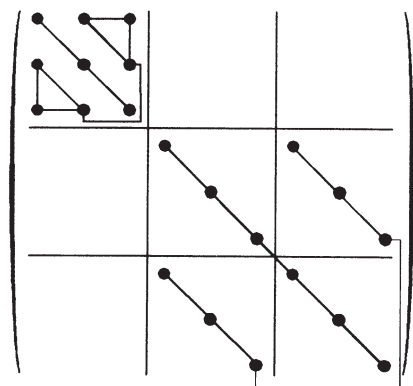


1. TENSORIAL ASPECTS OF PHYSICAL PROPERTIES

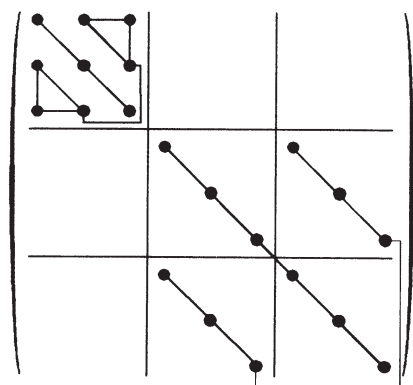
1.1.4.9.7.2. Groups $m\bar{3}m$, 432 , $\bar{4}3m$



There are 4 independent components. The tensor is symmetric.

1.1.4.9.8. Spherical system

1.1.4.9.8.1. Groups $\infty(A_\infty/M)C$ and ∞A_∞



with

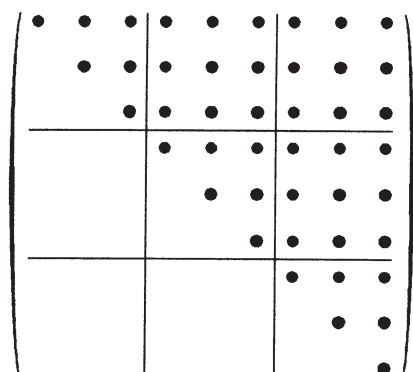
$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 3 independent components. The tensor is symmetric.

1.1.4.9.9. Symmetric tensors of rank 4

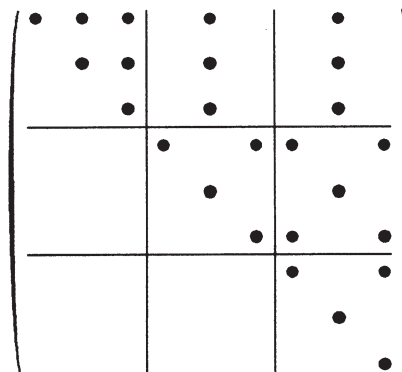
For symmetric tensors such as those representing principal properties, one finds the following, representing the nonzero components for the leading diagonal and for one half of the others.

1.1.4.9.9.1. Triclinic system



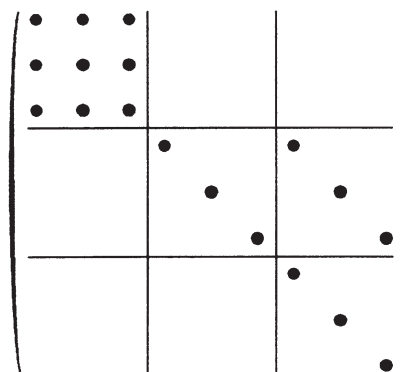
There are 45 independent coefficients.

1.1.4.9.9.2. Monoclinic system



There are 25 independent coefficients.

1.1.4.9.9.3. Orthorhombic system



There are 15 independent coefficients.

1.1.4.9.9.4. Trigonal system

(i) Groups 3 and $\bar{3}$

kl	11	22	33	23	31	12	32	13	21
11	1111	1122	1133	1123	-2231	1112	1132	-2213	-1112
22		1111	1133	-1123	2231	-1121	-1132	2213	-1112
33			3333			3312			-3312
23				2323	2331	2213	2332		2213
31					3131	1132		2332	1132
12						1212	2231	1123	1221
32							3131	-2331	2231
13								2323	1123
21									1212

with

$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 15 independent components.

1.1. INTRODUCTION TO THE PROPERTIES OF TENSORS

(ii) Groups $\bar{3}m, 32, 3m$

kl	11	22	33	23	31	12	32	13	21
ij									
11	1111	1122	1133	1123			1132		
22		1111	1133	-1123			-1132		
33			3333						
23				2323			2332		
31					3131	1132		2332	1132
12						1212		1123	1221
32							3131		
13								2323	1123
21									1212

with

$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 11 independent components.

1.1.4.9.6. Hexagonal and cylindrical systems

(i) Groups $6/m, \bar{6}, 6; (A_\infty/M)C, A_\infty$

kl	11	22	33	23	31	12	32	13	21
ij									
11	1111	1122	1133			1112			1121
22		1111	1133			-1121			-1112
33			3333			3312			-3312
23				2323	2331		2332		
31					3131		3132	2332	
12						1212			1221
32							3131	-2331	
13								2323	
21									1212

with

$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 12 independent components.

(ii) Groups $6/m\bar{m}, 622, 6mm, \bar{6}2m; (A_\infty/M)\infty(A_2/M)C, A_\infty\infty A_2$

kl	11	22	33	23	31	12	32	13	21
ij									
11	1111	1122	1133						
22		1111	1133						
33			3333						
23				2323			2332		
31					3131			3113	
12						1212			1221
32							3131		
13								2323	
21									1212

with

$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 10 independent components.

1.1.4.9.5. Tetragonal system

(i) Groups $4/m, 4, \bar{4}$

kl	11	22	33	23	31	12	32	13	21
ij									
11	1111	1122	1133			1112			-2212
22		1111	1133			2212			-1112
33			3333			3312			-3312
23				2323	2331		2332		
31					3131			2332	
12						1212			1221
32							3131	-2331	
13								2323	
21									1212

There are 13 independent components.

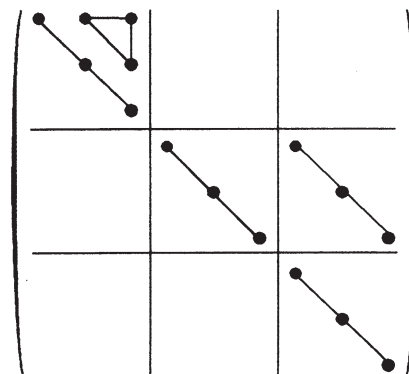
(ii) Groups $4/m\bar{m}, 422, 4mm, \bar{4}2m$

kl	11	22	33	23	31	12	32	13	21
ij									
11	1111	1122	1133						
22		1111	1133						
33			3333						
23				2323			2332		
31					3131			3113	
12						1212			1221
32							3131		
13								2323	
21									1212

There are 9 independent components.

1.1.4.9.7. Cubic system

(i) Groups $23, \bar{3}m$



with

$$t_{1111} - t_{1122} = t_{1212} + t_{1221}.$$

There are 5 independent components.