Initially

$$\rho = \frac{1}{3}\begin{pmatrix} a(t) & 0 & 0 & 0 \\ 0 & b(t) & z(t) & 0 \\ 0 & z^*(t) & c(t) & 0 \\ 0 & 0 & 0 & d(t) \end{pmatrix}$$

For simplicity, consider an important class of mixed states with a single parameter "a" satisfying initially $a \geq 0$, $d = 1-a$, $b = c = z = 1$

Let's assume, initially $a = 1$ then the density matrix becomes:

$$\rho_{AB}(0) = \frac{1}{3}\begin{array}{c} \begin{array}{cccc} ee & eg & ge & gg \\ \langle\uparrow\uparrow| & \langle\uparrow\downarrow| & \langle\downarrow\uparrow| & \langle\downarrow\downarrow| \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \end{array} \begin{array}{c} \\ \\ \langle\uparrow\uparrow| \\ \langle\uparrow\downarrow| \\ \langle\downarrow\uparrow| \\ \langle\downarrow\downarrow| \end{array}$$

$$\rho_{sys}(0) = \underbrace{\rho_{AB}(0)}_{\text{Atom}} \otimes \underbrace{|0_a 0_b\rangle\langle 0_a 0_b|}_{\text{Cavity}}$$

$$\rho_{sys}(t) = ?$$

- WHAT CAN BE DONE FOR INFINITE NODES?

- IS CONSERVATION STILL POSSIBLE?

1. Write down the $\rho_{AB}(0)$ in terms of e and g

$$\rho_{AB}(0) = \frac{1}{3}|e_A,e_B\rangle\langle e_A,e_B| + \frac{1}{3}|e_A,g_B\rangle\langle e_A,g_B| + \frac{1}{3}|g_A,e_B\rangle\langle e_A,g_B|$$
$$+ \frac{1}{3}|e_A,g_B\rangle\langle g_A,e_B| + \frac{1}{3}|g_A,e_B\rangle\langle g_A,e_B|$$

$$\rho_{AB}(0) = \sum_i p_i |\psi_i(0)\rangle\langle\psi_i(0)|$$

$$\bar{\Psi}_1(0) = |e_A,e_B\rangle \quad , p_1 = \frac{1}{3} \rightarrow \text{Find } \Psi_1(t)$$

$$\bar{\Psi}_2(0) = \frac{1}{\sqrt{2}}\left(|e_A,g_B\rangle + |g_A,e_B\rangle\right) \quad , p_2 = \frac{2}{3} \rightarrow \text{Find } \Psi_2(t)$$

$$\boxed{\rho_{AB}(0) = \frac{1}{3}|\bar{\Psi}_1(0)\rangle\langle\bar{\Psi}_1(0)| + \frac{2}{3}|\bar{\Psi}_2(0)\rangle\langle\bar{\Psi}_2(0)|}$$

$\bar{\Psi}_1(0)$ can be written in terms of $|\Phi_{AB}\rangle = \cos\alpha|e_A,e_B\rangle + \sin\alpha|g_A,g_B\rangle$

For $\alpha = 0$ $\quad \bar{\Psi}_1(0) = |\Phi_{AB}\rangle = |e_A,e_B\rangle$

$$\Psi_1(0) = \bar{\Psi}_1(0) \otimes |0_a,0_b\rangle$$

Thus $\Psi_1(t)$ can be written in terms of

$$\boxed{\Psi_1(t) = x_1 |\overset{e_A\, e_B\, 0_a\, 0_b}{\uparrow\uparrow 00}\rangle + x_2|\downarrow\downarrow 11\rangle + x_3|\uparrow\downarrow 01\rangle + x_4|\downarrow\uparrow 10\rangle}$$

$$+ \cancel{x_5}|\downarrow\downarrow 00\rangle$$

$\sin\alpha = 0$

$\Delta = 0$ Tuned case:

$$x_1 = \left(\overset{1/2}{L} e^{-i\lambda^+ t} + \overset{1/2}{M} e^{-i\lambda_- t}\right)^2 \overset{1}{\cos\alpha}$$

$$x_2 = \left(\overset{1/2}{\sqrt{LM}}\, e^{-i\lambda_+ t} + \overset{1/2}{\sqrt{LM}}\, e^{-i\lambda_- t}\right)^2 \overset{1}{\cos\alpha}$$

$$x_3 = \left(\overset{1/2}{L} e^{-i\lambda_+ t} + \overset{1/2}{M} e^{-i\lambda_- t}\right)\left(N e^{-i\lambda_+ t} - N e^{-i\lambda_- t}\right) \overset{1}{\cos\alpha}$$

$$x_4 = x_3$$

$$x_5 = \sin\alpha = 0$$

$\Psi_2(t)$ can be written in terms of $|\Psi_{AB}\rangle = \cos\alpha\, |e_A g_B\rangle + \sin\alpha\, |g_A e_B\rangle$

For $\alpha = \frac{\pi}{4}$

$$\tilde{\Psi}_2(0) = |\Psi_{AB}\rangle = \frac{1}{\sqrt{2}} |e_A, g_B\rangle + \frac{1}{\sqrt{2}} |g_A, e_B\rangle$$

$$\Psi_2(0) = \tilde{\Psi}_2(0) \otimes |0_a, 0_b\rangle$$

Thus $\Psi_2(t)$ can be written in terms of

$$\boxed{\Psi_2(t) = x_1' |\uparrow\downarrow 00\rangle + x_2' |\downarrow\uparrow 00\rangle + x_3' |\downarrow\downarrow 10\rangle + x_4' |\downarrow\downarrow 01\rangle}$$

$$x_1' = \overset{1/\sqrt{2}}{\cos\alpha}\left(\overset{1/2}{L} e^{-i\lambda_+ t} + \overset{1/2}{M} e^{-i\lambda_- t}\right)$$

$$x_2' = \overset{1/\sqrt{2}}{\sin\alpha}\left(L e^{-i\lambda_+ t} + M e^{-i\lambda_- t}\right)$$

$$x_3' = \overset{1/\sqrt{2}}{\cos\alpha}\left(N e^{-i\lambda_+ t} - N e^{-i\lambda_- t}\right)$$

$$x_4' = \underset{1/\sqrt{2}}{\sin\alpha}\left(\underset{1/2}{N} e^{-i\lambda_+ t} - N e^{-i\lambda_- t}\right)$$

$$\boxed{\rho_{sys}(t) = \frac{1}{3}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right] + \frac{2}{3}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}$$

2. Find the 6 Concurrences

2.1 $C_{AB}(t)$

$$\rho_{AB}(t) = Tr_{ab}\left[\rho_{sys}(t)\right]$$

$$\rho_{AB}(t) = \underbrace{\frac{1}{3} Tr_{ab}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right]}_{\rho_{AB,1}} + \underbrace{\frac{2}{3} Tr_{ab}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}_{\rho_{AB,2}}$$

For $\Psi_1(t)$:

$$\frac{1}{3} \times \rho^{AB1} = \begin{array}{c} \\ \uparrow\uparrow \\ \uparrow\downarrow \\ \downarrow\uparrow \\ \downarrow\downarrow \end{array} \begin{array}{c} \begin{array}{cccc} \uparrow\uparrow & \uparrow\downarrow & \downarrow\uparrow & \downarrow\downarrow \end{array} \\ \begin{bmatrix} |x_1|^2 & 0 & 0 & \cancelto{0}{x_1 x_5^*} \\ 0 & |x_3|^2 & 0 & 0 \\ 0 & 0 & |x_4|^2 & 0 \\ \cancelto{0}{x_1^* x_5} & 0 & 0 & |x_2|^2 + \underbrace{|x_5|^2}_{0} \end{bmatrix} \end{array}$$

For $\Psi_2(t)$:

$$\frac{2}{3} \times \rho^{AB_2} = \begin{array}{c} \\ \uparrow\uparrow \\ \uparrow\downarrow \\ \downarrow\uparrow \\ \downarrow\downarrow \end{array} \begin{array}{c} \begin{array}{cccc} \uparrow\uparrow & \uparrow\downarrow & \downarrow\uparrow & \downarrow\downarrow \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & |x_1'|^2 & x_1'^* x_2' & 0 \\ 0 & x_1' x_2'^* & |x_2'|^2 & 0 \\ 0 & 0 & 0 & |x_3'|^2 + |x_4'|^2 \end{bmatrix} \end{array}$$

TWS $\rho^{AB} = \frac{1}{3}\rho^{AB\text{-}1} + \frac{2}{3}\rho^{AB\text{-}2}$ "X" form

$$\rho^{AB} = \begin{bmatrix} \frac{1}{3}|x_1|^2 & 0 & 0 & 0 \\ 0 & \frac{1}{3}|x_3|^2 + \frac{2}{3}|x_1'|^2 & \frac{2}{3}x_1'^{*}x_2' & 0 \\ 0 & \frac{2}{3}x_1'x_2'^{*} & \frac{1}{3}|x_4|^2 + \frac{2}{3}|x_2'|^2 & 0 \\ 0 & 0 & 0 & \frac{1}{3}|x_2|^2 + \frac{2}{3}\left(|x_3'|^2 + |x_4'|^2\right) \end{bmatrix}$$

a, b, z, z^*, c, d

$$C(\rho) = \max[0, Q(t)] = 2\max\left[0, |z| - \sqrt{ad}\right]$$

$$Q(t) = 2\left(|z| - \sqrt{ad}\right)$$

$$\boxed{Q(t) = 2\left(\frac{4}{9}|x_1'||x_2'| - \sqrt{\left(\frac{1}{3}|x_1|^2\right)\left(\frac{1}{3}|x_2|^2 + \frac{2}{3}\left(|x_3'|^2 + |x_4'|^2\right)\right)}\right)}$$

$$Q(t) = 2\left(\frac{4}{9}\times\frac{1}{2}\cos^2\left(\frac{6t}{2}\right) - \sqrt{\left(\frac{1}{3}\cos^4\left(\frac{6t}{2}\right)\right)\cdot\left(\frac{1}{3}\sin^4\left(\frac{6t}{2}\right) + \frac{2}{3}\sin^2\left(\frac{6t}{2}\right)\right)}\right)$$

All Abs. values of Coefficients

For the $\psi_1(t)$ part: where $\alpha = 0$

$$|x_1| = |\cos\alpha| \cos^2\left(\frac{6t}{2}\right) = \cos^2\left(\frac{6t}{2}\right)$$

$$|x_2| = |\cos\alpha| \sin^2\left(\frac{6t}{2}\right) = \sin^2\left(\frac{6t}{2}\right)$$

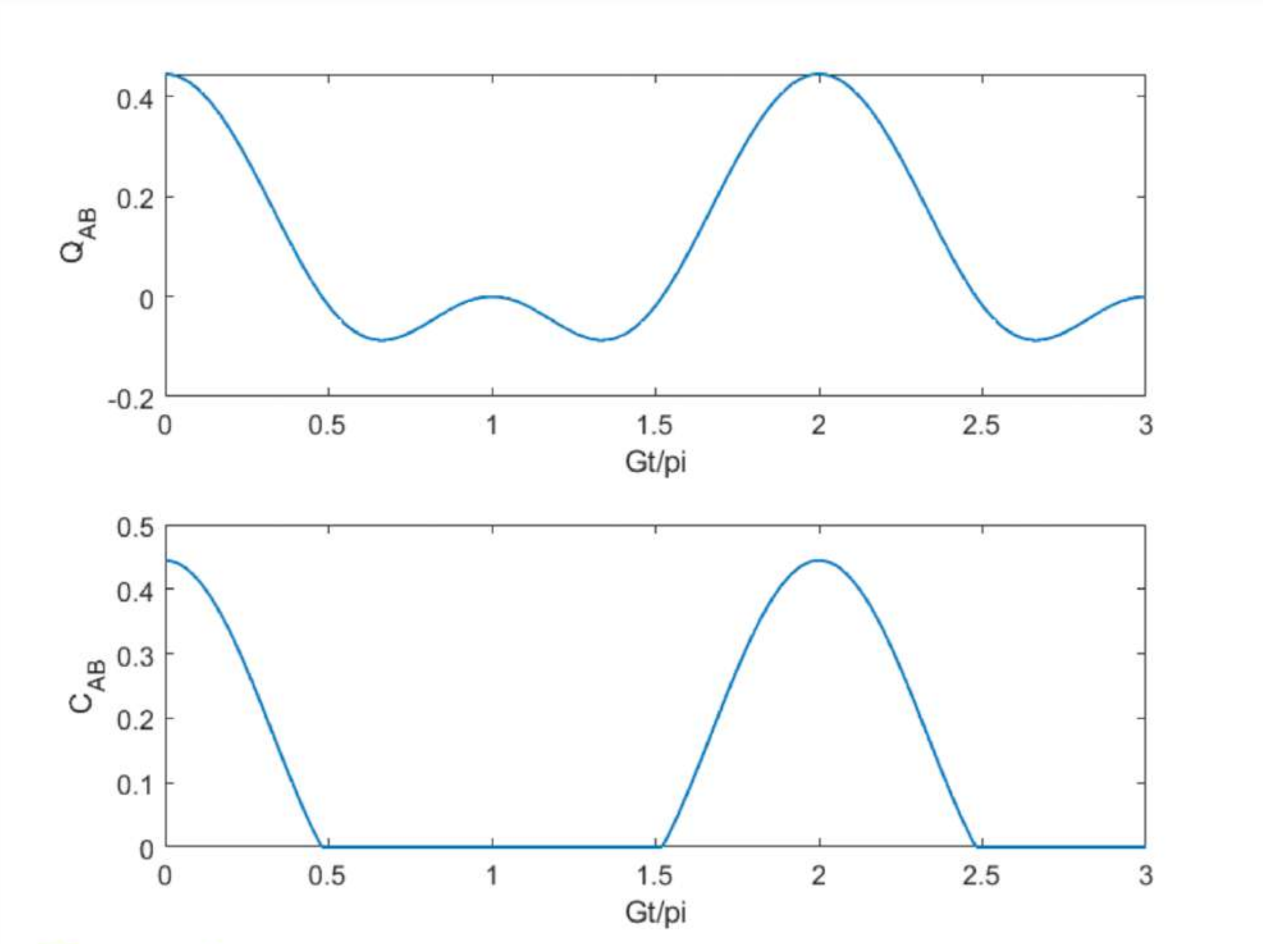
$$|x_3| = \overbrace{|\cos\alpha|}^{1} \left|\cos\left(\frac{6t}{2}\right)\right| \left|\sin\left(\frac{6t}{2}\right)\right| = \frac{1}{2} |\sin(6t)|$$

$$|x_4| = |x_3|$$

For the $\psi_2(t)$ part: where $\alpha = \frac{\pi}{4}$

$$\left.\begin{aligned} |x_1'| &= |\cos\alpha| \left|\cos\left(\frac{6t}{2}\right)\right| = \frac{1}{\sqrt{2}} \left|\cos\left(\frac{6t}{2}\right)\right| \\ |x_2'| &= |\sin\alpha| \left|\cos\left(\frac{6t}{2}\right)\right| = \frac{1}{\sqrt{2}} \left|\cos\left(\frac{6t}{2}\right)\right| \end{aligned}\right\} |x_1'| = |x_2'|$$

$$\left.\begin{aligned} |x_3'| &= |\cos\alpha| \left|\sin\left(\frac{6t}{2}\right)\right| = \frac{1}{\sqrt{2}} \left|\sin\left(\frac{6t}{2}\right)\right| \\ |x_4'| &= |\sin\alpha| \left|\sin\left(\frac{6t}{2}\right)\right| = \frac{1}{\sqrt{2}} \left|\sin\left(\frac{6t}{2}\right)\right| \end{aligned}\right\} |x_3'| = |x_4'|$$



2. $C_{ab}(t)$

$$\rho_{ab} = Tr_{AB}\left[\rho_{sys}(t)\right]$$

$$\rho_{ab} = \frac{1}{3}\underbrace{Tr_{AB}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right]}_{\rho_{ab,1}} + \frac{2}{3}\underbrace{Tr_{AB}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}_{\rho_{ab,2}}$$

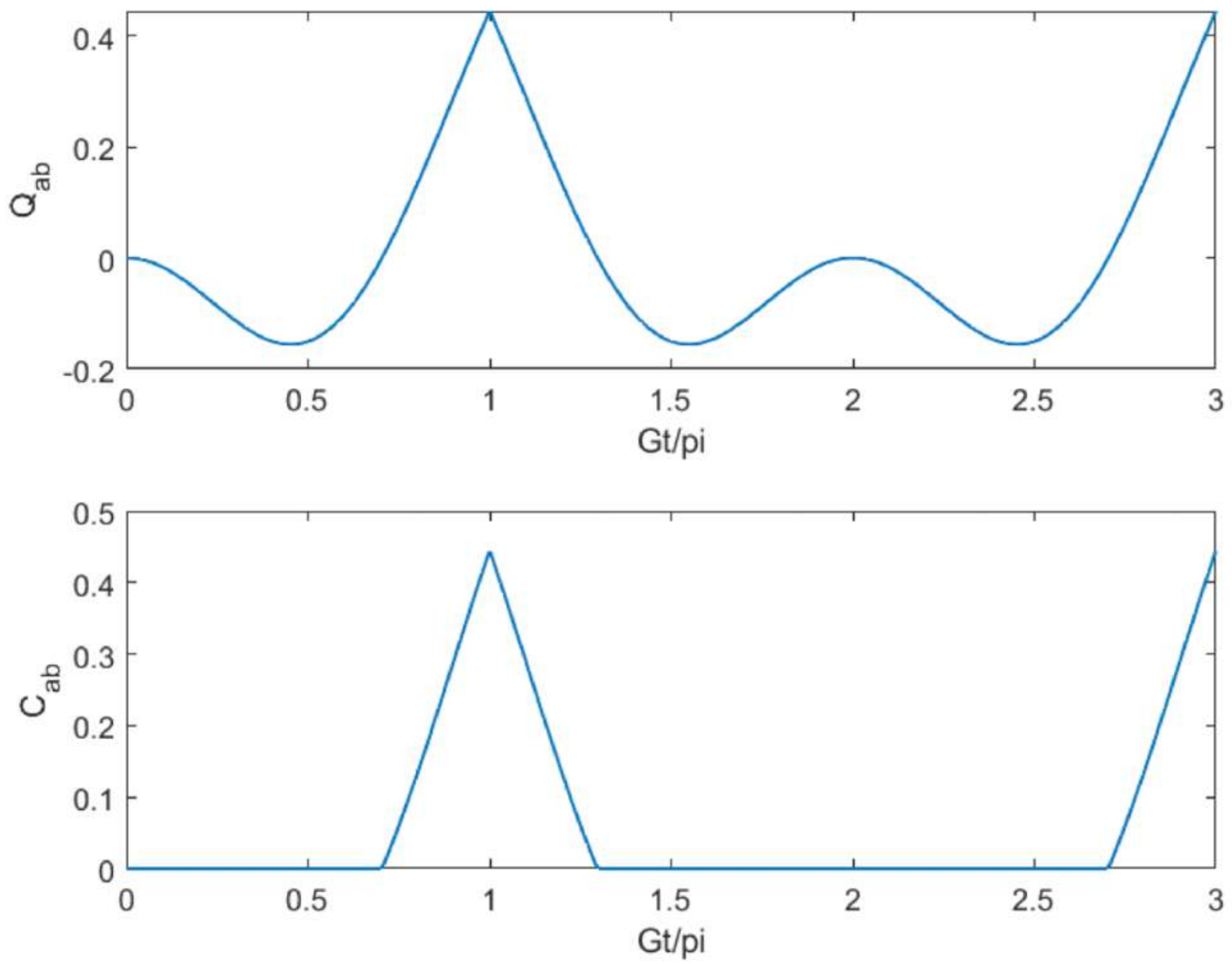
$$\frac{1}{3}\times \quad \rho_{ab,1} = \begin{array}{c|cccc} & 00 & 01 & 10 & 11 \\ \hline 00 & |x_1|^2 + \cancel{|x_5|^2}\ 0 & 0 & 0 & \cancel{x_2^* x_5}\ 0 \\ 01 & 0 & |x_3|^2 & 0 & 0 \\ 10 & 0 & 0 & |x_4|^2 & 0 \\ 11 & \cancel{x_2 x_5^*}\ 0 & 0 & 0 & |x_2|^2 \end{array}$$

$$\frac{2}{3} \times \rho_{ab,2} = \begin{array}{c} \\ 00 \\ 01 \\ 10 \\ 11 \end{array} \begin{array}{c} \begin{array}{cccc} 00 & 01 & 10 & 11 \end{array} \\ \begin{bmatrix} |x_1'|^2 + |x_2'|^2 & 0 & 0 & 0 \\ 0 & |x_4'|^2 & x_3'^{*} x_4' & 0 \\ 0 & x_3' x_4'^{*} & |x_3'|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$$\rho_{ab} = \begin{bmatrix} \overbrace{\frac{1}{3}|x_1|^2 + \frac{2}{3}|x_1'|^2 + \frac{2}{3}|x_2'|^2}^{a} & 0 & 0 & 0 \\ 0 & \frac{1}{3}\overbrace{|x_3|^2 + \frac{2}{3}|x_4'|}^{b}{}^2 & \frac{2}{3}\overbrace{x_3'^{*} x_4'}^{z} & 0 \\ 0 & \frac{2}{3}\underbrace{x_3' x_4'^{*}}_{z^*} & \frac{1}{3}\underbrace{|x_4|^2 + \frac{2}{3}|x_3'|^2}_{c} & 0 \\ 0 & 0 & 0 & \frac{1}{3}\underbrace{|x_2|^2}_{d} \end{bmatrix}$$

$$C(\rho) = \max[0, Q(t)] = 2\max[0, |z| - \sqrt{ad}]$$

$$Q_1(f) = 2\left(\frac{4}{9}|x_3||x_4| - \sqrt{\left(\frac{1}{3}(|x_4|^2 + |x_5|^2) + \frac{2}{3}(|x_1'|^2 + |x_2'|^2)\right) \cdot \frac{1}{3}|x_2|^2}\right.$$



3) $C_{Ab}(t)$

$$\rho_{Ab} = Tr_{aB}\left[\rho_{sys}(t)\right]$$

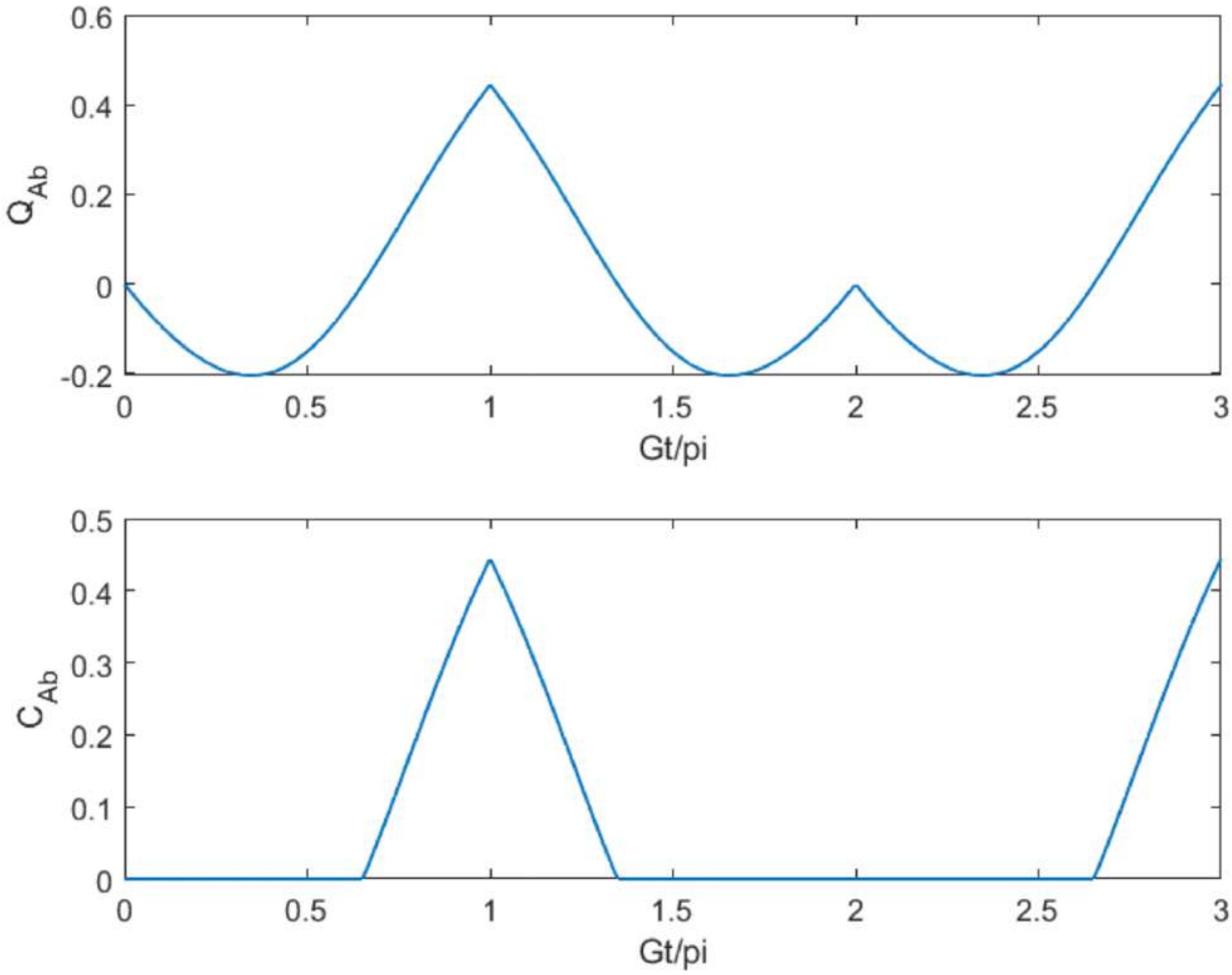
$$\rho_{Ab} = \frac{1}{3}\underbrace{Tr_{aB}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right]}_{\rho_{Ab,1}} + \frac{2}{3}\underbrace{Tr_{aB}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}_{\rho_{Ab,2}}$$

$$\frac{1}{3}\times\rho_{Ab,1} = \begin{array}{c c} & \begin{array}{cccc} \downarrow 0 & \downarrow 1 & \downarrow 0 & \uparrow 1 \end{array} \\ \begin{array}{c} \downarrow 0 \\ \downarrow 1 \\ \uparrow 0 \\ \uparrow 1 \end{array} & \begin{bmatrix} \cancel{|x_5|^2}_{\to 0} + |x_4|^2 & 0 & 0 & \cancel{x_3^* x_5}_{\to 0} \\ 0 & |x_2|^2 & 0 & 0 \\ & 0 & |x_1|^2 & \\ \cancel{x_3 x_5^*}_{\to 0} & 0 & 0 & |x_3|^2 \end{bmatrix} \end{array}$$

$$\frac{2}{3}\times \rho_{Ab,2} = \begin{array}{c} \\ \downarrow 0 \\ \downarrow 1 \\ \uparrow 0 \\ \uparrow 1 \end{array} \begin{array}{c} \begin{array}{cccc} \downarrow 0 & \downarrow 1 & \uparrow 0 & \uparrow 1 \end{array} \\ \begin{bmatrix} |x_3'|^2+|x_2'|^2 & 0 & 0 & 0 \\ 0 & |x_4'|^2 & x_1'^{*}x_4' & 0 \\ 0 & x_1'x_4'^{*} & |x_1'|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$$\rho_{Ab} = \begin{bmatrix} \underbrace{\frac{1}{3}|x_4|^2+\frac{2}{3}\left(|x_3'|^2+|x_2'|^2\right)}_{a} & 0 & 0 & 0 \\ 0 & \frac{1}{3}|x_2|^2+\frac{2}{3}|x_4'|^2 & \frac{2}{3}\underbrace{x_1'^{*}x_4'}_{z} & 0 \\ 0 & \frac{2}{3}\underbrace{x_1'x_4'^{*}}_{z^*} & \frac{1}{3}|x_1|^2+\frac{2}{3}|x_1'|^2 & 0 \\ 0 & 0 & 0 & \underbrace{\frac{1}{3}|x_3|^2}_{d} \end{bmatrix}$$

$$C(\rho) = \max\left[0,\ Q(t)\right] = 2\left[0,\ |z|-\sqrt{ad}\right]$$



4) $C_{Ba}(t)$

$$\rho_{Ba} = \mathrm{Tr}_{Ab}\left[\rho_{sys}(t)\right]$$

$$\rho_{Ba} = \frac{1}{3}\underbrace{\mathrm{Tr}_{Ab}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right]}_{\substack{\rho_{Ba,1} \\ \shortparallel \\ \rho_{Ab,1}}} + \frac{2}{3}\underbrace{\mathrm{Tr}_{Ab}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}_{\substack{\rho_{Ba,2} \\ \shortparallel \\ \rho_{Ab,2}}}$$

$$\boxed{\rho_{Ba} = \rho_{Ab}}$$

5) $C_{Aa}(t)$

$$\rho_{Aa} = Tr_{Bb}\left[\rho_{sys}(t)\right]$$

$$\rho_{Aa} = \frac{1}{3}\underbrace{Tr_{Bb}\left[|\psi_1(t)\rangle\langle\psi_1(t)|\right]}_{\rho_{Aa,1}} + \frac{2}{3}\underbrace{Tr_{Bb}\left[|\psi_2(t)\rangle\langle\psi_2(t)|\right]}_{\rho_{Aa,2}}$$

$$\frac{1}{3}\times\rho_{Aa,1} = \begin{array}{c} \\ \downarrow 0 \\ \downarrow 1 \\ \uparrow 0 \\ \uparrow 1 \end{array}\begin{array}{c} \begin{array}{cccc} \downarrow 0 & \downarrow 1 & \uparrow 0 & \uparrow 1 \end{array} \\ \begin{bmatrix} \cancelto{0}{|x_5|^2} & 0 & 0 & 0 \\ 0 & |x_2|^2+|x_4|^2 & x_2x_3^* + x_4x_1^* & 0 \\ 0 & x_2x_3^* + x_4^*x_1 & |x_3|^2+|x_1|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$$\frac{2}{3}\times\rho_{Aa,2} = \begin{bmatrix} |x_2'|^2+|x_4'|^2 & 0 & 0 & 0 \\ 0 & |x_3'|^2 & x_1'^*x_3' & 0 \\ 0 & x_1'x_3'^* & |x_1'|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\rho_{Aa} = \begin{bmatrix} a & 0 & 0 & 0 \\ 0 & b & \overbrace{\frac{1}{3}(x_2 x_3^* + x_4 x_1^*) + \frac{2}{3} x_1^{\prime *} x_3^{\prime}}^{z} & 0 \\ 0 & \underbrace{\frac{1}{3}(x_2^* x_3 + x_4^* x_1) + \frac{2}{3} x_1^{\prime} x_3^{\prime *}}_{z^*} & c & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$C(\rho) = \max[0, Q(t)] = 2\max[0, |z| - \sqrt{a\cancel{d}}_{\,0}]$$

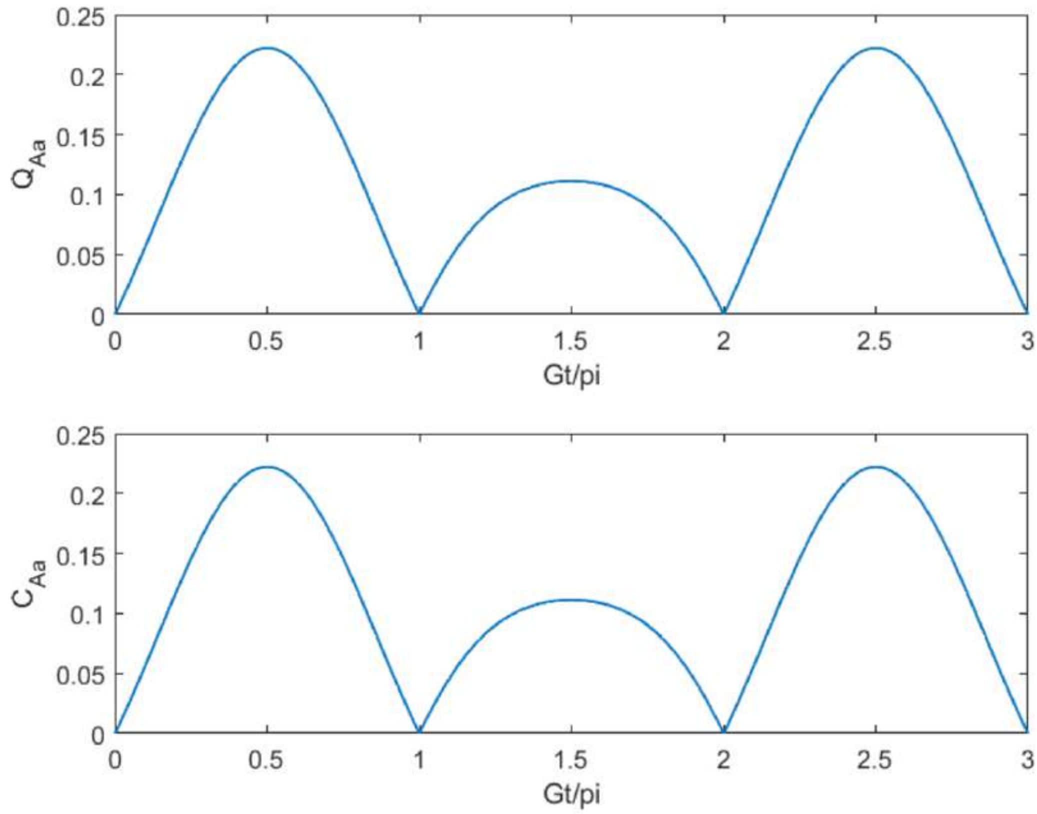
$$|z| = z^* z = z^2 = \left(\frac{1}{3}(x_2 x_3 + \overset{x_3}{x_4} x_1) + \frac{2}{3}(x_1' x_3')\right)^2$$

$$|z| = \left| \frac{1}{9} x_3 (\underbrace{x_1 + x_2}_{1}) + \frac{4}{9} x_3 (\underbrace{x_1 + x_2}_{1}) x_3' x_1' + \frac{4}{9} x_1' x_3' \right|$$

$$\left.\begin{aligned} x_1 &= \overset{1}{\cos\alpha} \cos^2\left(\frac{6t}{2}\right) \\ x_2 &= \overset{1}{\cos\alpha} \sin^2\left(\frac{6t}{2}\right) \\ x_3 &= \frac{1}{2} \underbrace{\cos\alpha}_{1} \sin(6t) \\ x_3' &= \underbrace{\cos\overset{\pi/4}{\alpha}}_{1/\sqrt{2}} \sin\left(\frac{6t}{2}\right) \\ x_1' &= \underbrace{\cos\alpha}_{1/\sqrt{2}} \cos\left(\frac{6t}{2}\right) \end{aligned}\right\} \quad (x_1 + x_2) = \cos\overset{\to 0}{\alpha} = \underline{1}$$

$$|z| = \left| \frac{1}{9} \cdot \frac{1}{2} \sin(6t) + \frac{\cancel{4}}{9} \cdot \frac{1}{2} \sin(6t) \cdot \frac{1}{\cancel{4}} \sin(6t) + \frac{\cancel{4}}{9} \cdot \frac{1}{\cancel{4}} \sin(6t) \right|$$

$$|z| = \left| \frac{3}{18} \sin(6t) + \frac{1}{18} \sin^2(6t) \right|$$



6) $C_{Bb}(t)$

$$\rho_{Bb} = \mathrm{Tr}_{Aa}\left[\rho_{sys}(t)\right]$$

$$\rho_{Bb} = \frac{1}{3}\underbrace{\mathrm{Tr}_{Aa}\left[|\Psi_1(t)\rangle\langle\Psi_1(t)|\right]}_{\rho_{Bb,1} = \rho_{Aa,1}} + \frac{2}{3}\underbrace{\mathrm{Tr}_{Aa}\left[|\Psi_2(t)\rangle\langle\Psi_2(t)|\right]}_{\rho_{Bb,2}}$$

$$\frac{1}{3} \times \rho_{Bb,1} = \begin{array}{c} \\ \downarrow 0 \\ \downarrow 1 \\ \uparrow 0 \\ \uparrow 1 \end{array} \begin{array}{c} \begin{array}{cccc} \downarrow 0 & \downarrow 1 & \uparrow 0 & \uparrow 1 \end{array} \\ \begin{bmatrix} \cancel{|x_5|^2}\ 0 & 0 & 0 & 0 \\ 0 & |x_2|^2 + |x_4|^2 & x_2 x_3^* + x_4 x_1^* & 0 \\ 0 & x_2 x_3^* + x_4^* x_1 & |x_3|^2 + |x_1|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

$$\frac{2}{3} \times \rho_{Bb,2} = \begin{bmatrix} |x_1'|^2 + |x_3'|^2 & 0 & 0 & 0 \\ 0 & |x_4'|^2 & x_2'^* x_4' & 0 \\ 0 & x_2' x_4'^* & |x_2'|^2 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\rho_{Bb} = \begin{bmatrix} a & 0 & 0 & 0 \\ 0 & b & \frac{1}{3}\overbrace{(x_2 x_3^* + x_4 x_1^*) + \frac{2}{3} x_2'^* x_4'}^{z} & 0 \\ 0 & \underbrace{\frac{1}{3}(x_2^* x_3 + x_4^* x_1) + \frac{2}{3}}_{z^*} x_2' x_4'^* & c & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

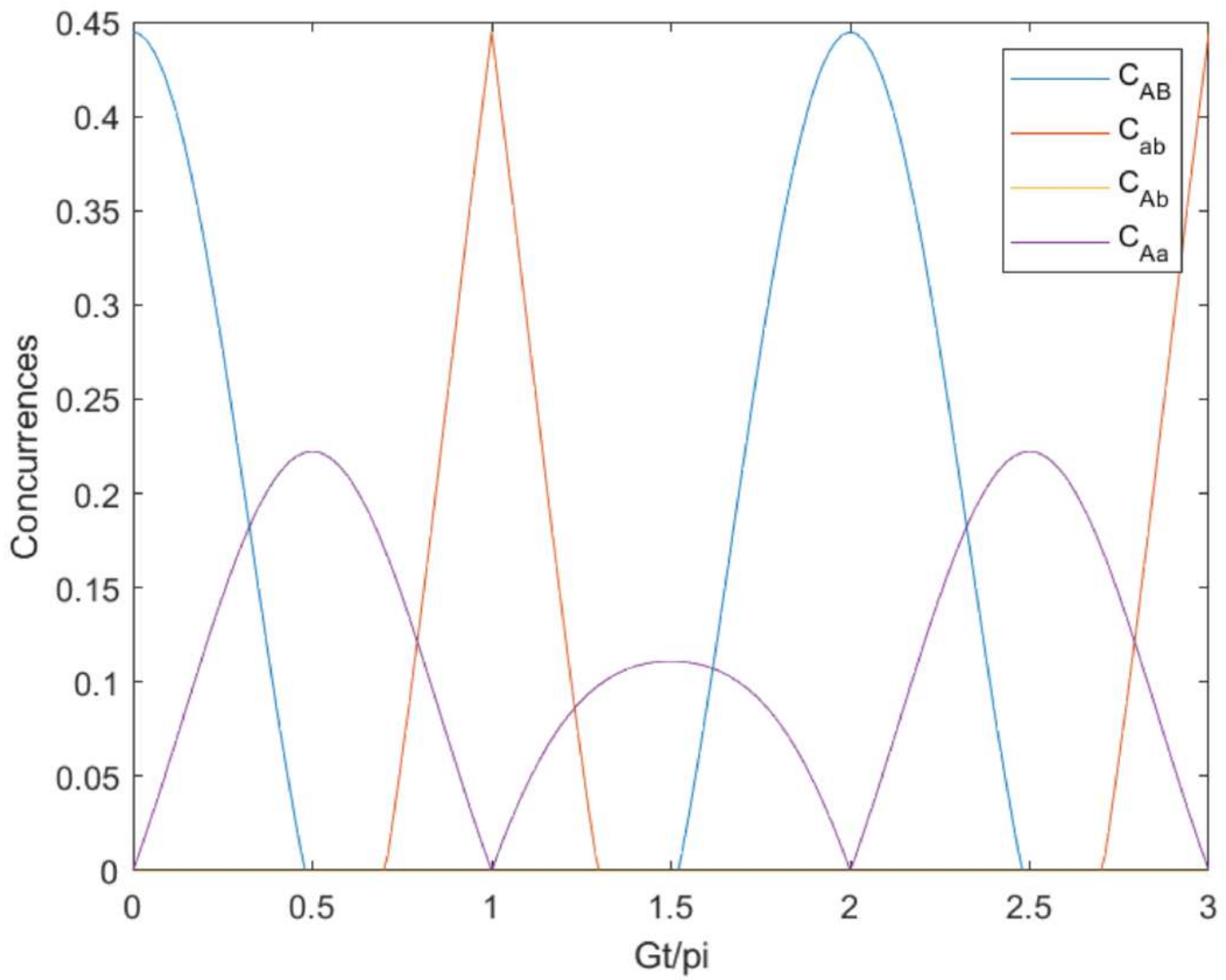
$$C(\rho) = \max[0, Q(t)] = 2\max[0, |z| - \cancel{\sqrt{ad}}\ 0]$$

$$|z| = z^{*}z = z^{2} = \left(\frac{1}{3}\left(x_2 x_3 + \overset{\overset{x_3}{\uparrow}}{x_4} x_1\right) + \frac{2}{3}\left(x_1' x_3'\right)\right)^2$$

$$\left.\begin{aligned}
x_1 &= \overset{1}{\cos\alpha}\, \cos^2\left(\frac{Gt}{2}\right) \\
x_2 &= \overset{1}{\cos\alpha}\, \sin^2\left(\frac{Gt}{2}\right) \\
x_3 &= \frac{1}{2}\underbrace{\cos\alpha}_{1}\, \sin(Gt) \\
x_4' &= \underbrace{\sin\overset{\pi/4}{\alpha}}_{1/\sqrt{2}}\, \sin\left(\frac{Gt}{2}\right) \\
x_2' &= \underbrace{\sin\alpha}_{1/\sqrt{2}}\, \cos\left(\frac{Gt}{2}\right)
\end{aligned}\right\}$$

Thus $\Rightarrow$ $\boxed{C_{Bb} = C_{Aa}}$

Since $\alpha = \frac{\pi}{4}$ for $|\Psi_2(t)\rangle$



where $\underbrace{C_{Ab} = C_{Ba}}_{0\,(?)}$ & $C_{Aa} = C_{Bb}$

CONCLUSIONS

* Rebirth occurs.
* If we have infinite modes, we don't have rebirths.
* Rebirth does not depend on initial states.
* look at conservation