, (d) show upward or downward poles uniquely or in combination, (e) the index labels of poles. Figure 3 shows a dialog, in which the appearance of the symmetric symbols and poles in size and color and font style and size can be optimized.



Input Parameters

Point Group: 30. O 432 Cubic

Lattice parameters (Å, °)

a =	10	b =	10	c =	10
α =	90	β =	90	γ =	90

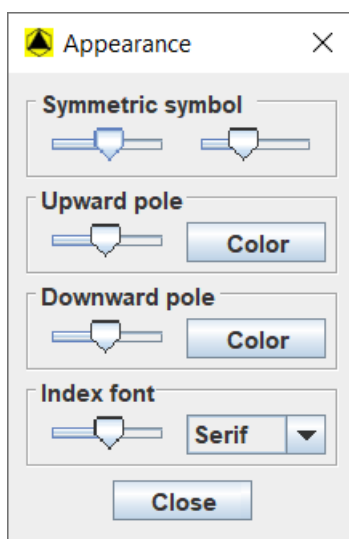
h k l: 1 2 3

Insert Remove

1	2	3

Clear Show Close

Figure 2. A dialog of the input parameters.



Appearance

Symmetric symbol

Upward pole

Downward pole

Index font

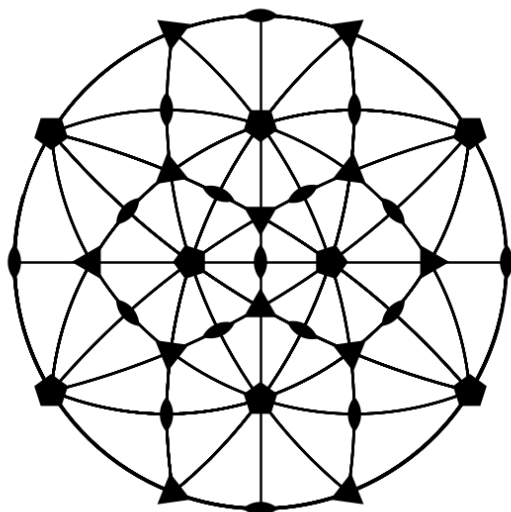
Close

Figure 3. A dialog of the appearance of the symbols and poles.

4.3 Stereogram

The usage of SPOGS is straightforward. For example, you can load one of two demo point groups, O 432 and I235. For cubic and icosahedral system, the lattice parameter does not change the distribution of the poles in stereogram. A general index or special index on high symmetric position can be added in the table and displayed in the stereogram. The symmetric symbols and poles can be optimized for display. A region of interest can be adjusted to select for output an image file. The index labels can be displayed on the screen for the 32 point groups, but only numeric labels for noncrystallographic point group. The index list can be saved to a file in both cases. Figure 4 is an example of icosahedral stereogram of symmetric symbols and with general poles. It can be used together with SPICA and CRYSP.

I 235 Icosahedral



I 235 Icosahedral

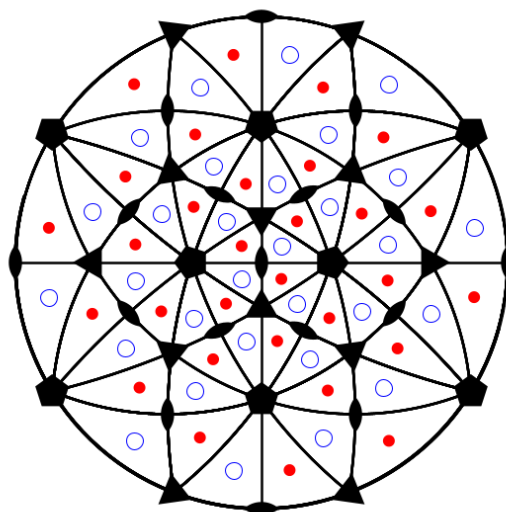


Figure 4. Icosahedral stereogram of symmetric symbols and with general poles.

5. Related software components

5.1 SPICA

SPICA was released in 2016 for stereographic projection for interactive crystallographic analysis. SPOGS can be viewed as extension of the SPICA for application to 32 point groups including icosahedral and pentagonal and decagonal point groups.

5.2 CRYSP

CRYSP was released in 2025 for visualization of crystallographic shape. The surface planes for the polyhedron can be viewed in SPOGS. So SPOGS can be treated as an addition-on software for CRYSP. An example of Aluminum $\{122\}$ planes in stereogram and shape in Figure 5.

6. Software suite

6.1 Landyne suite

Landyne (computer software & graphic design) was established in 2010 by X.Z. Li and Jane Li in Lincoln, NE. We have developed comprehensive software suited to electron diffraction simulation, electron microscopy image processing and crystallographic analysis. The suite serves as a valuable tool for TEM-related research and educational purposes in electron microscopy and crystallography.

6.2 Installation

OpenJDK21 must be installed for running SPOGS. The executable bytecodes, together with the data files for testing and this manual file, are available in compressed form (landyne6.7z)

Oh $m\bar{3}m$ Cubic

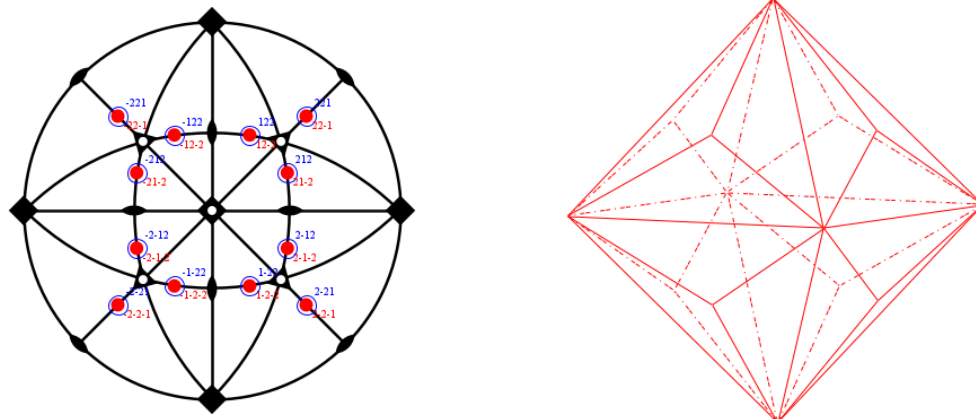


Figure 5. (a) the stereogram of $\{122\}$ planes of Aluminum and (b) the crystal shape of $\{122\}$ planes of Aluminum.

<https://temsoftware.unl.edu/>
<https://landyne.com/>.

Decompress landyne6.7z in a user-defined directory, e.g., c:\landyne6\ and execute launcher.exe.

6.3 Licenses

The software is fully functional in demo mode but is limited to using the demo input file. Both periodic-time and perpetual licenses are available. For licensing information, please contact LANDYNE at jlandyne@gmail.com. Suggestions and comments are always welcome.

7. References

<http://pd.chem.ucl.ac.uk/pdnn/symm2/pntgrp1.htm>

International Tables for Crystallography (2006). Vol. A, Chapter 10.1, pp. 762–803.
 Crystallographic and noncrystallographic point groups, by Th. Hahn and H. Klapper.

Li, X.-Z., J. Appl. Cryst. 49(2016) 1818-1826.

<https://landyne.com>