

MPG No. 7.4.23 $m'm'2$ [Type III, orthorhombic] [M tensor]

* Rank 0 tensor.

$$[M]$$

$$M = M_s^{(1)}$$

* Rank 1 tensor.

$$[0 \quad 0 \quad M_z]$$

$$M_z = M_{pz}^{(1)}$$

* Rank 2 tensor (s).

$$\begin{bmatrix} M_{xx} & 0 & 0 \\ 0 & M_{yy} & 0 \\ 0 & 0 & M_{zz} \end{bmatrix}$$

$$M_{xx} = -M_{du}^{(1)} + M_{dv}^{(1)} + M_s^{(1)}$$

$$M_{yy} = -M_{du}^{(1)} - M_{dv}^{(1)} + M_s^{(1)}$$

$$M_{zz} = 2M_{du}^{(1)} + M_s^{(1)}$$

* Rank 2 tensor (a). * Rank 3 tensor (s).

$$\begin{bmatrix} 0 & 0 & M_{xxz} \\ 0 & 0 & M_{yyz} \\ 0 & 0 & M_{zzz} \\ 0 & M_{yzy} & 0 \\ M_{zxx} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{xxz} = -M_{faz}^{(1)} + M_{fbz}^{(1)} + M_{pz}^{(1)} - 2T_{dxy}^{(1)}$$

$$M_{yyz} = -M_{faz}^{(1)} - M_{fbz}^{(1)} + M_{pz}^{(1)} + 2T_{dxy}^{(1)}$$

$$M_{zzz} = 2M_{faz}^{(1)} + M_{pz}^{(1)} + 2M_{pz}^{(2)}$$

$$M_{yzy} = -M_{faz}^{(1)} - M_{fbz}^{(1)} + M_{pz}^{(2)} - T_{dxy}^{(1)}$$

$$M_{zxx} = -M_{faz}^{(1)} + M_{fbz}^{(1)} + M_{pz}^{(2)} + T_{dxy}^{(1)}$$

* Rank 3 tensor (a).

$$\begin{bmatrix} 0 & M_{yzy} & 0 \\ M_{zxx} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{yzy} = M_{pz}^{(3)} + T_{dxy}^{(2)}$$

$$M_{zxx} = -M_{pz}^{(3)} + T_{dxy}^{(2)}$$

* Rank 4 tensor (sss).

$$\begin{bmatrix} M_{xxxx} & M_{xxyy} & M_{xxzz} & 0 & 0 & 0 \\ M_{xxyy} & M_{yyyy} & M_{yyzz} & 0 & 0 & 0 \\ M_{xxzz} & M_{yyzz} & M_{zzzz} & 0 & 0 & 0 \\ 0 & 0 & 0 & M_{yzyz} & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{zxxz} & 0 \\ 0 & 0 & 0 & 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$\begin{aligned}
M_{xxxx} &= -2M_{du}^{(1)} - 4M_{du}^{(2)} + 2M_{dv}^{(1)} + 4M_{dv}^{(2)} - M_{gu}^{(1)} + M_{gv}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} \\
M_{xxyy} &= -2M_{du}^{(1)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{xxzz} &= M_{du}^{(1)} + M_{dv}^{(1)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{yyyy} &= -2M_{du}^{(1)} - 4M_{du}^{(2)} - 2M_{dv}^{(1)} - 4M_{dv}^{(2)} - M_{gu}^{(1)} - M_{gv}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} \\
M_{yyzz} &= M_{du}^{(1)} - M_{dv}^{(1)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{zzzz} &= 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} \\
M_{yzyz} &= M_{du}^{(2)} - M_{dv}^{(2)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(2)} \\
M_{zxzx} &= M_{du}^{(2)} + M_{dv}^{(2)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(2)} \\
M_{xyxy} &= -2M_{du}^{(2)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)}
\end{aligned}$$

* Rank 4 tensor (ssa).

$$\begin{bmatrix} 0 & M_{xxyy} & M_{xxzz} & 0 & 0 & 0 \\ -M_{xxyy} & 0 & M_{yyzz} & 0 & 0 & 0 \\ -M_{xxzz} & -M_{yyzz} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{aligned}
M_{xxyy} &= -2M_{dv}^{(3)} + 4T_{f3}^{(1)} \\
M_{xxzz} &= 3M_{du}^{(3)} - M_{dv}^{(3)} - 4T_{f3}^{(1)} \\
M_{yyzz} &= 3M_{du}^{(3)} + M_{dv}^{(3)} + 4T_{f3}^{(1)}
\end{aligned}$$

* Rank 4 tensor (aas).

$$\begin{bmatrix} M_{yzyz} & 0 & 0 \\ 0 & M_{zxzx} & 0 \\ 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$\begin{aligned}
M_{yzyz} &= -2M_{du}^{(4)} + 2M_{dv}^{(4)} + M_s^{(3)} \\
M_{zxzx} &= -2M_{du}^{(4)} - 2M_{dv}^{(4)} + M_s^{(3)} \\
M_{xyxy} &= 4M_{du}^{(4)} + M_s^{(3)}
\end{aligned}$$

* Rank 4 tensor (aaa). * Rank 4 tensor (sa).

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ M_{yzyz} & 0 & 0 \\ 0 & M_{zxzx} & 0 \\ 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$\begin{aligned}
M_{yzyz} &= -3M_{du}^{(5)} - M_{dv}^{(5)} + T_{f3}^{(2)} \\
M_{zxzx} &= 3M_{du}^{(5)} - M_{dv}^{(5)} + T_{f3}^{(2)} \\
M_{xyxy} &= 2M_{dv}^{(5)} + T_{f3}^{(2)}
\end{aligned}$$

* Rank 4 tensor (as).

$$\begin{bmatrix} 0 & 0 & 0 & M_{yzyz} & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{zxzx} & 0 \\ 0 & 0 & 0 & 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$M_{yzyz} = -3M_{du}^{(6)} - M_{dv}^{(6)} + T_{f3}^{(3)}$$

$$M_{zxzx} = 3M_{du}^{(6)} - M_{dv}^{(6)} + T_{f3}^{(3)}$$

$$M_{xyxy} = 2M_{dv}^{(6)} + T_{f3}^{(3)}$$

* Rank 4 tensor (s).

$$\begin{bmatrix} M_{xxxx} & M_{xxyy} & M_{xxzz} & 0 & 0 & 0 & 0 & 0 \\ M_{yyxx} & M_{yyyy} & M_{yyzz} & 0 & 0 & 0 & 0 & 0 \\ M_{zzxx} & M_{zzyy} & M_{zzzz} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & M_{yzyz} & 0 & 0 & M_{yzyy} & 0 \\ 0 & 0 & 0 & 0 & M_{zxzx} & 0 & 0 & M_{zxzx} \\ 0 & 0 & 0 & 0 & M_{xyxy} & 0 & 0 & M_{xyyx} \end{bmatrix}$$

$$M_{xxxx} = -2M_{du}^{(1)} - 4M_{du}^{(2)} + 2M_{dv}^{(1)} + 4M_{dv}^{(2)} - M_{gu}^{(1)} + M_{gv}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)}$$

$$M_{xxyy} = -2M_{du}^{(1)} - 2M_{dv}^{(3)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} + 4T_{f3}^{(1)}$$

$$M_{xxzz} = M_{du}^{(1)} + 3M_{du}^{(3)} + M_{dv}^{(1)} - M_{dv}^{(3)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} - 4T_{f3}^{(1)}$$

$$M_{yyxx} = -2M_{du}^{(1)} + 2M_{dv}^{(3)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} - 4T_{f3}^{(1)}$$

$$M_{yyyy} = -2M_{du}^{(1)} - 4M_{du}^{(2)} - 2M_{dv}^{(1)} - 4M_{dv}^{(2)} - M_{gu}^{(1)} - M_{gv}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)}$$

$$M_{yyzz} = M_{du}^{(1)} + 3M_{du}^{(3)} - M_{dv}^{(1)} + M_{dv}^{(3)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} + 4T_{f3}^{(1)}$$

$$M_{zzxx} = M_{du}^{(1)} - 3M_{du}^{(3)} + M_{dv}^{(1)} + M_{dv}^{(3)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} + 4T_{f3}^{(1)}$$

$$M_{zzyy} = M_{du}^{(1)} - 3M_{du}^{(3)} - M_{dv}^{(1)} - M_{dv}^{(3)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} - 4T_{f3}^{(1)}$$

$$M_{zzzz} = 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)}$$

$$M_{yzyz} = M_{du}^{(2)} - 3M_{du}^{(5)} - M_{dv}^{(2)} - M_{dv}^{(5)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} + T_{f3}^{(2)}$$

$$M_{yzyy} = M_{du}^{(2)} + 3M_{du}^{(5)} - M_{dv}^{(2)} + M_{dv}^{(5)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(2)} - T_{f3}^{(2)}$$

$$M_{zxzx} = M_{du}^{(2)} + 3M_{du}^{(5)} + M_{dv}^{(2)} - M_{dv}^{(5)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(2)} + T_{f3}^{(2)}$$

$$M_{zxxz} = M_{du}^{(2)} - 3M_{du}^{(5)} + M_{dv}^{(2)} + M_{dv}^{(5)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(2)} - T_{f3}^{(2)}$$

$$M_{xyxy} = -2M_{du}^{(2)} + 2M_{dv}^{(5)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} + T_{f3}^{(2)}$$

$$M_{xyyx} = -2M_{du}^{(2)} - 2M_{dv}^{(5)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} + M_s^{(2)} - T_{f3}^{(2)}$$

* Rank 4 tensor (a).

$$\begin{bmatrix} 0 & 0 & 0 & M_{yzyz} & 0 & 0 & M_{yzyy} & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{zxzx} & 0 & 0 & M_{zxzx} & 0 \\ 0 & 0 & 0 & 0 & 0 & M_{xyxy} & 0 & 0 & M_{xyyx} \end{bmatrix}$$

$$M_{yzyz} = -2M_{du}^{(4)} - 3M_{du}^{(6)} + 2M_{dv}^{(4)} - M_{dv}^{(6)} + M_s^{(3)} + T_{f3}^{(3)}$$

$$M_{yzyy} = 2M_{du}^{(4)} - 3M_{du}^{(6)} - 2M_{dv}^{(4)} - M_{dv}^{(6)} - M_s^{(3)} + T_{f3}^{(3)}$$

$$M_{zxzx} = -2M_{du}^{(4)} + 3M_{du}^{(6)} - 2M_{dv}^{(4)} - M_{dv}^{(6)} + M_s^{(3)} + T_{f3}^{(3)}$$

$$M_{zxxz} = 2M_{du}^{(4)} + 3M_{du}^{(6)} + 2M_{dv}^{(4)} - M_{dv}^{(6)} - M_s^{(3)} + T_{f3}^{(3)}$$

$$M_{xyxy} = 4M_{du}^{(4)} + 2M_{dv}^{(6)} + M_s^{(3)} + T_{f3}^{(3)}$$

$$M_{xyyx} = -4M_{du}^{(4)} + 2M_{dv}^{(6)} - M_s^{(3)} + T_{f3}^{(3)}$$

* Rank 4 tensor (t).

$$\begin{bmatrix} M_{xxxx} & 0 & 0 \\ 0 & M_{yyyy} & 0 \\ 0 & 0 & M_{zzzz} \\ 0 & 0 & M_{yyzz} \\ M_{zzxx} & 0 & 0 \\ 0 & M_{xxyy} & 0 \\ 0 & M_{yzyy} & 0 \\ 0 & 0 & M_{zxxz} \\ M_{xxyy} + M_{yyzz} - M_{yzyy} - M_{zxxz} + M_{zzxx} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{xxxx} = -2M_{du}^{(1)} - 4M_{du}^{(2)} + 2M_{dv}^{(1)} + 4M_{dv}^{(2)} - M_{gu}^{(1)} + M_{gv}^{(1)} + 2M_g^{(1)} + 3M_s^{(1)}$$

$$M_{yyyy} = -2M_{du}^{(1)} - 4M_{du}^{(2)} - 2M_{dv}^{(1)} - 4M_{dv}^{(2)} - M_{gu}^{(1)} - M_{gv}^{(1)} + 2M_g^{(1)} + 3M_s^{(1)}$$

$$M_{zzzz} = 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + 3M_s^{(1)}$$

$$M_{yyzz} = M_{du}^{(1)} + 3M_{du}^{(3)} - M_{dv}^{(1)} + M_{dv}^{(3)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{zxxz} = M_{du}^{(1)} - 3M_{du}^{(3)} + M_{dv}^{(1)} + M_{dv}^{(3)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{xxyy} = -2M_{du}^{(1)} - 2M_{dv}^{(3)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{yzyy} = M_{du}^{(2)} + 3M_{du}^{(5)} - M_{dv}^{(2)} + M_{dv}^{(5)} - M_{gu}^{(1)} + M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{zxxz} = M_{du}^{(2)} - 3M_{du}^{(5)} + M_{dv}^{(2)} + M_{dv}^{(5)} - M_{gu}^{(1)} - M_{gv}^{(1)} - M_g^{(1)} + M_s^{(1)}$$