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Geometrical Symbols for All Crystallographic Symmetry Groups up to Three Dimensions

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A complete list of the individual symmetry groups belonging to all sets of such groups up to three dimensions is given, each set being characterized by symbols as agreed upon by the Commission on *International Tables* and each symmetry group by a symbol closely connected with the international space group symbols. Each set is characterized by the reducibility of the matrices of the transformations of space corresponding to the symmetry operations.

As pointed out elsewhere (Bohm & Dornberger-Schiff, 1966) the different kinds of symmetry group – not only the purely geometrical groups but also those including antisymmetry and other generalized symmetry – may be described and symbolized as geometrical symmetry groups. It is of advantage to have easily understandable symbols for the different sets of symmetry groups – differing *e.g.* in their dimensions of extension or periodicity – and also for the individual symmetry groups of these sets.

In the following a complete list of the symmetry groups of all sets up to three dimensions is given. In Tables 1 and 2 symbols for these sets are used (symbols $\mathscr{G}$) as agreed upon by the Commission on *International Tables* and originally proposed by Niggli (1966). For comparison, symbols for the sets proposed some time ago by one of the present authors (Bohm, 1963) are given (symbols G).

Because we included the possibility that one or more dimensions have a non-geometrical meaning, subsets of symmetry groups are of importance in which some of the directions (although all with or all without periodicity) are not exchanged by the transformations of the groups. This is indicated in the symbol of the subset by enumerating separately the dimensions which do not exchange (see below).

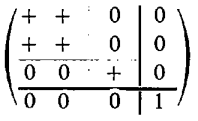
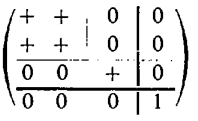
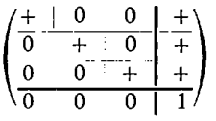
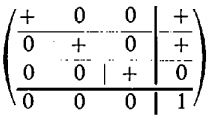
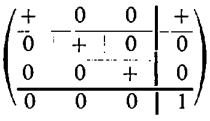
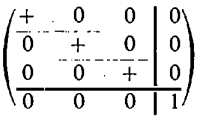
The matrices representing the symmetry groups of such a set are at least reducible in a characteristic way indicated in the line below the G-symbols. Matrices with 4 or 3 rows respectively are used in which the last column gives the translational components.

All symbols for the symmetry groups are deduced from the (full) international space group symbols in the following way: The symbols for the symmetry elements retain their well-known meaning. Symmetry elements referred to directions of missing periodicity are enclosed in round brackets. If two or more such directions of missing periodicity exist, and if exchange of these directions is possible within the particular set, the corresponding symmetry symbols are enclosed in

Table 1. *The three-dimen*

Symbol after Niggli	$\mathscr{G}^3$		$\mathscr{G}_1{}^2$		$\mathscr{G}_2{}^1$		$\mathscr{G}_3$		
Symbol after Bohm	G_3		G_{32}		G_{31}		G_{30}		
Form of matrices	$\left(\begin{array}{ccc\|c} + & + & + & + \\ + & + & + & + \\ + & + & + & + \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{ccc\|c} + & + & 0 & + \\ + & + & 0 & + \\ 0 & 0 & + & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{ccc\|c} + & 0 & 0 & + \\ 0 & + & + & 0 \\ 0 & + & + & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{ccc\|c} + & + & + & 0 \\ + & + & + & 0 \\ + & + & + & 0 \\ \hline 0 & 0 & 0 & 1 \end{array}\right)$		
Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
$P1$	1	$P111$	1	$P11(1)$	1	$P(11)1$	1	(111)	1
$P\bar{1}$	2	$P\bar{1}\bar{1}\bar{1}$	2	$P\bar{1}\bar{1}(\bar{1})$	2	$P(\bar{1}\bar{1})\bar{1}$	2	$(\bar{1}\bar{1}\bar{1})$	$\bar{1}$
Pm	3	$P1m1$	3	$P1m(1)$	3	$P(1m)1$	3	$(1m1)$	m
			4	$P11(m)$	4	$P(11)m$			
Pc	4	$P1c1$	5	$P1a(1)$	5	$P(1c)1$			
			6	$P11(b)$					
Cm	5	$C1m1$	7	$C1m(1)$					
Cc	6	$C1c1$							
$P2$	7	$P121$	8	$P12(1)$	6	$P(12)1$	4	(121)	2
			9	$P11(2)$	7	$P(11)2$			
$P2_1$	8	$P12_11$	10	$P12_1(1)$					
					8	$P(11)2_1$			
$C2$	9	$C121$	11	$C12(1)$					
$P\frac{2}{m}$	10	$P1\frac{2}{m}1$	12	$P1\frac{2}{m}(1)$	9	$P\left(1\frac{2}{m}\right)1$	5	$\left(1\frac{2}{m}1\right)$	$\frac{2}{m}$
			13	$P11\left(\frac{2}{m}\right)$	10	$P(11)\frac{2}{m}$			
$P\frac{2_1}{m}$	11	$P1\frac{2_1}{m}1$	14	$P1\frac{2_1}{m}(1)$					
					11	$P(11)\frac{2_1}{m}$			
$C\frac{2}{m}$	12	$C1\frac{2}{m}1$	15	$C1\frac{2}{m}(1)$					
$P\frac{2}{c}$	13	$P1\frac{2}{c}1$	16	$P1\frac{2}{a}(1)$	12	$P\left(1\frac{2}{c}\right)1$			
			17	$P11\left(\frac{2}{b}\right)$					

sional symmetry groups

$\mathcal{G}_{21}$	$\mathcal{G}21$	$\mathcal{G}111$	$\mathcal{G}_1{}^{11}$	$\mathcal{G}_{11}{}^{1}$	$\mathcal{G}_{111}$
$G_{320}=G_{310}$				G_{321}	G_{3210}
					

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
1	(11)(1)	1	$P11\|1$	1	$P1\|1\|1$	1	$P1\|1(1)$	1	$P(1)(1)1$	1	(1)(1)(1)
2	$(\bar{1}\bar{1})(\bar{1})$	2	$P\bar{1}\bar{1}\|\bar{1}$	2	$P\bar{1}\|\bar{1}\|\bar{1}$	2	$P\bar{1}\|\bar{1}(\bar{1})$	2	$P(\bar{1})(\bar{1})\bar{1}$	2	$(\bar{1})(\bar{1})(\bar{1})$
3	$(1m)(1)$	3	$P1m\|1$	3	$P1\|m\|1$	3	$P1\|m(1)$	3	$P(1)(m)1$	3	$(1)(m)(1)$
4	$(11)(m)$	4	$P11\|m$	4	$P1\|1\|m$	4	$P1\|1(m)$	4	$P(1)(1)m$	4	$(1)(1)(m)$
				5	$Pm\|1\|1$	5	$Pm\|1(1)$	5	$P(m)(1)1$	5	$(m)(1)(1)$
		5	$P1c\|1$	6	$P1\|c\|1$	6	$P1\|a(1)$	6	$P(1)(c)1$		
		6	$P11\|b$	7	$P1\|1\|c$	7	$P1\|1(b)$				
				8	$Pc\|1\|1$	8	$Pb\|1(1)$	7	$P(c)(1)1$		
		7	$C1m\|1$								
		8	$C1c\|1$								
5	(12)(1)	9	$P12\|1$	9	$P1\|2\|1$	9	$P1\|2(1)$	8	$P(1)(2)1$	6	(1)(2)(1)
6	(11)(2)	10	$P11\|2$	10	$P1\|1\|2$	10	$P1\|1(2)$	9	$P(1)(1)2$	7	(1)(1)(2)
				11	$P2\|1\|1$	11	$P2\|1(1)$	10	$P(2)(1)1$	8	(2)(1)(1)
		11	$P12_1\|1$	12	$P1\|2_1\|1$	12	$P1\|2_1(1)$				
		12	$P11\|2_1$	13	$P1\|1\|2_1$			11	$P(1)(1)2_1$		
				14	$P2_1\|1\|1$	13	$P2_1\|1(1)$				
		13	$C12\|1$								
7	$\left(1\frac{2}{m}\right)(1)$	14	$P1\frac{2}{m}\Big\|1$	15	$P1\Big\|\frac{2}{m}\Big\|1$	14	$P1\Big\|\frac{2}{m}(1)$	12	$P(1)\left(\frac{2}{m}\right)1$	9	$(1)\left(\frac{2}{m}\right)(1)$
8	$(11)\left(\frac{2}{m}\right)$	15	$P11\Big\|\frac{2}{m}$	16	$P1\|1\|\frac{2}{m}$	15	$P1\|1\left(\frac{2}{m}\right)$	13	$P(1)(1)\frac{2}{m}$	10	$(1)(1)\left(\frac{2}{m}\right)$
				17	$P\frac{2}{m}\|1\|1$	16	$P\frac{2}{m}\Big\|1(1)$	14	$P\left(\frac{2}{m}\right)(1)1$	11	$\left(\frac{2}{m}\right)(1)(1)$
		16	$P1\frac{2_1}{m}\Big\|1$	18	$P1\Big\|\frac{2_1}{m}\Big\|1$	17	$P1\Big\|\frac{2_1}{m}(1)$				
		17	$P11\Big\|\frac{2_1}{m}$	19	$P1\|1\|\frac{2_1}{m}$			15	$P(1)(1)\frac{2_1}{m}$		
				20	$P\frac{2_1}{m}\|1\|1$	18	$P\frac{2_1}{m}\Big\|1(1)$				
		18	$C1\frac{2}{m}\Big\|1$								
		19	$P1\frac{2}{c}\Big\|1$	21	$P1\Big\|\frac{2}{c}\Big\|1$	19	$P1\Big\|\frac{2}{a}(1)$	16	$P(1)\left(\frac{2}{c}\right)1$		
		20	$P11\Big\|\frac{2}{b}$	22	$P1\|1\|\frac{2}{b}$	20	$P1\|1\left(\frac{2}{b}\right)$				
		21	$P\frac{2}{c}1\|1$	23	$P\frac{2}{c}\|1\|1$	21	$P\frac{2}{b}\Big\|1(1)$	17	$P\left(\frac{2}{c}\right)(1)1$		

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
$P\frac{2_1}{c}$	14	$P1\frac{2_1}{c}1$	18	$P1\frac{2_1}{a}(1)$					
$C\frac{2}{c}$	15	$C1\frac{2}{c}1$							
Pmm	16	*Pmm*2	19	*Pmm*(2)	13	*P*(*mm*)2	6	(*mm*2)	*mm*2
			20	*P*2*m*(*m*)	14	*P*(2*m*)*m*			
Pmc	17	$Pmc2_1$			15	$P(mc)2_1$			
			21	$P2_1m(a)$					
			22	$P2_1a(m)$					
Pcc	18	*Pcc*2			16	*P*(*cc*)2			
			23	*P*2*a*(*a*)					
Pma	19	*Pma*2	24	*Pma*(2)					
			25	*P*2*m*(*b*)	17	*P*(2*c*)*m*			
Pca	20	$Pca2_1$							
			26	$P2_1a(b)$					
Pnc	21	*Pnc*2							
			27	*P*2*a*(*n*)					
Pmn	22	$Pmn2_1$							
			28	$P2_1m(n)$					
Pba	23	*Pba*2	29	*Pba*(2)					
Pna	24	$Pna2_1$							
Pnn	25	*Pnn*2							
Cmm	26	*Cmm*2	30	*Cmm*(2)					
			31	*C*2*m*(*m*)					
Cmc	27	$Cmc2_1$							
Ccc	28	*Ccc*2							
Amm	29	*Amm*2							
Abm	30	*Abm*2							
			32	*Cm*2(*a*)					

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
		22	$P1\,\frac{2_1}{c}\,\vert\,1$	24	$P1\,\vert\,\frac{2_1}{c}\,\vert\,1$	22	$P1\,\vert\,\frac{2_1}{a}\,(1)$				
		23	$P11\,\vert\,\frac{2_1}{b}$	25	$P1\vert1\vert\,\frac{2_1}{b}$						
				26	$P\,\frac{2_1}{c}\,\vert1\vert1$	23	$P\,\frac{2_1}{b}\,\vert\,1(1)$				
		24	$C1\,\frac{2}{c}\,\vert\,1$								
9	$(mm)(2)$	25	$Pmm\vert2$	27	$Pm\vert m\vert2$	24	$Pm\vert m(2)$	18	$P(m)(m)2$	12	$(m)(m)(2)$
10	$(2m)(m)$	26	$P2m\vert m$	28	$P2\vert m\vert m$	25	$P2\vert m(m)$	19	$P(2)(m)m$	13	$(2)(m)(m)$
				29	$Pm\vert2\vert m$			20	$P(m)(2)m$	14	$(m)(2)(m)$
		27	$Pmc\vert2_1$	30	$Pm\vert c\vert2_1$			21	$P(m)(c)2_1$		
				31	$Pc\vert m\vert2_1$			22	$P(c)(m)2_1$		
		28	$P2_1m\vert a$	32	$P2_1\vert m\vert a$	26	$P2_1\vert m(a)$				
		29	$P2_1a\vert m$	33	$P2_1\vert a\vert m$	27	$P2_1\vert a(m)$				
				34	$Pb\vert2_1\vert m$						
				35	$Pm\vert2_1\vert b$						
		30	$Pcc\vert2$	36	$Pc\vert c\vert2$	28	$Pc\vert c(2)$	23	$P(c)(c)2$		
				37	$P2\vert a\vert a$	29	$P2\vert a(a)$				
				38	$Pb\vert2\vert b$						
		31	$Pma\vert2$	39	$Pm\vert a\vert2$	30	$Pm\vert a(2)$				
				40	$Pb\vert m\vert2$	31	$Pb\vert m(2)$				
		32	$P2m\vert b$	41	$P2\vert m\vert b$						
		33	$P2c\vert m$	42	$P2\vert c\vert m$			24	$P(2)(c)m$		
				43	$Pc\vert2\vert m$			25	$P(c)(2)m$		
				44	$Pm\vert2\vert a$						
		34	$Pca\vert2_1$	45	$Pc\vert a\vert2_1$						
				46	$Pb\vert c\vert2_1$						
		35	$P2_1a\vert b$	47	$P2_1\vert a\vert b$						
		36	$P2_1c\vert a$	48	$P2_1\vert c\vert a$						
				49	$Pc\vert2_1\vert b$						
				50	$Pb\vert2_1\vert a$						
		37	$P2a\vert n$								
		38	$P2_1m\vert n$								
		39	$Pba\vert2$	51	$Pb\vert a\vert2$	32	$Pb\vert a(2)$				
		40	$P2c\vert b$	52	$P2\vert c\vert b$						
		41	$Pc2\vert a$	53	$Pc\vert2\vert a$						
		42	$P2_1c\vert n$								
		43	$Cmm\vert2$								
		44	$C2m\vert m$								
		45	$Cmc\vert2_1$								
		46	$Ccc\vert2$								
		47	$C2m\vert m$								
		48	$C2m\vert a$								

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
Ama	31	*Ama*2							
Aba	32	*Aba*2							
Fmm	33	*Fmm*2							
Fdd	34	*Fdd*2							
Imm	35	*Imm*2							
Iba	36	*Iba*2							
Ima	37	*Ima*2							
$P222$	38	$P222$	33	$P22(2)$	18	$P(22)2$	7	(222)	222
$P222_1$	39	$P222_1$	34	$P2_12(2)$	19	$P(22)2_1$			
$P2_12_12$	40	$P2_12_12$	35	$P2_12_1(2)$					
$P2_12_12_1$	41	$P2_12_12_1$							
$C222_1$	42	$C222_1$							
$C222$	43	$C222$	36	$C22(2)$					
$F222$	44	$F222$							
$I222$	45	$I222$							
$I2_12_12_1$	46	$I2_12_12_1$							
Pmmm	47	$P\frac{2}{m}\frac{2}{m}\frac{2}{m}$	37	$P\frac{2}{m}\frac{2}{m}\left(\frac{2}{m}\right)$	20	$P\left(\frac{2}{m}\frac{2}{m}\right)\frac{2}{m}$	8	$\left(\frac{2}{m}\frac{2}{m}\frac{2}{m}\right)$	*mmm*
Pnnn	48	$P\frac{2}{n}\frac{2}{n}\frac{2}{n}$							
Pccm	49	$P\frac{2}{c}\frac{2}{c}\frac{2}{m}$			21	$P\left(\frac{2}{c}\frac{2}{c}\right)\frac{2}{m}$			
			38	$P\frac{2}{m}\frac{2}{a}\left(\frac{2}{a}\right)$					
Pban	50	$P\frac{2}{b}\frac{2}{a}\frac{2}{n}$	39	$P\frac{2}{b}\frac{2}{a}\left(\frac{2}{n}\right)$					
Pmma	51	$P\frac{2_1}{m}\frac{2}{m}\frac{2}{a}$	40	$P\frac{2_1}{m}\frac{2}{m}\left(\frac{2}{a}\right)$					
					22	$P\left(\frac{2}{m}\frac{2}{c}\right)\frac{2_1}{m}$			

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
		49	$C2c\|m$								
		50	$C2c\|a$								
11	(22)(2)	51	$P22\|2$	54	$P2\|2\|2$	33	$P2\|2(2)$	26	$P(2)(2)2$	15	(2)(2)(2)
		52	$P22\|2_1$	55	$P2\|2\|2_1$			27	$P(2)(2)2_1$		
		53	$P2_12\|2$	56	$P2_1\|2\|2$	34	$P2_1\|2(2)$				
				57	$P2\|2_1\|2$	35	$P2\|2_1(2)$				
		54	$P2_12_1\|2$	58	$P2_1\|2_1\|2$	36	$P2_1\|2_1\|(2)$				
		55	$P22_1\|2_1$	59	$P2\|2_1\|2_1$						
				60	$P2_1\|2\|2_1$						
		56	$P2_12_1\|2_1$	61	$P2_1\|2_1\|2_1$						
		57	$C22\|2_1$								
		58	$C22\|2$								
12	$\left(\frac{2}{m}\ \frac{2}{m}\right)\left(\frac{2}{m}\right)$	59	$P\ \frac{2}{m}\ \frac{2}{m}\Big\vert\frac{2}{m}$	62	$P\ \frac{2}{m}\Big\vert\frac{2}{m}\Big\vert\frac{2}{m}$	37	$P\ \frac{2}{m}\Big\vert\frac{2}{m}\left(\frac{2}{m}\right)$	28	$P\left(\frac{2}{m}\right)\left(\frac{2}{m}\right)\frac{2}{m}$	16	$\left(\frac{2}{m}\right)\left(\frac{2}{m}\right)\left(\frac{2}{m}\right)$
		60	$P\ \frac{2}{c}\ \frac{2}{c}\Big\vert\frac{2}{m}$	63	$P\ \frac{2}{c}\Big\vert\frac{2}{c}\Big\vert\frac{2}{m}$			29	$P\left(\frac{2}{c}\right)\left(\frac{2}{c}\right)\frac{2}{m}$		
		61	$P\ \frac{2}{m}\ \frac{2}{a}\Big\vert\frac{2}{a}$	64	$P\ \frac{2}{m}\Big\vert\frac{2}{a}\Big\vert\frac{2}{a}$	38	$P\ \frac{2}{m}\Big\vert\frac{2}{a}\left(\frac{2}{a}\right)$				
				65	$P\ \frac{2}{b}\Big\vert\frac{2}{m}\Big\vert\frac{2}{b}$	39	$P\ \frac{2}{b}\Big\vert\frac{2}{m}\left(\frac{2}{b}\right)$				
		62	$P\ \frac{2}{b}\ \frac{2}{a}\Big\vert\frac{2}{n}$								
		63	$P\ \frac{2_1}{m}\ \frac{2}{m}\Big\vert\frac{2}{a}$	66	$P\ \frac{2_1}{m}\Big\vert\frac{2}{m}\Big\vert\frac{2}{a}$	40	$P\ \frac{2_1}{m}\Big\vert\frac{2}{m}\left(\frac{2}{a}\right)$				
				67	$P\ \frac{2}{m}\Big\vert\frac{2_1}{m}\Big\vert\frac{2}{b}$	41	$P\ \frac{2}{m}\Big\vert\frac{2_1}{m}\left(\frac{2}{b}\right)$				
		64	$P\ \frac{2_1}{m}\ \frac{2}{a}\Big\vert\frac{2}{m}$	68	$P\ \frac{2_1}{m}\Big\vert\frac{2}{a}\Big\vert\frac{2}{m}$	42	$P\ \frac{2_1}{m}\Big\vert\frac{2}{a}\left(\frac{2}{m}\right)$				
		65	$P\ \frac{2}{m}\ \frac{2}{c}\Big\vert\frac{2_1}{m}$	69	$P\ \frac{2}{m}\Big\vert\frac{2}{c}\Big\vert\frac{2_1}{m}$			30	$P\left(\frac{2}{m}\right)\left(\frac{2}{c}\right)\frac{2_1}{m}$		

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
			41	$P\frac{2}{b}\frac{2_1}{m}\left(\frac{2}{m}\right)$					
Pnna	52	$P\frac{2}{n}\frac{2_1}{n}\frac{2}{a}$							
Pmna	53	$P\frac{2}{m}\frac{2}{n}\frac{2_1}{a}$							
			42	$P\frac{2_1}{b}\frac{2}{m}\left(\frac{2}{n}\right)$					
Pcca	54	$P\frac{2_1}{c}\frac{2}{c}\frac{2}{a}$							
			43	$P\frac{2}{b}\frac{2_1}{a}\left(\frac{2}{a}\right)$					
Pbam	55	$P\frac{2_1}{b}\frac{2_1}{a}\frac{2}{m}$	44	$P\frac{2_1}{b}\frac{2_1}{a}\left(\frac{2}{m}\right)$					
Pccn	56	$P\frac{2_1}{c}\frac{2_1}{c}\frac{2}{n}$							
Pbcm	57	$P\frac{2}{b}\frac{2_1}{c}\frac{2_1}{m}$							
			45	$P\frac{2_1}{m}\frac{2_1}{a}\left(\frac{2}{b}\right)$					
Pnnm	58	$P\frac{2_1}{n}\frac{2_1}{n}\frac{2}{m}$							
Pmmn	59	$P\frac{2_1}{m}\frac{2_1}{m}\frac{2}{n}$	46	$P\frac{2_1}{m}\frac{2_1}{m}\left(\frac{2}{n}\right)$					

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
				70	$P\,\frac{2}{b}\left\|\frac{2_1}{m}\right\|\frac{2}{m}$	43	$P\,\frac{2}{b}\left\|\frac{2_1}{m}\right\|\left(\frac{2}{m}\right)$				
				71	$P\,\frac{2}{c}\left\|\frac{2}{m}\right\|\frac{2_1}{m}$			31	$P\left(\frac{2}{c}\right)\left(\frac{2}{m}\right)\frac{2_1}{m}$		
		66	$P\,\frac{2_1}{b}\,\frac{2}{m}\left\|\frac{2}{n}\right.$								
		67	$P\,\frac{2_1}{c}\,\frac{2}{c}\left\|\frac{2}{a}\right.$	72	$P\,\frac{2_1}{c}\left\|\frac{2}{c}\right\|\frac{2}{a}$						
				73	$P\,\frac{2}{c}\left\|\frac{2_1}{c}\right\|\frac{2}{b}$						
		68	$P\,\frac{2_1}{b}\,\frac{2}{a}\left\|\frac{2}{b}\right.$	74	$P\,\frac{2_1}{b}\left\|\frac{2}{a}\right\|\frac{2}{b}$	44	$P\,\frac{2_1}{b}\left\|\frac{2}{a}\right\|\left(\frac{2}{b}\right)$				
		69	$P\,\frac{2}{b}\,\frac{2}{c}\left\|\frac{2_1}{b}\right.$	75	$P\,\frac{2}{b}\left\|\frac{2}{c}\right\|\frac{2_1}{b}$						
				76	$P\,\frac{2}{b}\left\|\frac{2_1}{a}\right\|\frac{2}{a}$	45	$P\,\frac{2}{b}\left\|\frac{2_1}{a}\right\|\left(\frac{2}{a}\right)$				
				77	$P\,\frac{2}{c}\left\|\frac{2}{a}\right\|\frac{2_1}{a}$						
		70	$P\,\frac{2_1}{b}\,\frac{2_1}{a}\left\|\frac{2}{m}\right.$	78	$P\,\frac{2_1}{b}\left\|\frac{2_1}{a}\right\|\frac{2}{m}$	46	$P\,\frac{2_1}{b}\left\|\frac{2_1}{a}\right\|\left(\frac{2}{m}\right)$				
		71	$P\,\frac{2_1}{c}\,\frac{2}{m}\left\|\frac{2_1}{a}\right.$	79	$P\,\frac{2_1}{c}\left\|\frac{2}{m}\right\|\frac{2_1}{a}$						
				80	$P\,\frac{2}{m}\left\|\frac{2_1}{c}\right\|\frac{2_1}{b}$						
		72	$P\,\frac{2_1}{c}\,\frac{2_1}{c}\left\|\frac{2}{n}\right.$								
		73	$P\,\frac{2}{b}\,\frac{2_1}{c}\left\|\frac{2_1}{m}\right.$	81	$P\,\frac{2}{b}\left\|\frac{2_1}{c}\right\|\frac{2_1}{m}$						
		74	$P\,\frac{2_1}{b}\,\frac{2_1}{m}\left\|\frac{2}{a}\right.$	82	$P\,\frac{2_1}{b}\left\|\frac{2_1}{m}\right\|\frac{2}{a}$	47	$P\,\frac{2_1}{b}\left\|\frac{2_1}{m}\right\|\left(\frac{2}{a}\right)$				
				83	$P\,\frac{2_1}{c}\left\|\frac{2}{a}\right\|\frac{2_1}{m}$						
		75	$P\,\frac{2}{c}\,\frac{2_1}{m}\left\|\frac{2_1}{b}\right.$	84	$P\,\frac{2}{c}\left\|\frac{2_1}{m}\right\|\frac{2_1}{b}$						
				85	$P\,\frac{2_1}{m}\left\|\frac{2_1}{a}\right\|\frac{2}{b}$	48	$P\,\frac{2_1}{m}\left\|\frac{2_1}{a}\right\|\left(\frac{2}{b}\right)$				
				86	$P\,\frac{2_1}{m}\left\|\frac{2}{c}\right\|\frac{2_1}{a}$						
		76	$P\,\frac{2_1}{m}\,\frac{2_1}{m}\left\|\frac{2}{n}\right.$								

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
Pbcn	60	$P\frac{2_1}{b}\frac{2}{c}\frac{2_1}{n}$							
Pbca	61	$P\frac{2_1}{b}\frac{2_1}{c}\frac{2_1}{a}$							
Pnma	62	$P\frac{2_1}{n}\frac{2_1}{m}\frac{2_1}{a}$							
Cmcm	63	$C\frac{2}{m}\frac{2}{c}\frac{2_1}{m}$							
Cmca	64	$C\frac{2}{m}\frac{2}{c}\frac{2_1}{a}$							
Cmmm	65	$C\frac{2}{m}\frac{2}{m}\frac{2}{m}$	47	$C\frac{2}{m}\frac{2}{m}\left(\frac{2}{m}\right)$					
Cccm	66	$C\frac{2}{c}\frac{2}{c}\frac{2}{m}$							
Cmma	67	$C\frac{2}{m}\frac{2}{m}\frac{2}{a}$	48	$C\frac{2}{m}\frac{2}{m}\left(\frac{2}{a}\right)$					
Ccca	68	$C\frac{2}{c}\frac{2}{c}\frac{2}{a}$							
Fmmm	69	$F\frac{2}{m}\frac{2}{m}\frac{2}{m}$							
Fddd	70	$F\frac{2}{d}\frac{2}{d}\frac{2}{d}$							
Immm	71	$I\frac{2}{m}\frac{2}{m}\frac{2}{m}$							
Ibam	72	$I\frac{2}{b}\frac{2}{a}\frac{2}{m}$							
Ibca	73	$I\frac{2_1}{b}\frac{2_1}{c}\frac{2_1}{a}$							
Imma	74	$I\frac{2_1}{m}\frac{2_1}{m}\frac{2_1}{a}$							
$P\bar{4}$	75	$P\bar{4}11$	49	$P(\bar{4})11$	23	$P\bar{4}(11)$	9	$(\bar{4}11)$	$\bar{4}$
$I\bar{4}$	76	$I\bar{4}11$							
$P\bar{4}2m$	77	$P\bar{4}2m$	50	$P(\bar{4})2m$	24	$P\bar{4}(2m)$	10	$(\bar{4}2m)$	$\bar{4}2m$
$P\bar{4}2c$	78	$P\bar{4}2c$			25	$P\bar{4}(2c)$			
$P\bar{4}2_1m$	79	$P\bar{4}2_1m$	51	$P(\bar{4})2_1m$					

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
		77	$P\frac{2_1}{b}\ \frac{2}{c}\Big\vert\frac{2_1}{n}$								
		78	$P\frac{2}{c}\ \frac{2_1}{a}\Big\vert\frac{2_1}{n}$								
		79	$P\frac{2_1}{b}\ \frac{2_1}{c}\Big\vert\frac{2_1}{a}$	87	$P\frac{2_1}{b}\Big\vert\frac{2_1}{c}\Big\vert\frac{2_1}{a}$						
		80	$P\frac{2_1}{c}\ \frac{2_1}{m}\Big\vert\frac{2_1}{n}$								
		81	$P\frac{2_1}{m}\ \frac{2_1}{c}\Big\vert\frac{2_1}{n}$								
		82	$C\frac{2}{m}\ \frac{2}{c}\Big\vert\frac{2_1}{m}$								
		83	$C\frac{2}{m}\ \frac{2}{c}\Big\vert\frac{2_1}{a}$								
		84	$C\frac{2}{m}\ \frac{2}{m}\Big\vert\frac{2}{m}$								
		85	$C\frac{2}{c}\ \frac{2}{c}\Big\vert\frac{2}{m}$								
		86	$C\frac{2}{m}\ \frac{2}{m}\Big\vert\frac{2}{a}$								
		87	$C\frac{2}{c}\ \frac{2}{c}\Big\vert\frac{2}{a}$								
13	$(\bar{4})(11)$	88	$P\bar{4}\vert 11$								
14	$(\bar{4})(2m)$	89	$P\bar{4}\vert 2m$								
		90	$P\bar{4}\vert 2c$								
		91	$P\bar{4}\vert 2_1 m$								

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbo
$P\bar{4}2_1c$	80	$P\bar{4}2_1c$							
$C\bar{4}2m$	81	$C\bar{4}2m$	52	$P(\bar{4})m2$					
$C\bar{4}2c$	82	$C\bar{4}2c$							
$C\bar{4}2b$	83	$C\bar{4}2b$	53	$P(\bar{4})b2$					
$C\bar{4}2n$	84	$C\bar{4}2n$							
$F\bar{4}2m$	85	$F\bar{4}2m$							
$F\bar{4}2c$	86	$F\bar{4}2c$							
$I\bar{4}2m$	87	$I\bar{4}2m$							
$I\bar{4}2d$	88	$I\bar{4}2d$							
$P4$	89	$P411$	54	$P(4)11$	26	$P4(11)$	11	(411)	4
$P4_1$	90	$P4_111$			27	$P4_1(11)$			
$P4_2$	91	$P4_211$			28	$P4_2(11)$			
$P4_3$	92	$P4_311$			29	$P4_3(11)$			
$I4$	93	$I411$							
$I4_1$	94	$I4_111$							
$P\frac{4}{m}$	95	$P\frac{4}{m}11$	55	$P\left(\frac{4}{m}\right)11$	30	$P\frac{4}{m}(11)$	12	$\left(\frac{4}{m}11\right)$	$\frac{4}{m}$
$P\frac{4_2}{m}$	96	$P\frac{4_2}{m}11$			31	$P\frac{4_2}{m}(11)$			
$P\frac{4}{n}$	97	$P\frac{4}{n}11$	56	$P\left(\frac{4}{n}\right)11$					
$P\frac{4_2}{n}$	98	$P\frac{4_2}{n}11$							
$I\frac{4}{m}$	99	$I\frac{4}{m}11$							
$I\frac{4_1}{a}$	100	$I\frac{4_1}{a}11$							
$P4mm$	101	$P4mm$	57	$P(4)mm$	32	$P4(mm)$	13	(4*mm*)	4*mm*
$P4bm$	102	$P4bm$	58	$P(4)bm$					
$P4_2cm$	103	$P4_2cm$			33	$P4_2(cm)$			
$P4_2nm$	104	$P4_2nm$							
$P4cc$	105	$P4cc$			34	$P4(cc)$			
$P4nc$	106	$P4nc$							
$P4_2mc$	107	$P4_2mc$							

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
		92	$P\bar{4}\|2_1c$								
		93	$P\bar{4}\|m2$								
		94	$P\bar{4}\|c2$								
		95	$P\bar{4}\|b2$								
15	(4)(11)	96	$P4\|11$								
		97	$P4_1\|11$								
		98	$P4_2\|11$								
		99	$P4_3/11$								
16	$\left(\frac{4}{m}\right)$(11)	100	$P\frac{4}{m}\Big\|11$								
		101	$P\frac{4_2}{m}\Big\|11$								
		102	$P\frac{4}{n}\Big\|11$								
17	(4)(*mm*)	103	$P4\|mm$								
		104	$P4\|bm$								
		105	$P4_2\|cm$								
		106	$P4\|cc$								
		107	$P4_2\|mc$								

Table 1 (*cont.*)

Short space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
$P4_2bc$	108	$P4_2bc$							
$I4mm$	109	$I4mm$							
$I4cm$	110	$I4cm$							
$I4_1md$	111	$I4_1md$							
$I4_1cd$	112	$I4_1cd$							
$P42$	113	$P422$	59	$P(4)22$	35	$P4(22)$	14	(422)	422
$P42_1$	114	$P42_12$	60	$P(4)2_12$					
$P4_12$	115	$P4_122$			36	$P4_1(22)$			
$P4_12_1$	116	$P4_12_12$							
$P4_22$	117	$P4_222$			37	$P4_2(22)$			
$P4_22_1$	118	$P4_22_12$							
$P4_32$	119	$P4_322$			38	$P4_3(22)$			
$P4_32_1$	120	$P4_32_12$							
$I42$	121	$I422$							
$I4_12$	122	$I4_122$							
$P\frac{4}{m}mm$	123	$P\frac{4}{m}\frac{2}{m}\frac{2}{m}$	61	$P\left(\frac{4}{m}\right)\frac{2}{m}\frac{2}{m}$	39	$P\frac{4}{m}\left(\frac{2}{m}\frac{2}{m}\right)$	15	$\left(\frac{4}{m}\frac{2}{m}\frac{2}{m}\right)$	$\frac{4}{m}mm$
$P\frac{4}{m}cc$	124	$P\frac{4}{m}\frac{2}{c}\frac{2}{c}$			40	$P\frac{4}{m}\left(\frac{2}{c}\frac{2}{c}\right)$			
$P\frac{4}{n}bm$	125	$P\frac{4}{n}\frac{2}{b}\frac{2}{m}$	62	$P\left(\frac{4}{n}\right)\frac{2}{b}\frac{2}{m}$					
$P\frac{4}{n}nc$	126	$P\frac{4}{n}\frac{2}{n}\frac{2}{c}$							
$P\frac{4}{m}bm$	127	$P\frac{4}{m}\frac{2_1}{b}\frac{2}{m}$	63	$P\left(\frac{4}{m}\right)\frac{2_1}{b}\frac{2}{m}$					
$P\frac{4}{m}nc$	128	$P\frac{4}{m}\frac{2_1}{n}\frac{2}{c}$							
$P\frac{4}{n}mm$	129	$P\frac{4}{n}\frac{2_1}{m}\frac{2}{m}$	64	$P\left(\frac{4}{n}\right)\frac{2_1}{m}\frac{2}{m}$					
$P\frac{4}{n}cc$	130	$P\frac{4}{n}\frac{2_1}{c}\frac{2}{c}$							
$P\frac{4_2}{m}mc$	131	$P\frac{4_2}{m}\frac{2}{m}\frac{2}{c}$			41	$P\frac{4_2}{m}\left(\frac{2}{m}\frac{2}{c}\right)$			
$P\frac{4_2}{m}cm$	132	$P\frac{4_2}{m}\frac{2}{c}\frac{2}{m}$							
$P\frac{4_2}{n}bc$	133	$P\frac{4_2}{n}\frac{2}{b}\frac{2}{c}$							
$P\frac{4_2}{n}nm$	134	$P\frac{4_2}{n}\frac{2}{n}\frac{2}{m}$							

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
18	(4)(22)	108	$P4\|22$								
		109	$P4\|2_12$								
		110	$P4_1\|22$								
		111	$P4_2\|22$								
		112	$P4_3\|22$								
19	$\left(\frac{4}{m}\right)\left(\frac{2}{m}\ \frac{2}{m}\right)$	113	$P\frac{4}{m}\left\|\frac{2}{m}\ \frac{2}{m}\right.$								
		114	$P\frac{4}{m}\left\|\frac{2}{c}\ \frac{2}{c}\right.$								
		115	$P\frac{4}{n}\left\|\frac{2}{b}\ \frac{2}{m}\right.$								
		116	$P\frac{4}{m}\left\|\frac{2_1}{b}\ \frac{2}{m}\right.$								
		117	$P\frac{4}{n}\left\|\frac{2_1}{m}\ \frac{2}{m}\right.$								
		118	$P\frac{4_2}{m}\left\|\frac{2}{m}\ \frac{2}{c}\right.$								
		119	$P\frac{4_2}{m}\left\|\frac{2}{c}\ \frac{2}{m}\right.$								

Table 1 (*cont.*)

Short Space group	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
$P\frac{4_2}{m}bc$	135	$P\frac{4_2}{m}\frac{2_1}{b}\frac{2}{c}$							
$P\frac{4_2}{m}nm$	136	$P\frac{4_2}{m}\frac{2_1}{n}\frac{2}{m}$							
$P\frac{4_2}{n}mc$	137	$P\frac{4_2}{n}\frac{2_1}{m}\frac{2}{c}$							
$P\frac{4_2}{n}cm$	138	$P\frac{4_2}{n}\frac{2_1}{c}\frac{2}{m}$							
$I\frac{4}{m}mm$	139	$I\frac{4}{m}\frac{2}{m}\frac{2}{m}$							
$I\frac{4}{m}cm$	140	$I\frac{4}{m}\frac{2}{c}\frac{2}{m}$							
$I\frac{4_1}{a}md$	141	$I\frac{4_1}{a}\frac{2}{m}\frac{2}{d}$							
$I\frac{4_1}{a}cd$	142	$I\frac{4_1}{a}\frac{2}{c}\frac{2}{d}$							
$P3$	143	$P311$	65	$P(3)11$	42	$P3(11)$	16	(311)	3
$P3_1$	144	$P3_111$			43	$P3_1(11)$			
$P3_2$	145	$P3_211$			44	$P3_2(11)$			
$R3$	146	$R311$							
$P\bar{3}$	147	$P\bar{3}11$	66	$P(\bar{3})11$	45	$P\bar{3}(11)$	17	$(\bar{3}11)$	$\bar{3}$
$R\bar{3}$	148	$R\bar{3}11$							
$P3m1$	149	$P3m1$	67	$P(3)m1$	46	$P3(m1)$	18	$(3m1)$	$3m$
$P31m$	150	$P31m$	68	$P(3)1m$					
$P3c1$	151	$P3c1$			47	$P3(c1)$			
$P31c$	152	$P31c$							
$R3m$	153	$R3m1$							
$R3c$	154	$R3c1$							
$P321$	155	$P321$	69	$P(3)21$	48	$P3(21)$	19	(321)	32
$P312$	156	$P312$	70	$P(3)12$					
$P3_121$	157	$P3_121$			49	$P3_1(21)$			
$P3_112$	158	$P3_112$							
$P3_221$	159	$P3_221$			50	$P3_2(21)$			
$P3_212$	160	$P3_212$							
$R32$	161	$R32$							
$P\bar{3}m1$	162	$P\bar{3}m1$	71	$P(\bar{3})m1$	51	$P\bar{3}(m1)$	20	$(\bar{3}m1)$	$\bar{3}m$
$P\bar{3}c1$	163	$P\bar{3}c1$			52	$P\bar{3}(c1)$			
$P\bar{3}1m$	164	$P\bar{3}1m$	72	$P(\bar{3})1m$					

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
20	(3)(11)	120	$P3\|11$								
		121	$P3_1\|11$								
		122	$P3_2\|11$								
21	$(\bar{3})(11)$	123	$P\bar{3}\|11$								
22	(3)(m1)	124	$P3\|m1$								
		125	$P3\|1m$								
		126	$P3\|c1$								
		127	$P3\|1c$								
23	(3)(21)	128	$P3\|21$								
		129	$P3\|12$								
		130	$P3_1\|21$								
		131	$P3_1\|12$								
		132	$P3_2\|21$								
		133	$P3_2\|12$								
24	$(\bar{3})(m1)$	134	$P\bar{3}\|m1$								
		135	$P\bar{3}\|c1$								
		136	$P\bar{3}\|1m$								

Table 1 (*cont.*)

Short Space gruop	No.	Full symbol	No.	Symbol	No.	Symbol	No.	Symbol	Short symbol
$P\bar{3}1c$	165	$P\bar{3}1c$							
$R\bar{3}2m$	166	$R\bar{3}2m$							
$R\bar{3}2c$	167	$R\bar{3}2c$							
$P\bar{6}$	168	$P\bar{6}11$	73	$P(\bar{6})11$	53	$P\bar{6}(11)$	21	$(\bar{6}11)$	$\bar{6}$
$P\bar{6}m2$	169	$P\bar{6}m2$	74	$P(\bar{6})m2$	54	$P\bar{6}(m2)$	22	$(\bar{6}m2)$	$\bar{6}m2$
$P\bar{6}c2$	170	$P\bar{6}c2$			55	$P\bar{6}(c2)$			
$P\bar{6}2m$	171	$P\bar{6}2m$	75	$P(\bar{6})2m$					
$P\bar{6}2c$	172	$P\bar{6}2c$							
$P6$	173	$P611$	76	$P(6)11$	56	$P6(11)$	23	(611)	6
$P6_1$	174	$P6_111$			57	$P6_1(11)$			
$P6_5$	175	$P6_511$			58	$P6_5(11)$			
$P6_2$	176	$P6_211$			59	$P6_2(11)$			
$P6_4$	177	$P6_411$			60	$P6_4(11)$			
$P6_3$	178	$P6_311$			61	$P6_3(11)$			
$P\frac{6}{m}$	179	$P\frac{6}{m}11$	77	$P\left(\frac{6}{m}\right)11$	62	$P\frac{6}{m}(11)$	24	$\left(\frac{6}{m}11\right)$	$\frac{6}{m}$
$P\frac{6_3}{m}$	180	$P\frac{6_3}{m}11$			63	$P\frac{6_3}{m}(11)$			
$P6mm$	181	$P6mm$	78	$P(6)mm$	64	$P6(mm)$	25	$(6mm)$	$6mm$
$P6cc$	182	$P6cc$			65	$P6(cc)$			
$P6_3cm$	183	$P6_3cm$			66	$P6_3(cm)$			
$P6_3mc$	184	$P6_3mc$							
$P62$	185	$P622$	79	$P(6)22$	67	$P6(22)$	26	(622)	622
$P6_12$	186	$P6_122$			68	$P6_1(22)$			
$P6_52$	187	$P6_522$			69	$P6_5(22)$			
$P6_22$	188	$P6_222$			70	$P6_2(22)$			
$P6_42$	189	$P6_422$			71	$P6_4(22)$			
$P6_32$	190	$P6_322$			72	$P6_3(22)$			
$P\frac{6}{m}mm$	191	$P\frac{6}{m}\frac{2}{m}\frac{2}{m}$	80	$P\left(\frac{6}{m}\right)\frac{2}{m}\frac{2}{m}$	73	$P\frac{6}{m}\left(\frac{2}{m}\frac{2}{m}\right)$	27	$\left(\frac{6}{m}\frac{2}{m}\frac{2}{m}\right)$	$\frac{6}{m}mm$
$P\frac{6}{m}cc$	192	$P\frac{6}{m}\frac{2}{c}\frac{2}{c}$			74	$P\frac{6}{m}\left(\frac{2}{c}\frac{2}{c}\right)$			
$P\frac{6_3}{m}cm$	193	$P\frac{6_3}{m}\frac{2}{c}\frac{2}{m}$			75	$P\frac{6}{m}\left(\frac{2}{c}\frac{2}{m}\right)$			
$P\frac{6_3}{m}mc$	194	$P\frac{6_3}{m}\frac{2}{m}\frac{2}{c}$							
	+26 230	cubic space groups					+5 32	cubic crystal classes	

Table 1 (*cont.*)

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
		137	$P\bar{3}\|1c$								
25	$(\bar{6})(11)$	138	$P\bar{6}\|11$								
26	$(\bar{6})(m2)$	139	$P\bar{6}\|m2$								
		140	$P\bar{6}\|c2$								
		141	$P\bar{6}\|2m$								
		142	$P\bar{6}\|2c$								
27	(6)(11)	143	$P6\|11$								
		144	$P6_1\|11$								
		145	$P6_5\|11$								
		146	$P6_2\|11$								
		147	$P6_4\|11$								
		148	$P6_3\|11$								
28	$\left(\frac{6}{m}\right)(11)$	149	$P\frac{6}{m}\Big\|11$								
		150	$P\frac{6_3}{m}\Big\|11$								
29	(6)(mm)	151	$P6\|mm$								
		152	$P6\|cc$								
		153	$P6_3\|cm$								
		154	$P6_3\|mc$								
30	(6)(22)	155	$P6\|22$								
		156	$P6_1\|22$								
		157	$P6_5\|22$								
		158	$P6_2\|22$								
		159	$P6_4\|22$								
		160	$P6_3\|22$								
31	$\left(\frac{6}{m}\right)\frac{2}{m}\frac{2}{m}$	161	$P\frac{6}{m}\Big\|\frac{2}{m}\frac{2}{m}$								
		162	$P\frac{6}{m}\Big\|\frac{2}{c}\frac{2}{c}$								
		163	$P\frac{6}{m}\Big\|\frac{2}{c}\frac{2}{m}$								
		164	$P\frac{6_3}{m}\Big\|\frac{2}{m}\frac{2}{c}$								

Table 2. *The two-dimensional symmetry groups*

Symbol after Niggli		$\mathscr{G}^2$		$\mathscr{G}_1{}^1$		$\mathscr{G}_2$		$\mathscr{G}_{11}$		$\mathscr{G}^{11}$
Symbol after Bohm		G_2		G_{21}		G_{20}		G_{210}		
Form of matrices		$\left(\begin{array}{cc\|c} + & + & + \\ + & + & + \\ \hline 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{cc\|c} + & 0 & + \\ 0 & + & 0 \\ \hline 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{cc\|c} + & + & 0 \\ + & + & 0 \\ \hline 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{cc\|c} + & 0 & 0 \\ 0 & + & 0 \\ \hline 0 & 0 & 1 \end{array}\right)$		$\left(\begin{array}{cc\|c} + & 0 & + \\ 0 & + & + \\ \hline 0 & 0 & 1 \end{array}\right)$
Symbol of the corresponding three-dimensional space group	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
*P*1	1	*p*[1]11	1	*p*[1](1)1	1	[1](11)	1	[1](1)(1)	1	*p*(1)1|1
Pm	2	*p*[1]*m*1	2	*p*[1](*m*)1	2	[1](*m*1)	2	[1](*m*)(1)	2	*p*[1]*m*|1
			3	*p*[1](1)*m*			3	[1](1)(*m*)	3	*p*[1]1|*m*
Pc	3	*p*[1]*c*1	4	*p*[1](*c*)1					4	*p*[1]*c*|1
									5	*p*[1]1|*c*
Cm	4	*a**[1]*m*1								
*P*2	5	*p*[2]11	5	*p*[2](1)1	3	[2](11)	4	[2](1)(1)	6	*p*[2]1|1
Pmm	6	*p*[2]*mm*	6	*p*[2](*m*)*m*	4	[2](*mm*)	5	[2](*m*)(*m*)	7	*p*[2]*m*|*m*
Pma	7	*p*[2]*ma*†							8	*p*[2]*m*|*a*†
			7	*p*[2](*c*)*m*					9	*p*[2]*c*|*m*
Pba	8	*p*[2]*cb*							10	*p*[2]*c*|*b*
Cmm	9	*a**[2]*mm*								
*P*4	10	*p*[4]11			5	[4](11)				
*P*4*mm*	11	*p*[4]*mm*			6	[4](*mm*)				
*P*4*bm*	12	*p*[4]*bm*								
*P*3	13	*p*[3]11			7	[3](11)				
*P*3*m*1	14	*p*[3]*m*1			8	[3](*m*1)				
*P*31*m*	15	*p*[3]1*m*								
*P*6	16	*p*[6]11			9	[6](11)				
*P*6*mm*	17	*p*[6]*mm*			10	[6](*mm*)				

* *a* means a face-centred lattice.
† *a* means a glide-mirror-plane.

one pair of brackets; if such an exchange is not permitted within the set, then separate pairs of brackets are used.

Capital letters are used to indicate the Bravais lattice of objects extending in three dimensions, small letters to indicate the Bravais lattice of two-dimensional objects.

For the symmetry groups with two-dimensional space of transformation (two-dimensional objects) a third place in the symbol is needed not referring to either of the two directions. The place is indicated by square brackets and put in the first position of the symbol. In this way the symbols for the two-dimensional groups correspond closely to the well-known (three-dimensional) space group symbols, as indicated in the first column of Table 2.

Symbols '1' are used to fill places where there are no other symmetry elements.

Sets of symmetry groups with two (or more) non-exchangeable directions with periodicity have not, so far, been listed. They are included in Tables 1 and 2. In their symbols vertical lines separate the symmetry elements corresponding to such non-exchangeable directions. The numbers of the corresponding symmetry groups are: 124 $\mathscr{G}^{21}$; 87 $\mathscr{G}^{111}$; 48 $\mathscr{G}_1^{11}$; and 10 $\mathscr{G}^{11}$. The numbers of the symmetry groups for the other sets have been known for some time.

In the first column of the Tables the corresponding (three-dimensional, short) space group symbol is listed. Different orientations have to be considered in the various sets, and for each orientation a separate line is used.

For a one-dimensional space of transformation only two sets of symmetry groups exist, with two groups each:

the space groups $p1$ and pm for $\mathscr{G}^1$ (G_1), and
the point groups (1) and (m) for $\mathscr{G}_1$ (G_{10}).

The symbols for symmetry groups proposed here seem to us to have the following advantages: They are sufficiently similar to the international space group symbols to be easily understood and visualized, and the tables of equivalent positions *etc.* given in *International Tables* can be used almost as they stand for the corresponding symmetry groups of all sets.

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A Scattering Curve for a Rotating Methane Molecule

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Various scattering factor curves have been calculated for a rotating methane molecule in an attempt to elucidate the effect of slightly different interatomic distances and angular terms. It is concluded that the effect of using slightly different interatomic distances is obscured by effects caused by different methods of obtaining the wave functions, while in the case of methane and, presumably, ammonium the effect of the angular terms is small.

Davis & Whitaker (1966) reported figures for a scattering curve for a spherically symmetrical ammonium group. The scattering curves were calculated for the Hartree self-consistent wave functions of Bernal & Massey (1954) and the analytical wave functions with exchange of Bernal (1953). The values of the scattering factors from these wave functions differed by up to 10% although both wave functions were calculated for the same nitrogen–hydrogen distance of 0·972 Å. This value is somewhat lower than the average value obtained in practice: 1·033 Å (*International Tables for X-ray Crystallography*, 1962, p. 270).

In an attempt to estimate the effect of small differences of interatomic distances on the scattering curves, these have been calculated for a rotating methane molecule.

There are two wave functions for methane comparable with those for ammonium, namely; the Hartree self-consistent wave functions of Buckingham, Massey & Tibbs (1941), calculated assuming a carbon–hydrogen distance of 1·056 Å and the analytical wave functions including exchange of Bernal (1953), calculated assuming a carbon–hydrogen distance of 1·043 Å.

The scattering curve based on the wave functions of Buckingham, Massey & Tibbs (1941) has already been reported (Banyard & March, 1956). However, it has been recalculated for ease in comparison with the other scattering curves; the ammonium wave functions of Bernal & Massey (1954) were calculated by the same method. Bernal (1953) used the same technique for the wave functions of both ammonium and methane. Thus it was thought that comparison of the various curves for ammonium and methane may give an indication as to the effect of slight differences of interatomic distances on the scattering curves. Incidentally, the interatomic distances for methane for which the wave functions were calculated are all considerably less than the average experimental value 1·091 Å (*International Tables for X-ray Crystallography*, 1962, p. 276).

In addition to these wave functions the Hartree–Fock self-consistent wave functions have also been calculated (Mills, 1958) assuming an interatomic distance of 1·056 Å and, in addition, Mills (1961) estimated the effect of the tetrahedral symmetry of the molecule on the radial density distribution (angular terms). The scattering curves for both these models have been calculated to estimate the effect of including the angular terms.

The electron density distributions of these wavefunctions are given in Fig. 1; as expected, the effect of using a smaller interatomic distance causes the electron cloud to be contracted; exchange has a similar although smaller effect, while the effect of the angular terms is to make the electron cloud slightly more diffuse. The last conclusion was also obtained by Banyard & March (1961), but it appears that their conclusions were based on the incorrect angular terms given by Mills (1958). These have now been corrected (Mills, 1961).

However, in the case of ammonium, the use of analytical wave functions gives a contracted electron cloud compared with Hartree wave functions even