Evaluation of gate designs

For trapped ion quantum computers

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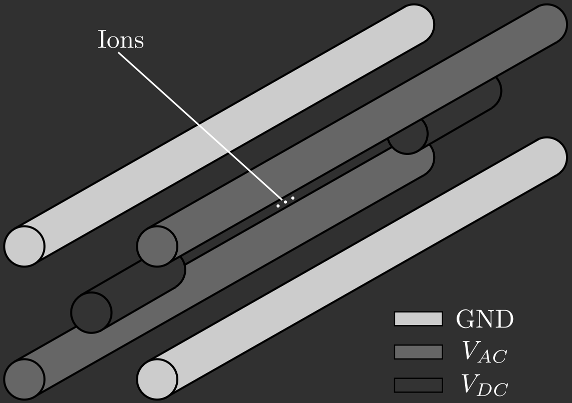
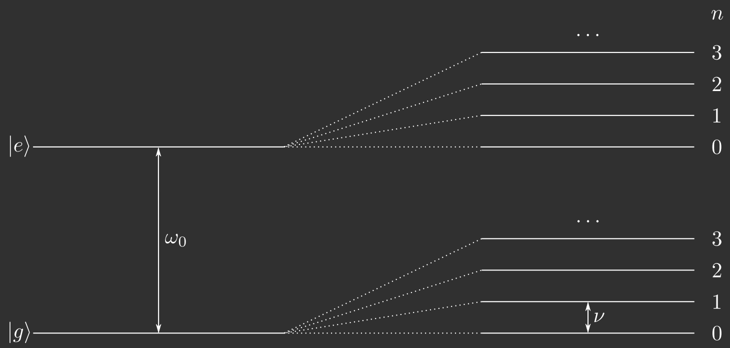
Introduction



Energy structure



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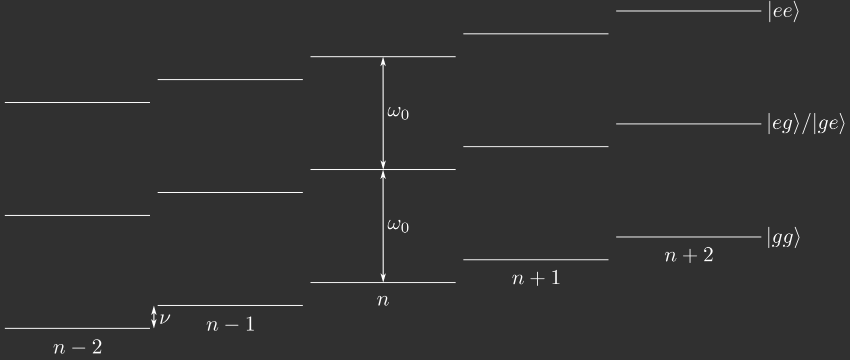

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Driving the system

$$\hat{H} = -\frac{\hbar\omega_0}{2}\sum_{i}^{n}\hat{\sigma}_z^{(i)} + \hbar\nu\left(\hat{a}^\dagger\hat{a} + \frac{1}{2}\right) + \sum_l \frac{\Omega_l}{2}\hat{\sigma}_+^{(n_l)} e^{-i(\mathbf{kz}-\omega_l t)} + h.c.$$

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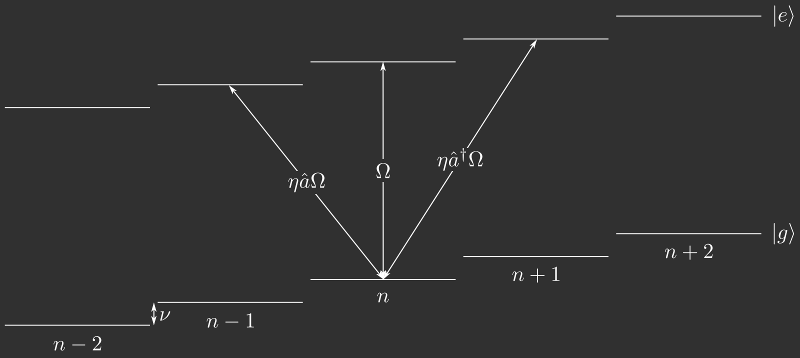
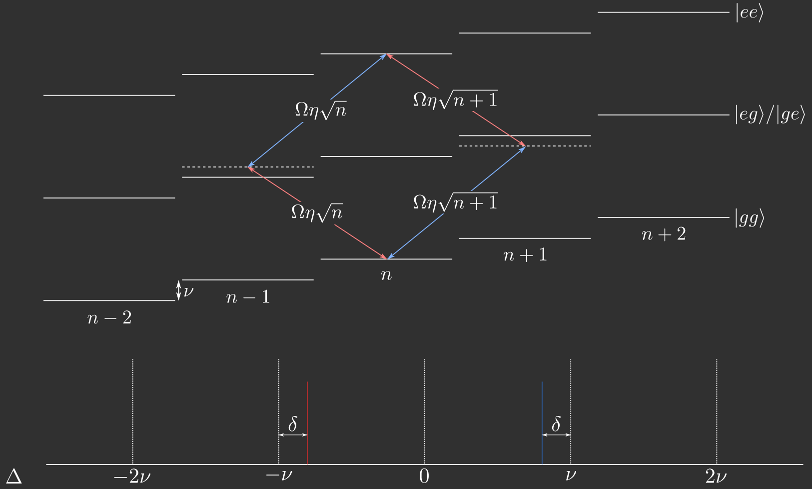
Lamb-Dicke regime



$$e^{-i\eta\left(\hat{\hat{a}}+\hat{\hat{a}}^\dagger\right)} \approx \hat{\mathbb{1}} - i\eta\left(\hat{\hat{a}}+\hat{\hat{a}}^\dagger\right) + \mathcal{O}\left(\eta^2\right)$$

Mølmer-Sørensen gate[1]



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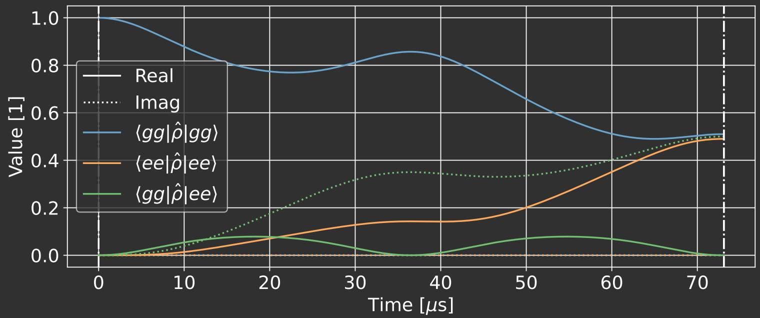

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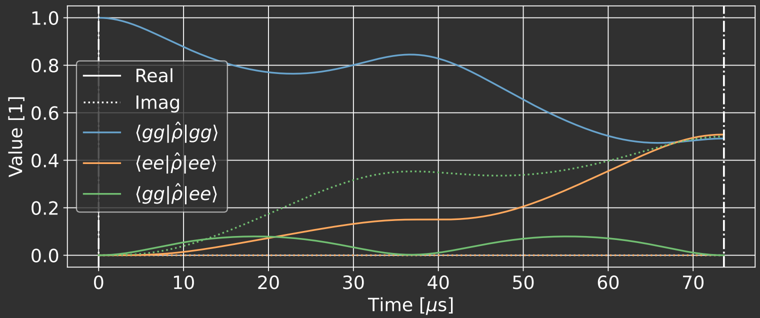
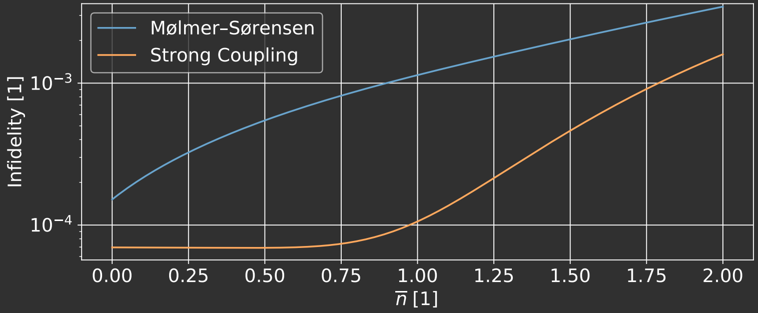
Strong coupling gate[2]



[2] M. Sameti, J. Lishman, and F. Mintert, "Strong-coupling quantum logic of trapped ions,", 2021.

Strong coupling gate[2]



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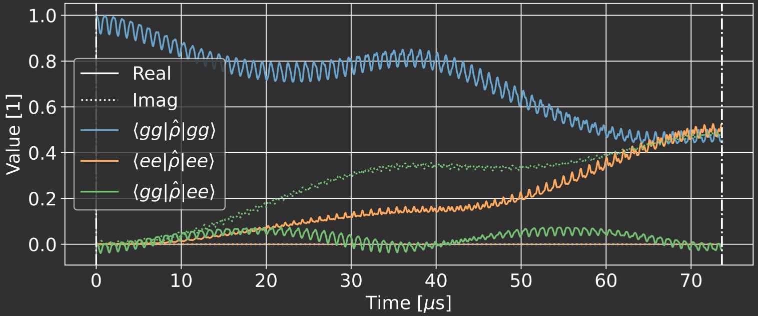

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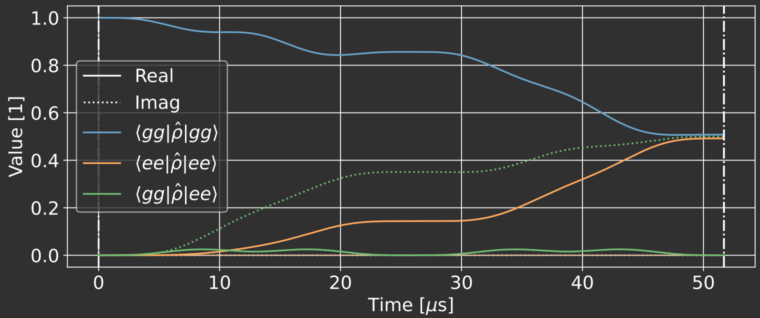
Cardioid gate[3]



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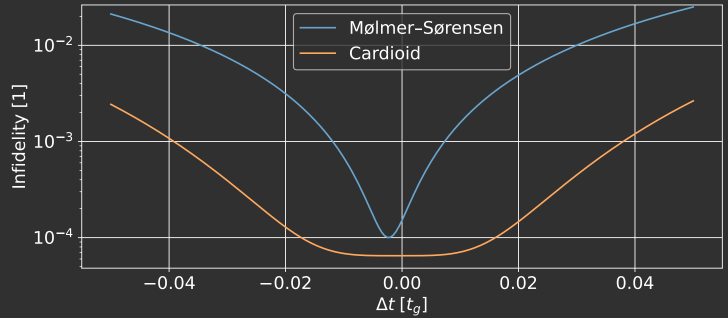

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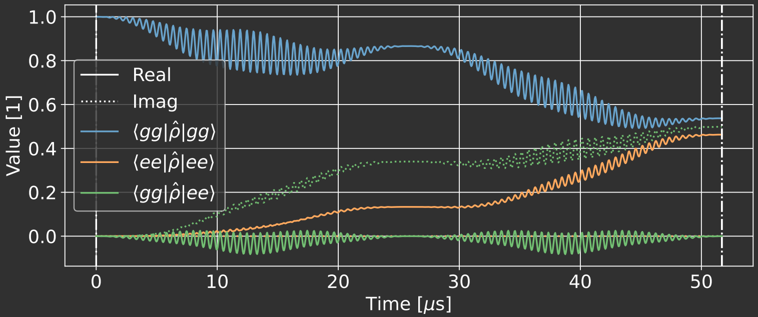

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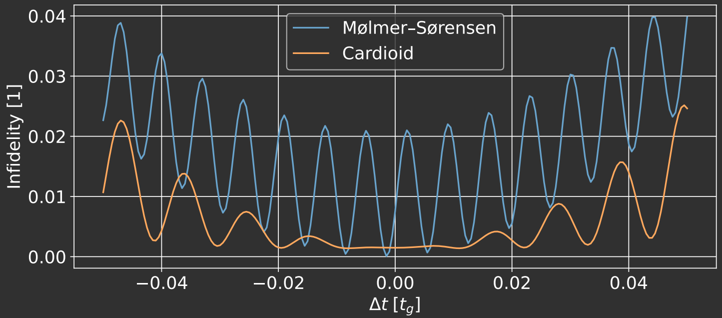

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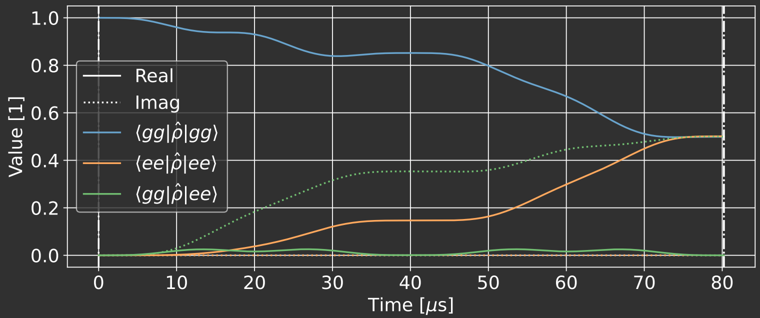
Compound gate



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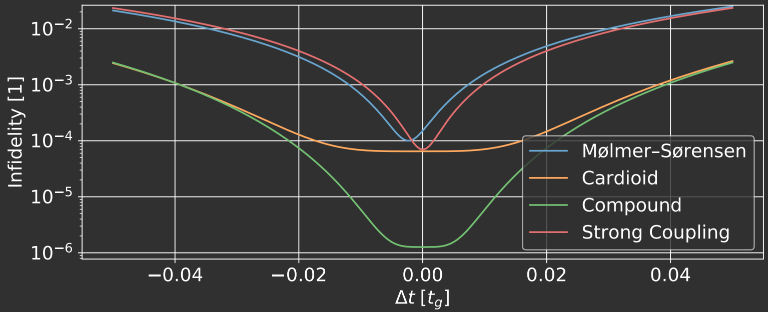

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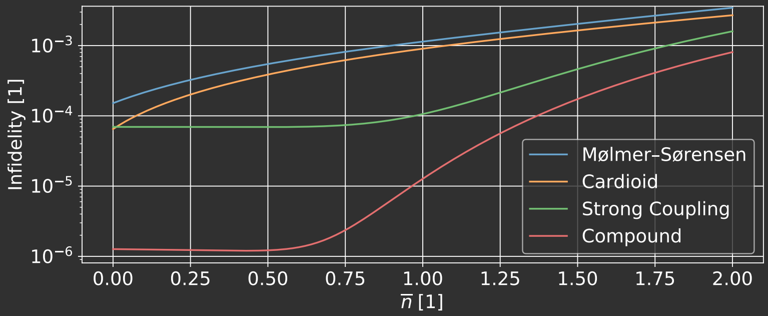

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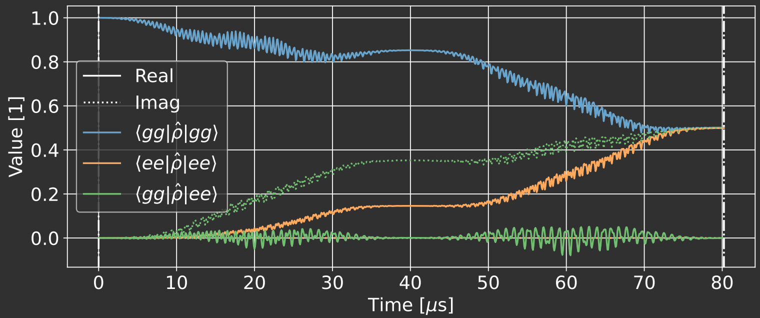

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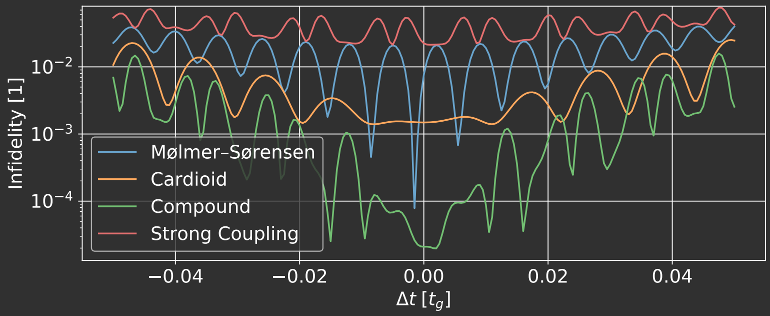

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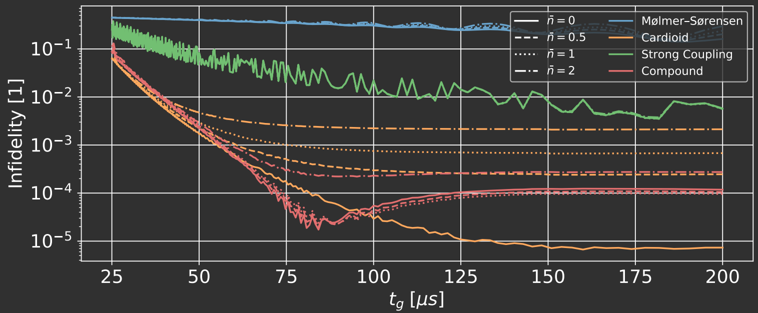
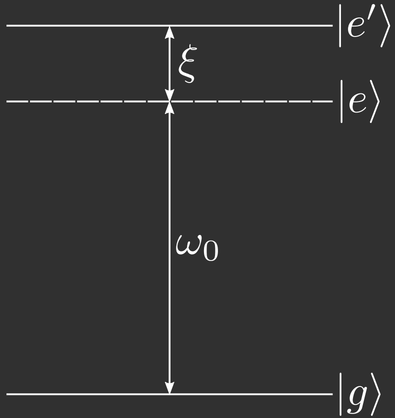


Qubit frequency error



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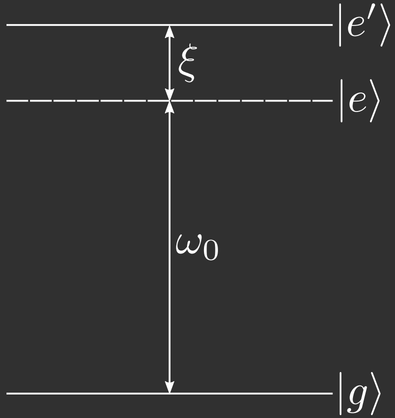
$$\left[\hat{H}_G, \hat{\sigma}_y^{(i)}\right] = 0 \qquad \Omega_c \gg \xi_i \qquad \Omega_c \gg \frac{1}{t_g}$$

Dynamical decoupling[4]



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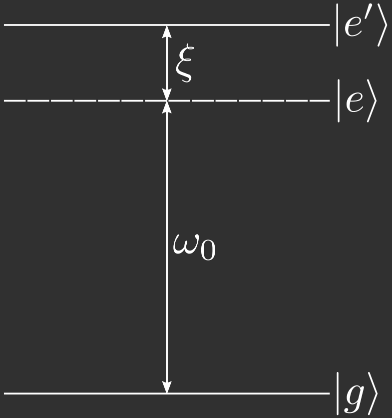

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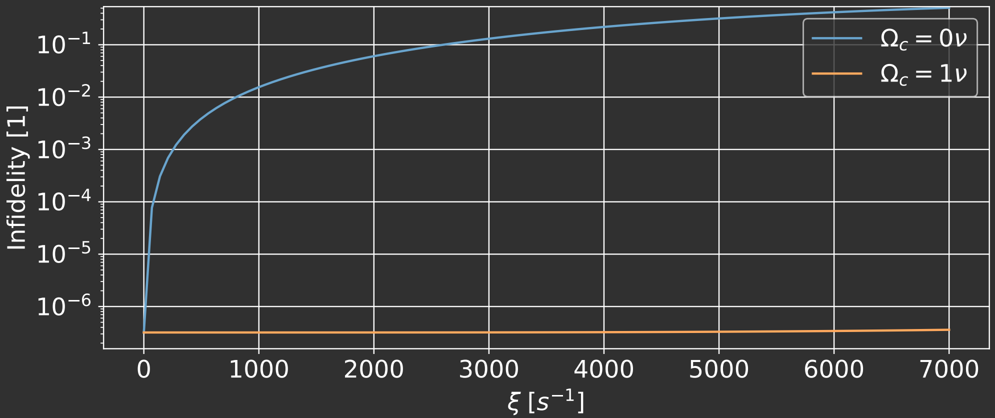
Dynamically decoupled compound gate



Thank you for the attention!