SHORT COMMUNICATIONS

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Magnetic subperiodic groups†

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Abstract

The magnetic subperiodic groups, the 31 magnetic frieze-group types, the 394 magnetic rod-group types and the 528 magnetic layer-group types, are derived and given symbols based on the symbols for the nonmagnetic subperiodic groups in Volume E of *International Tables for Crystallography*. The symbols are constructed in analogy to the Opechowski–Guccione symbols for magnetic space groups. Tables are given that list one group from each type. Each group is specified not only by its symbol but also by explicitly listing the coset representatives of the coset decomposition of the group with respect to its translational subgroup.

1. Introduction

The *subperiodic groups* in the title refer to the frieze groups, two-dimensional groups with one-dimensional translations, rod groups, three-dimensional groups with one-dimensional translations and layer groups, three-dimensional groups with two-dimensional translations. There are 7, 75 and 80 nonmagnetic frieze-, rod- and layer-group types, respectively (see *e.g.* Shubnikov & Koptsik, 1974; *International Tables for Crystallography*, 1999). The magnetic frieze groups have been derived by Belov (1956; Shubnikov & Belov, 1964) and the magnetic rod and layer groups by Neronova & Belov (1961) [see also the review by Zamorzaev & Palistrant (1980) and the monograph by Zamorzaev (1976)].

We have re-derived the magnetic subperiodic groups as an extension of the nonmagnetic subperiodic groups. The form and meaning of the symbols is in analogy to the form and meaning of the Opechowski–Guccione symbols (Opechowski & Guccione, 1965) for magnetic space groups which differs (see Opechowski & Litvin, 1977) from the form and meaning of the symbols used by Belov (1956; Shubnikov & Belov, 1964) and Neronova & Belov (1961) (see also Belov *et al.*, 1955; Shubnikov & Belov, 1964).

In distinction from previous listings of only a symbol of each magnetic subperiodic group type, a specification of one group of each type is given. This is provided for by explicitly giving the coset representatives of the coset decomposition of each group with respect to its translational subgroup. By explicitly giving the definition of the group specified by each symbol, one ensures no future ambiguities in the meaning of symbols as has arisen in the case of symbols for magnetic space groups (Litvin, 1998).

The survey of all magnetic subperiodic groups consists of a listing of a symbol of one group from each type of magnetic subperiodic group and of the coset representatives of the decomposition of that group with respect to its translational subgroup. The symbol for each listed group is used to denote both the group and the group's type. The magnetic subperiodic groups are divided into *magnetic superfamilies* (Opechowski, 1986). The magnetic superfamily of crystallographic groups of type **F** consists of: (i) groups of type **F**; (ii) groups of type **F**1′, where 1′ denotes time inversion; (iii) groups of the type $\mathbf{F(D)} = \mathbf{D} + (\mathbf{F} - \mathbf{D})1'$, where **D** is a subgroup of index two of **F**.

The format of the tables‡ is:

(i) Serial number of the magnetic subperiodic group type.

(ii) Symbol of the magnetic subperiodic group and the group's type.

(iii) Symbol of the subgroup **D** of index two of **F** for magnetic subperiodic groups **F**(**D**).

(iv) A set of coset representatives of the decomposition of the magnetic subperiodic group with respect to its translational subgroup.

An example from the tables is the survey of the magnetic layer groups of the magnetic superfamily of $p2_122$ as shown in Table 1.

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‡ The complete tables, with an extensive introduction, are available from the IUCr electronic archives (Reference: CR0537). Services for accessing these data are described at the back of the journal. The complete tables may also be downloaded from http://www.bk.psu.edu/faculty/Litvin.

Table 1. *The magnetic layer groups of the magnetic superfamily of $p2_122$*

20.1.111	$p2_122$		$(1\|000)$	$(2_x\|\frac{1}{2}00)$	$(2_y\|\frac{1}{2}00)$	$(2_z\|000)$
20.2.112	$p2_1221'$					
20.3.113	$p2_12'2'$	$p2_111(000;a,b,c)$	$(1\|000)$	$(2_x\|\frac{1}{2}00)$	$(2_y\|\frac{1}{2}00)'$	$(2_z\|000)'$
20.4.114	$p2_1'22'$	$p211(\frac{1}{4}00;b,\bar{a},c)$	$(1\|000)$	$(2_x\|\frac{1}{2}00)'$	$(2_y\|\frac{1}{2}00)$	$(2_z\|000)'$
20.5.115	$p2_1'2'2$	$p112(000;a,b,c)$	$(1\|000)$	$(2_x\|\frac{1}{2}00)'$	$(2_y\|\frac{1}{2}00)'$	$(2_z\|000)$
20.6.116	$p_{2b}2_1'2'2$	$p2_12_12(000;a,2b,c)$	$(1\|000)$	$(2_x\|\frac{1}{2}10)$	$(2_y\|\frac{1}{2}10)$	$(2_z\|000)$
20.7.117	$p_{2b}2_122$	$p2_122\ (000;a,2b,c)$	$(1\|000)$	$(2_x\|\frac{1}{2}00)$	$(2_y\|\frac{1}{2}00)$	$(2_z\|000)$

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