Case I

$$\Gamma'_{ij} = \left\langle \frac{A^R_{ri} + A^R_{ri+1}}{\sqrt{2}}, \frac{B^C_{cj} + B^C_{cj+1}}{\sqrt{2}} \right\rangle \tag{1}$$

$$\Gamma'_{i,j} = \frac{1}{2}(\langle A^R_{ri}, B^C_{cj} \rangle + \langle A^R_{ri+1}, B^C_{cj} \rangle + \langle A^R_{ri}, B^C_{cj+1} \rangle + \langle A^R_{ri+1}, B^C_{cj+1} \rangle)$$

$$\psi(AB) = \psi(\Gamma)$$

$$C_{i,j} = \langle A_{ri}, B_{cj} \rangle$$

$$\psi_{1C}(\Gamma)_{i,j} = \frac{1}{\sqrt{2}} \langle A_{ri}, B_{cj} \rangle + \langle A_{ri+1}, B_{cj} \rangle \tag{2}$$

$$\psi_{1C}(\Gamma)_{i,j+1} = \frac{1}{\sqrt{2}} \langle A_{ri}, B_{cj+1} \rangle + \langle A_{ri+1}, B_{cj+1} \rangle \tag{3}$$

$$\psi(\Gamma) = \frac{1}{\sqrt{2}}(\psi_{1C}(\Gamma)_{i,j} + \psi_{1C}(\Gamma)_{i,j+1}) \tag{4}$$

$$\psi(\Gamma) = \frac{1}{2}(\langle A_{ri}, B_{cj} \rangle + \langle A_{ri+1}, B_{cj} \rangle + \langle A_{ri}, B_{cj+1} \rangle + \langle A_{ri+1}, B_{cj+1} \rangle) \tag{5}$$