# Fast Polarization Manipulation

**Ismail Nassar**

**Research Proposal**

**Under the supervision of**

**Prof. David Gershoni**

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# 1 The Proposal

## 1.1 Problem Definition and Solution Approach.

## 1.2 Theoretical formulation (exciton).

$$|\Psi(t)\rangle = \alpha(|H_{XX} \otimes H_X\rangle \cdot e^{\frac{-iE_H t}{\hbar}} + |V_{XX} \otimes V_X\rangle \cdot e^{\frac{-iE_V t}{\hbar}}) \tag{1}$$

## 1.3 Theoretical formulation (biexciton-exciton)

$$|\Psi(t)\rangle = \alpha(|H_{XX} \otimes H_X\rangle \cdot e^{\frac{-iE_H t}{\hbar}} + |V_{XX} \otimes V_X\rangle \cdot e^{\frac{-iE_V t}{\hbar}}) \tag{2}$$

$$|\Psi(t)\rangle = \alpha(|H_{XX} \otimes H_X\rangle + |V_{XX} \otimes V_X\rangle \cdot e^{\frac{-i(\triangle E t)}{\hbar}}) \tag{3}$$

## 1.4 Rotation of the exciton's polarization.

## 1.5 Restoring the entanglement of the photons in the biexciton-exciton radiative cascade.

If we construct two interferometers that allow us to induce phase shift to both the biexciton and exciton polarizations, then we can write the time-dependent phase relations as:

$$\begin{aligned}
\Phi_{H_{XX}}(t, t_{prop}) &= k_{H_{XX}} \cdot (t - t_{prop}) + \Phi^0_{H_{XX}} \\
\Phi_{V_{XX}}(t, t_{prop}) &= k_{V_{XX}} \cdot (t - t_{prop}) + \Phi^0_{V_{XX}} \\
\Phi_{H_X}(t, t_{prop}) &= k_{H_X} \cdot (t - t_{prop}) + \Phi^0_{H_X} \\
\Phi_{V_X}(t, t_{prop}) &= k_{V_X} \cdot (t - t_{prop}) + \Phi^0_{V_X}
\end{aligned} \tag{4}$$

Here the K's are the different slopes that introduce the shift to the photons' polarizations, and $\Phi^0$'s are the initial phase of the photons at the time of emission. $t_{prop}$

is the propagation times of the photons from the quantum dot to the device. Since it's a constant time we can simplify the function by including it in the constant phase $\Phi^0$. By taking the starting time of our system as the biexciton excitation time we can write the state using the $t_x$ and $t_{xx}$ ( where $t_{xx}$ and $t_x$ are the random emission times of the biexciton and exciton respectively), as follows:

$$\begin{aligned}|\Psi(t)\rangle = \alpha(|H_{XX}\rangle \cdot e^{i*\Phi_{H_{XX}}(t_{XX}-t^{xx}_{start})} \otimes |H_X\rangle \cdot e^{i\Phi_{H_X}(t_X-t^{x}_{start})} + \\ |V_{XX}\rangle \cdot e^{i\Phi_{V_{XX}}(t_{XX}-t^{xx}_{start})} \otimes |V_X\rangle \cdot e^{i\Phi_{V_X}(t_X-t^{x}_{start})} \cdot e^{-i(\triangle E t)/\hbar})\end{aligned} \tag{5}$$

next, plug it in

$$\Psi(t) = |H_{xx}H_x\rangle + e^{i\Phi}|V_{xx}V_x\rangle \tag{6}$$

where $\Phi(t)$ :

$$\begin{aligned}\Phi(t) = (K_{V_{XX}} - K_{H_{XX}} + K_{V_X} - K_{H_X}) \cdot t_{xx} + (K_{V_X} - K_{H_X} + \triangle E/\hbar) * t_x + \\ (K_{V_{XX}} - K_{H_{XX}}) \cdot -t^{XX}_{Start} + (K_{V_X} - K_{H_X}) \cdot -t^{X}_{Start} + \\ (\Phi^0_{V_{XX}} - \Phi^0_{H_{XX}} + \Phi^0_{V_X} - \Phi^0_{H_X}).\end{aligned} \tag{7}$$

Conditions:

$$K_{V_X} - K_{H_X} = -\triangle E/\hbar \tag{8}$$

$$(K_{V_{XX}} - K_{H_{XX}}) = -(K_{V_X} - K_{H_X}) \tag{9}$$

1. 
2. Two
3. Three

## 1.6 Additional proposed advances

### 1.6.1 Combining the radiative cascade into the knitting machine.

### 1.6.2 Using the experimental system for feed-forward operations in 1D cluster states.

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# Appendices

## Appendix I

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## Appendix 2

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