$\mathbf{H}_{\Lambda\text{-doubling}}$:

$\Sigma = \Omega - 1$. The raising and lowering operators are implicitly Λ dependent*. The convention is that, for example, $\langle \Lambda = 1 | S_-^2 | \Lambda = -1 \rangle$ and $\langle \Lambda = -1 | S_+^2 | \Lambda = 1 \rangle$ (i.e. the matrix elements are assumed to connect states of opposite Λ exclusively).

$$
\begin{aligned}
\langle \Lambda = \pm 1, S\Sigma' J\Omega'\pi' | H_{\Lambda-doubling} | \Lambda = \mp 1, S\Sigma J\Omega\pi \rangle &= \delta_{\Omega+\Omega',0}(o+p+q)\frac{\pi}{2}(-1)^{J-S} \\
&\quad \times \sqrt{\begin{matrix}[S(S+1)-\Sigma(\Sigma+1)] \\ \times [S(S+1)-(\Sigma+1)(\Sigma+2)]\end{matrix}} \\
&\quad + \delta_{\Omega+\Omega',1}(p+2q)\frac{\pi}{2}(-1)^{J-S+1}\sqrt{[S(S+1)-\Sigma(\Sigma+1)][J(J+1)-\Omega(\Omega-1)]} \\
&\quad + \delta_{\Omega+\Omega',2}\, q\frac{\pi}{2}(-1)^{J-S}\sqrt{[J(J+1)-\Omega(\Omega-1)][J(J+1)-(\Omega-1)(\Omega-2)]}
\end{aligned}
$$

$$
\begin{aligned}
\langle \Lambda = \pm 1, S\Sigma' J\Omega'\pi' | H_{\Lambda-doubling,cd} | \Lambda = \mp 1, S\Sigma J\Omega\pi \rangle &= (o_D + p_D + q_D)\frac{1}{4}(-1)^{J-S} \\
&\times \left[\begin{matrix} \pi'\delta_{\Omega+\Omega'',0}\sqrt{\begin{matrix}[S(S+1)-\Sigma'(\Sigma'+1)] \\ \times [S(S+1)-(\Sigma'+1)(\Sigma'+2)]\end{matrix}}\dfrac{\langle \Lambda, S\Sigma'' J\Omega''\pi'' | H_{rot} | \Lambda = \mp 1, S\Sigma J\Omega\pi \rangle}{B} \\ + \pi\delta_{\Omega'+\Omega'',0}\sqrt{\begin{matrix}[S(S+1)-\Sigma(\Sigma+1)] \\ \times [S(S+1)-(\Sigma+1)(\Sigma+2)]\end{matrix}}\dfrac{\langle \Lambda = \pm 1, S\Sigma' J\Omega'\pi' | H_{rot} | \Lambda, S\Sigma'' J\Omega''\pi'' \rangle}{B} \end{matrix} \right] \\
&+ (p_D + 2q_D)\frac{1}{4}(-1)^{J-S+1} \\
&\times \left[\begin{matrix} \pi'\delta_{\Omega+\Omega'',1}\sqrt{[S(S+1)-\Sigma'(\Sigma'+1)][J(J+1)-\Omega'(\Omega'-1)]}\dfrac{\langle \Lambda, S\Sigma'' J\Omega''\pi'' | H_{rot} | \Lambda = \mp 1, S\Sigma J\Omega\pi \rangle}{B} \\ + \pi\delta_{\Omega'+\Omega'',1}\sqrt{[S(S+1)-\Sigma(\Sigma+1)][J(J+1)-\Omega(\Omega-1)]}\dfrac{\langle \Lambda = \pm 1, S\Sigma' J\Omega'\pi' | H_{rot} | \Lambda S\Sigma'' J\Omega''\pi'' \rangle}{B} \end{matrix} \right] \\
&+ q_D\frac{1}{4}(-1)^{J-S} \\
&\times \left[\begin{matrix} \pi'\delta_{\Omega+\Omega'',2}\sqrt{[J(J+1)-\Omega'(\Omega'-1)][J(J+1)-(\Omega'-1)(\Omega'-2)]}\dfrac{\langle \Lambda S\Sigma'' J\Omega''\pi'' | H_{rot} | \Lambda = \mp 1, S\Sigma J\Omega\pi \rangle}{B} \\ + \pi\delta_{\Omega''+\Omega',2}\sqrt{[J(J+1)-\Omega(\Omega-1)][J(J+1)-(\Omega-1)(\Omega-2)]}\dfrac{\langle \Lambda = \pm 1, S\Sigma' J\Omega'\pi' | H_{rot} | \Lambda S\Sigma'' J\Omega''\pi'' \rangle}{B} \end{matrix} \right]
\end{aligned}
$$

* J.M. Brown and A.J. Merer, *J. Mol. Spec.*, **74**, 488-494 (1979).