

Appendix: SU(3) generators

Define a function

$$F[(p, q), Y, I] = \frac{1}{\sqrt{2I}} \sqrt{\left(\frac{1}{3}(q-p) + I - Y\right)} \times \sqrt{\left(1 + \frac{1}{3}(p+2q) - I + \frac{1}{2}Y\right) \left(1 + \frac{1}{3}(2p+2) + I - \frac{1}{2}Y\right)}. \quad (1)$$

With this we have:

$$\begin{aligned} V_+ \left| (p, q), Y, I, I_3 \right\rangle &= \sqrt{\frac{I+I_3+1}{2I+1}} F[(q, p), -Y, I+1] \left| (p, q), Y+1, I+\frac{1}{2}, I_3+\frac{1}{2} \right\rangle \\ &\quad + \sqrt{\frac{I-I_3}{2I+1}} F[(p, q), Y, I] \left| (p, q), Y+1, I-\frac{1}{2}, I_3+\frac{1}{2} \right\rangle, \\ V_- \left| (p, q), Y, I, I_3 \right\rangle &= \sqrt{\frac{I-I_3+1}{2I+1}} F[(p, q), Y, I+1] \left| (p, q), Y-1, I+\frac{1}{2}, I_3-\frac{1}{2} \right\rangle \\ &\quad + \sqrt{\frac{I+I_3}{2I+1}} F[(q, p), -Y, I] \left| (p, q), Y-1, I-\frac{1}{2}, I_3-\frac{1}{2} \right\rangle, \end{aligned} \quad (2)$$

and

$$\begin{aligned} U_+ \left| (p, q), Y, I, I_3 \right\rangle &= \sqrt{\frac{I-I_3+1}{2I+1}} F[(q, p), -Y, I+1] \left| (p, q), Y+1, I+\frac{1}{2}, I_3-\frac{1}{2} \right\rangle \\ &\quad - \sqrt{\frac{I+I_3}{2I+1}} F[(p, q), Y, I] \left| (p, q), Y+1, I-\frac{1}{2}, I_3-\frac{1}{2} \right\rangle, \\ U_- \left| (p, q), Y, I, I_3 \right\rangle &= -\sqrt{\frac{I+I_3+1}{2I+1}} F[(p, q), Y, I+1] \left| (p, q), Y-1, I+\frac{1}{2}, I_3+\frac{1}{2} \right\rangle \\ &\quad + \sqrt{\frac{I-I_3}{2I+1}} F[(q, p), -Y, I] \left| (p, q), Y-1, I-\frac{1}{2}, I_3+\frac{1}{2} \right\rangle. \end{aligned} \quad (3)$$