Spin-correlated $SU(M)$ coherent states

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We shall generalise the $SU(M)$ fermionic coherent state construction to

$$\left\langle \phi_0^\alpha + A^\alpha - B^\alpha ; \phi_0^\beta + A^\beta - B^\beta \middle| Z \right\rangle \propto \det_{M_\alpha, M_\beta} Z_{\langle A^\alpha \rangle, \langle B^\alpha \rangle, \langle A^\beta \rangle, \langle B^\beta \rangle} \tag{1}$$

where the two-determinant is defined as

$$\det_{m,n} S = \sum_{P_a \in P^m} \sum_{P_b \in P^n} \mathrm{sgn} P_a \mathrm{sgn} P_b \prod_{i=1}^{m} \prod_{j=1}^{n} S_{i, P_a(i), j, P_b(j)} \tag{2}$$

where S is a map $U \otimes V \to U \otimes V$ on a pair of vector spaces with $\dim U = m, \dim V = n$ spanned by $\hat{e}_i, \hat{e}_{i'}$, such that

$$S \hat{e}_i \otimes \hat{e}_{i'} = \sum_{j=1}^{m} \sum_{j'=1}^{n} S_{iji'j'} \hat{e}_j \otimes \hat{e}_{j'} \tag{3}$$