

Problem 2

$\text{In}[*]:= \{\hat{u}, \hat{v}, \hat{w}\} = \text{IdentityMatrix}[3];$

$\vec{\hat{R}}_\theta = -\hat{w};$

$\phi = \text{ArcTan}\left[\frac{\sqrt{\Omega^2 - \Omega_\theta^2}}{\Omega_\theta}\right];$

$\text{In}[*]:= \left(\text{RotationMatrix}[-\phi, \hat{v}].\text{RotationMatrix}[\theta, \hat{u}].\text{RotationMatrix}[\phi, \hat{v}].\vec{\hat{R}}_\theta /. \right. \\ \left. \left\{ \sqrt{\Omega^2 - \Omega_\theta^2} \rightarrow \delta \right\} \right) // \text{FullSimplify} // \text{MatrixForm}$

$\text{Out}[*]//\text{MatrixForm} =$

$$\begin{pmatrix} \frac{\delta (-1 + \cos[\theta]) \Omega_\theta}{\Omega^2} \\ \frac{\sin[\theta] \Omega_\theta}{\Omega} \\ -1 - \frac{(-1 + \cos[\theta]) \Omega_\theta^2}{\Omega^2} \end{pmatrix}$$

Problem 3

$\text{In}[*]:= \{\sigma_x, \sigma_y, \sigma_z\} = \text{Table}[\text{PauliMatrix}[i], \{i, 1, 3\}];$

$\{\sigma_+, \sigma_-\} = \frac{1}{2} (\sigma_x \mp i \sigma_y); \sigma_\theta = \sigma_+ . \sigma_-;$

$\text{rho} = \{\{\rho_{11}, \rho_{12}\}, \{\rho_{21}, \rho_{22}\}\};$

$\text{In}[*]:= (-\gamma (\sigma_\theta . \text{rho} + \text{rho} . \sigma_\theta) + \gamma_2 \sigma_- . \text{rho} . \sigma_+ + 2 \Gamma \sigma_\theta . \text{rho} . \sigma_\theta // \text{FullSimplify}) /. \\ \{-\gamma + \Gamma \rightarrow -\gamma_2 / 2\} // \text{MatrixForm}$

$\text{Out}[*]//\text{MatrixForm} =$

$$\begin{pmatrix} \gamma_2 \rho_{22} & -\gamma \rho_{12} \\ -\gamma \rho_{21} & -\gamma_2 \rho_{22} \end{pmatrix}$$

Problem 4

$\text{In}[*]:= H_d = \frac{-\hbar}{2} \Omega_\theta \sigma_z + \hbar \dot{\theta} \sigma_y;$

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In[ ]:= rhoDot =  $\frac{1}{i \hbar}$  comm[Hd, rho] // FullSimplify;
rhoDot // MatrixForm

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Out[]//MatrixForm=

$$\begin{pmatrix} -\dot{\theta} (\rho_{12} + \rho_{21}) & \dot{\theta} (\rho_{11} - \rho_{22}) + i \rho_{12} \Omega_0 \\ \dot{\theta} (\rho_{11} - \rho_{22}) - i \rho_{21} \Omega_0 & \dot{\theta} (\rho_{12} + \rho_{21}) \end{pmatrix}$$

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In[ ]:= rhoDot + (-\gamma (\sigma_0.rho + rho.\sigma_0) + \gamma_2 \sigma_-.rho.\sigma_+ + 2 \Gamma \sigma_0.rho.\sigma_0 // FullSimplify) /.
{-\gamma + \Gamma \rightarrow -\gamma_2 / 2} // MatrixForm

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Out[]//MatrixForm=

$$\begin{pmatrix} -\dot{\theta} (\rho_{12} + \rho_{21}) + \gamma_2 \rho_{22} & -\gamma \rho_{12} + \dot{\theta} (\rho_{11} - \rho_{22}) + i \rho_{12} \Omega_0 \\ -\gamma \rho_{21} + \dot{\theta} (\rho_{11} - \rho_{22}) - i \rho_{21} \Omega_0 & \dot{\theta} (\rho_{12} + \rho_{21}) - \gamma_2 \rho_{22} \end{pmatrix}$$