

MSG No. 222.98  $Pn\bar{3}n$  [ Type I, cubic ]

\* symmetry operation

Table 1: Symmetry operations for 3d polar vector.

| No. | tag  | matrix (polar)   | det | TR |
|-----|--|--|-----|----|
| 1   | {1 0}  | $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$                                  | 1   | 1  |
| 2   | {4 <sup>+</sup> <sub>100</sub>  0 <sub>2</sub> <sup>1</sup> 0}                                       | $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & \frac{1}{2} \\ 0 & 1 & 0 & 0 \end{bmatrix}$                       | 1   | 1  |
| 3   | {4 <sup>-</sup> <sub>100</sub>  00 <sub>2</sub> <sup>1</sup> }                                       | $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & \frac{1}{2} \end{bmatrix}$                       | 1   | 1  |
| 4   | {4 <sup>+</sup> <sub>010</sub>  00 <sub>2</sub> <sup>1</sup> }                                       | $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$                       | 1   | 1  |
| 5   | {4 <sup>-</sup> <sub>010</sub>   <sub>2</sub> <sup>1</sup> 00}                                       | $\begin{bmatrix} 0 & 0 & -1 & \frac{1}{2} \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$                       | 1   | 1  |
| 6   | {4 <sup>+</sup> <sub>001</sub>   <sub>2</sub> <sup>1</sup> 00}                                       | $\begin{bmatrix} 0 & -1 & 0 & \frac{1}{2} \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$                       | 1   | 1  |
| 7   | {4 <sup>-</sup> <sub>001</sub>  0 <sub>2</sub> <sup>1</sup> 0}                                       | $\begin{bmatrix} 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & 0 \end{bmatrix}$                       | 1   | 1  |
| 8   | {2 <sub>100</sub>  0 <sub>2</sub> <sup>1</sup> <sub>2</sub> <sup>1</sup> }                           | $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 9   | {2 <sub>010</sub>   <sub>2</sub> <sup>1</sup> 0 <sub>2</sub> <sup>1</sup> }                          | $\begin{bmatrix} -1 & 0 & 0 & \frac{1}{2} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 10  | {2 <sub>001</sub>   <sub>2</sub> <sup>1</sup> <sub>2</sub> <sup>1</sup> 0}                           | $\begin{bmatrix} -1 & 0 & 0 & \frac{1}{2} \\ 0 & -1 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & 0 \end{bmatrix}$            | 1   | 1  |
| 11  | {2 <sub>110</sub>  00 <sub>2</sub> <sup>1</sup> }  | $\begin{bmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & \frac{1}{2} \end{bmatrix}$                       | 1   | 1  |
| 12  | {2 <sub>1-10</sub>   <sub>2</sub> <sup>1</sup> <sub>2</sub> <sup>1</sup> <sub>2</sub> <sup>1</sup> } | $\begin{bmatrix} 0 & -1 & 0 & \frac{1}{2} \\ -1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & \frac{1}{2} \end{bmatrix}$ | 1   | 1  |
| 13  | {2 <sub>011</sub>   <sub>2</sub> <sup>1</sup> 00}  | $\begin{bmatrix} -1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$                       | 1   | 1  |

continued ...

Table 1

| No. | tag  | matrix (polar)   | det | TR |
|-----|--|--|-----|----|
| 14  | $\{2_{01-1} \frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ | $\begin{bmatrix} -1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & \frac{1}{2} \\ 0 & -1 & 0 & \frac{1}{2} \end{bmatrix}$ | 1   | 1  |
| 15  | $\{2_{101} 0\frac{1}{2}0\}$                      | $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & \frac{1}{2} \\ 1 & 0 & 0 & 0 \end{bmatrix}$                       | 1   | 1  |
| 16  | $\{2_{-101} \frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ | $\begin{bmatrix} 0 & 0 & -1 & \frac{1}{2} \\ 0 & -1 & 0 & \frac{1}{2} \\ -1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ | 1   | 1  |
| 17  | $\{3^+_{111} 0\}$                                | $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$                                  | 1   | 1  |
| 18  | $\{3^-_{111} 0\}$                                | $\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$                                  | 1   | 1  |
| 19  | $\{3^-_{1-1-1} \frac{1}{2}0\frac{1}{2}\}$        | $\begin{bmatrix} 0 & -1 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & 0 \\ -1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 20  | $\{3^+_{1-1-1} \frac{1}{2}\frac{1}{2}0\}$        | $\begin{bmatrix} 0 & 0 & -1 & \frac{1}{2} \\ -1 & 0 & 0 & \frac{1}{2} \\ 0 & 1 & 0 & 0 \end{bmatrix}$            | 1   | 1  |
| 21  | $\{3^-_{-11-1} \frac{1}{2}\frac{1}{2}0\}$        | $\begin{bmatrix} 0 & -1 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & \frac{1}{2} \\ 1 & 0 & 0 & 0 \end{bmatrix}$            | 1   | 1  |
| 22  | $\{3^+_{-11-1} 0\frac{1}{2}\frac{1}{2}\}$        | $\begin{bmatrix} 0 & 0 & 1 & 0 \\ -1 & 0 & 0 & \frac{1}{2} \\ 0 & -1 & 0 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 23  | $\{3^-_{-1-11} 0\frac{1}{2}\frac{1}{2}\}$        | $\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & \frac{1}{2} \\ -1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 24  | $\{3^+_{-1-11} \frac{1}{2}0\frac{1}{2}\}$        | $\begin{bmatrix} 0 & 0 & -1 & \frac{1}{2} \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & \frac{1}{2} \end{bmatrix}$            | 1   | 1  |
| 25  | $\{-1 0\}$                                       | $\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \end{bmatrix}$                               | -1  | 1  |
| 26  | $\{-4^+_{100} 0\frac{1}{2}0\}$                   | $\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & -1 & 0 & 0 \end{bmatrix}$                      | -1  | 1  |
| 27  | $\{-4^-_{100} 00\frac{1}{2}\}$                   | $\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & \frac{1}{2} \end{bmatrix}$                      | -1  | 1  |

continued ...

Table 1

| No. | tag  | matrix (polar)  | det | TR |
|-----|--|---|-----|----|
| 28  | $\{-4_{010}^+ 00\frac{1}{2}\}$                   | $\begin{bmatrix} 0 & 0 & -1 & 0 \\ 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$                   | -1  | 1  |
| 29  | $\{-4_{010}^- \frac{1}{2}00\}$                   | $\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 0 \end{bmatrix}$                   | -1  | 1  |
| 30  | $\{-4_{001}^+ \frac{1}{2}00\}$                   | $\begin{bmatrix} 0 & 1 & 0 & \frac{1}{2} \\ -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 \end{bmatrix}$                   | -1  | 1  |
| 31  | $\{-4_{001}^- 0\frac{1}{2}0\}$                   | $\begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & 0 \end{bmatrix}$                   | -1  | 1  |
| 32  | $\{m_{100} 0\frac{1}{2}\frac{1}{2}\}$            | $\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & \frac{1}{2} \end{bmatrix}$          | -1  | 1  |
| 33  | $\{m_{010} \frac{1}{2}0\frac{1}{2}\}$            | $\begin{bmatrix} 1 & 0 & 0 & \frac{1}{2} \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \end{bmatrix}$          | -1  | 1  |
| 34  | $\{m_{001} \frac{1}{2}\frac{1}{2}0\}$            | $\begin{bmatrix} 1 & 0 & 0 & \frac{1}{2} \\ 0 & 1 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & 0 \end{bmatrix}$          | -1  | 1  |
| 35  | $\{m_{110} 00\frac{1}{2}\}$                      | $\begin{bmatrix} 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \end{bmatrix}$                   | -1  | 1  |
| 36  | $\{m_{1-10} \frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ | $\begin{bmatrix} 0 & 1 & 0 & \frac{1}{2} \\ 1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 37  | $\{m_{011} \frac{1}{2}00\}$                      | $\begin{bmatrix} 1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}$                   | -1  | 1  |
| 38  | $\{m_{01-1} \frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ | $\begin{bmatrix} 1 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & 1 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 39  | $\{m_{101} 0\frac{1}{2}0\}$                      | $\begin{bmatrix} 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & \frac{1}{2} \\ -1 & 0 & 0 & 0 \end{bmatrix}$                   | -1  | 1  |
| 40  | $\{m_{-101} \frac{1}{2}\frac{1}{2}\frac{1}{2}\}$ | $\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ 0 & 1 & 0 & \frac{1}{2} \\ 1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 41  | $\{-3_{111}^+ 0\}$                               | $\begin{bmatrix} 0 & 0 & -1 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{bmatrix}$                            | -1  | 1  |

continued ...

Table 1

| No. | tag   | matrix (polar)   | det | TR |
|-----|---|--|-----|----|
| 42  | $\{-3_{111}^- 0\}$                          | $\begin{bmatrix} 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ -1 & 0 & 0 & 0 \end{bmatrix}$                   | -1  | 1  |
| 43  | $\{-3_{-1-1-1}^- \frac{1}{2}0\frac{1}{2}\}$ | $\begin{bmatrix} 0 & 1 & 0 & \frac{1}{2} \\ 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 44  | $\{-3_{1-1-1}^+ \frac{1}{2}\frac{1}{2}0\}$  | $\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ 1 & 0 & 0 & \frac{1}{2} \\ 0 & -1 & 0 & 0 \end{bmatrix}$ | -1  | 1  |
| 45  | $\{-3_{-11-1}^- \frac{1}{2}\frac{1}{2}0\}$  | $\begin{bmatrix} 0 & 1 & 0 & \frac{1}{2} \\ 0 & 0 & 1 & \frac{1}{2} \\ -1 & 0 & 0 & 0 \end{bmatrix}$ | -1  | 1  |
| 46  | $\{-3_{-11-1}^+ 0\frac{1}{2}\frac{1}{2}\}$  | $\begin{bmatrix} 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & \frac{1}{2} \\ 0 & 1 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 47  | $\{-3_{-1-11}^- 0\frac{1}{2}\frac{1}{2}\}$  | $\begin{bmatrix} 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 1 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |
| 48  | $\{-3_{-1-11}^+ \frac{1}{2}0\frac{1}{2}\}$  | $\begin{bmatrix} 0 & 0 & 1 & \frac{1}{2} \\ -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & \frac{1}{2} \end{bmatrix}$ | -1  | 1  |