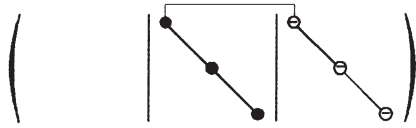


1. TENSORIAL ASPECTS OF PHYSICAL PROPERTIES

1.1.4.8.7.2. Groups 432 and $\infty A_\infty/M$

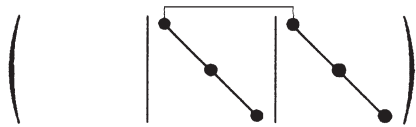
One combines the reductions corresponding to groups 422 and 23:



There is 1 independent component.

1.1.4.8.7.3. Group $\bar{4}3m$

One combines the reductions corresponding to groups $\bar{4}2m$ and 23:



There is 1 independent component.

1.1.4.8.7.4. Groups $m\bar{3}$, $m\bar{3}m$ and $\infty(A_\infty/M)C$

All the components are equal to zero.

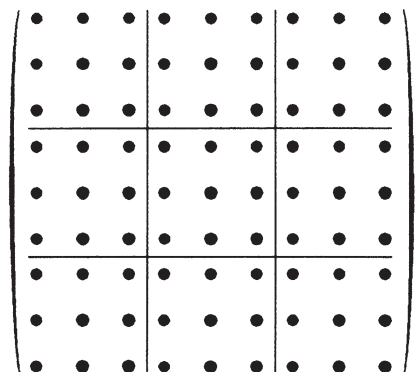
1.1.4.9. Reduction of the components of a tensor of rank 4

1.1.4.9.1. Triclinic system (groups $\bar{1}$, 1)

There is no reduction; all the components are independent. Their number is equal to 81. They are usually represented as a 9×9 matrix, where components t_{ijkl} are replaced by $ijkl$, for brevity:

| <i>kl</i> | 11 | 22 | 33 | 23 | 31 | 12 | 32 | 13 | 21 |
|-----------|------|------|------|------|------|------|------|------|------|
| <i>ij</i> | | | | | | | | | |
| 11 | 1111 | 1122 | 1133 | 1123 | 1131 | 1112 | 1132 | 1113 | 1121 |
| 22 | 2211 | 2222 | 2233 | 2223 | 2231 | 2212 | 2232 | 2213 | 2221 |
| 33 | 3311 | 3322 | 3333 | 3323 | 3331 | 3312 | 3332 | 3313 | 3321 |
| 23 | 2311 | 2322 | 2333 | 2323 | 2331 | 2312 | 2332 | 2313 | 2321 |
| 31 | 3111 | 3122 | 3133 | 3123 | 3131 | 3112 | 3132 | 3113 | 3121 |
| 12 | 1211 | 1222 | 1233 | 1223 | 1231 | 1212 | 1232 | 1213 | 1221 |
| 32 | 3211 | 3222 | 3233 | 3223 | 3231 | 3212 | 3232 | 3213 | 3221 |
| 13 | 1311 | 1322 | 1333 | 1323 | 1331 | 1312 | 1332 | 1313 | 1321 |
| 21 | 2111 | 2122 | 2133 | 2123 | 2131 | 2112 | 2132 | 2113 | 2121 |

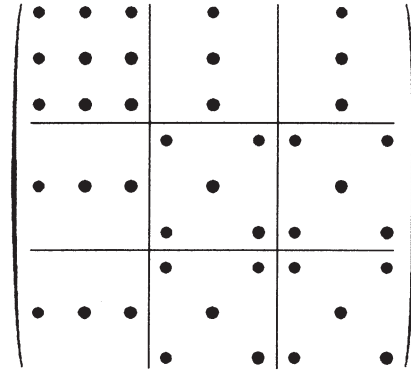
This matrix can be represented symbolically by



where the 9×9 matrix has been subdivided for clarity in to nine 3×3 submatrices.

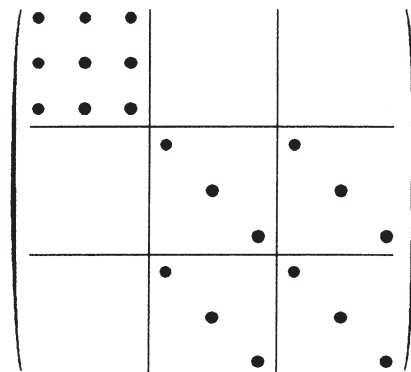
1.1.4.9.2. Monoclinic system (groups $2/m$, 2 , m)

The reduction is obtained by the method of direct inspection. For a twofold axis parallel to Ox_2 , one finds



There are 41 independent components.

1.1.4.9.3. Orthorhombic system (groups mmm , $2mm$, 222)



There are 21 independent components.

1.1.4.9.4. Trigonal system

1.1.4.9.4.1. Groups 3 and $\bar{3}$

The reduction is first applied in the system of axes tied to the eigenvectors of the operator representing a threefold axis. The system of axes is then changed to a system of orthonormal axes with Ox_3 parallel to the threefold axis:

| <i>kl</i> | 11 | 22 | 33 | 23 | 31 | 12 | 32 | 13 | 21 |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>ij</i> | | | | | | | | | |
| 11 | 1111 | 1122 | 1133 | 1123 | -2231 | 1112 | 1132 | -2213 | 1121 |
| 22 | 1122 | 1111 | 1133 | -1123 | 2231 | -1121 | -1132 | 2213 | -1112 |
| 33 | 3311 | 3311 | 3333 | | | 3312 | | | -3312 |
| 23 | 2311 | -2311 | | 2323 | 2331 | 1322 | 2332 | 2313 | 1322 |
| 31 | -3122 | 3122 | | 3123 | 3131 | 3211 | 3132 | 3113 | 3211 |
| 12 | 1211 | -2111 | 1233 | 2213 | 1132 | 1212 | 2231 | 1123 | 1221 |
| 32 | 3211 | -3211 | | 3113 | -3132 | 3122 | 3131 | -3123 | 3122 |
| 13 | -1322 | 1322 | | -2313 | 2332 | 2311 | -2331 | 2323 | 2311 |
| 21 | 2111 | -121 | -1233 | 2213 | 1132 | 1221 | 2231 | 1123 | 1212 |

with

$$\left. \begin{aligned} t_{1111} - t_{1122} &= t_{1212} + t_{1221} \\ t_{1112} + t_{1121} &= -(t_{1211} + t_{2111}). \end{aligned} \right\}$$

There are 27 independent components.