a. The “LIT equation”

$$\left(\hat{H}_{\text{nuclear}}\underbrace{-E_0-\mathcal{R}\left[\sigma\right]-i\,\mathcal{I}\left[\sigma\right]}_{:=-\mathcal{E}}\right)\Psi^{J^\pi}_{\text{LIT}}=\left[\hat{\mathcal{O}}_{LM}\left\{\left|\boldsymbol{k}\right|,\boldsymbol{j}_i\right\}\otimes\Psi_0^{J_0^{\pi_0}}\right]^{J^\pi}\quad . \tag{1}$$

with

$$i\in\{\ \boldsymbol{j}_o(\boldsymbol{x})=\dots\ ,\ \boldsymbol{j}_s(\boldsymbol{x})=\dots\ ,\ \boldsymbol{j}_{mec}(\boldsymbol{x})=\dots\ ,\ \dots\}\quad ; \tag{2}$$

b. The variational basis

$$\Psi^{J^\pi}_{\text{LIT}}=\sum_n c_n\ \phi_n^{J^\pi}\quad . \tag{3}$$

with

$$\phi_n^{J^\pi}=\left[\xi_{S_n}\otimes\mathcal{Y}_{l_n}(\boldsymbol{\rho})\right]^J\ e^{-\gamma_n\boldsymbol{\rho}^2}\quad (i.e.\text{ , LS coupling})\ ; \tag{4}$$

c. The matrix form of the “LIT equation”

$$\sum_{s=1}^{N_{\text{LIT}}}\phi_r^{J^\pi}\left(\hat{H}_{\text{nuclear}}-\mathcal{E}\right)\phi_s^{J^\pi}\ u_s=\phi_m^{J^\pi}\hat{\mathcal{O}}_{LM}\cdot\left(\ L\ \ M\ \ J_0\ \ M_0\,\middle|\,J\ \ M\ \right)\ \sum_{n=1}^{N_0}\phi_n^{J_0^{\pi_0}}\ c_n\quad . \tag{5}$$

with

$$\dots \tag{6}$$

d. The matrix element

$$\phi_m^{J^\pi}\ \hat{\mathcal{O}}_{LM}\ \phi_n^{J_0^{\pi_0}}:=\langle\ mJ_lj_l\ \mid\mathcal{A}\ \mathcal{O}_{LM}\ \mid nJ_rj_r\ \ \rangle \tag{7}$$

$$= \tag{8}$$

with

$$\dots \tag{9}$$

I. FORMULAS AND CONSTANTS

(Wigner) 3-j symbol:

$$\begin{pmatrix} L & S & J \\ m_l & m_s & -m_j \end{pmatrix} = (-1)^{L-S+m_j}\ (2J+1)^{-\frac{1}{2}}\ (Lm_l\ Sm_s \mid LS\ Jm_j) \tag{10}$$

Matrix for single-axis rotation:

$$\begin{aligned} \mathcal{D}^{(j)}_{m',m}(0\ \beta\ 0) &\equiv d^{(j)}_{m',m}(\beta) \\ &= \left[\frac{(j+m')!(j-m')!}{(j+m)!(j-m)!}\right]^{\frac{1}{2}} \\ &\quad \cdot \sum_{\sigma} \binom{j+m}{j-m'-\sigma} \binom{j-m}{\sigma} (-1)^{j-m'-\sigma} \\ &\quad \cdot \left(\cos\frac{\beta}{2}\right)^{2\sigma+m+m'} \left(\sin\frac{\beta}{2}\right)^{2j-2\sigma-m-m'} \end{aligned} \tag{11}$$