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EVROPSKÁ UNIE
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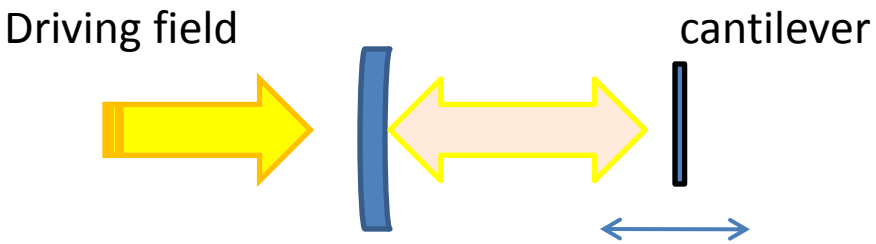
Mechanical Oscillator



$$\Delta = \omega_c - \omega_L$$

$$H_0 = \frac{p^2}{2m} + \frac{1}{2}m\omega_m^2 q^2 + \hbar(\omega_c - \omega_L)a^\dagger a + i\hbar\epsilon(a^\dagger - a)$$

$$H_{int} = \hbar g a^\dagger a q \approx \hbar g q(|a_s|^2 + \delta a^\dagger \delta a + a_s \delta a^\dagger + a_s^* \delta a)$$

$$\mathcal{O} = \mathcal{O}^s + \delta\mathcal{O}$$

$$\langle \xi(t)\xi(t')\rangle = \frac{\gamma}{2\pi\omega_m}\int \omega e^{-i\omega(t-t')}\coth\left(\frac{\hbar\omega}{2k_BT}+1\right)d\omega$$

$$\dot{\delta q} = \frac{\delta p}{m}$$

$$\langle a_{IN}(t), a_{IN}^\dagger(t')\rangle = \delta(t-t')$$

$$\dot{\delta p} = -m\omega_m^2 q + hg(a_s^*\delta a + a_s\delta a^\dagger) - \gamma\delta p + \xi$$

$$\dot{\delta a} = (-i\Delta + igq^s)\delta a - \kappa\delta a + iga_s\delta q + \sqrt{2\kappa}\delta a_{IN}$$

$$\dot{\delta q} = \frac{\delta p}{m} \qquad \dot{\delta p} = -m\omega_m^2 q + hg(a_s^* \delta a + a_s \delta a^\dagger) - \gamma \delta p + \xi$$

$$\dot{\delta a} = (-i\Delta + igq^s)\delta a - \kappa \delta a + iga_s \delta q + \sqrt{2\kappa}\delta a_{IN}$$

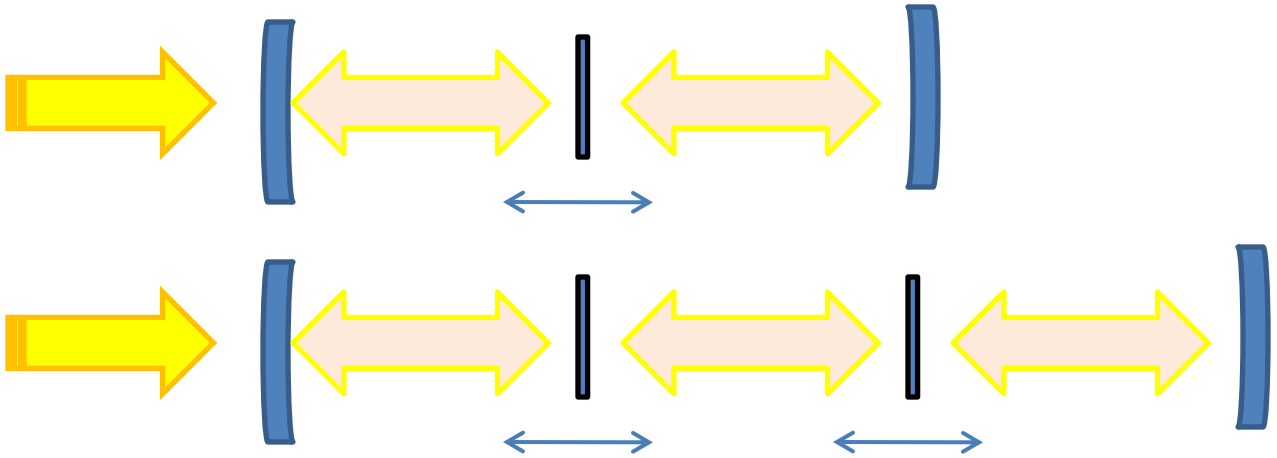
Stationary solutions can be found:

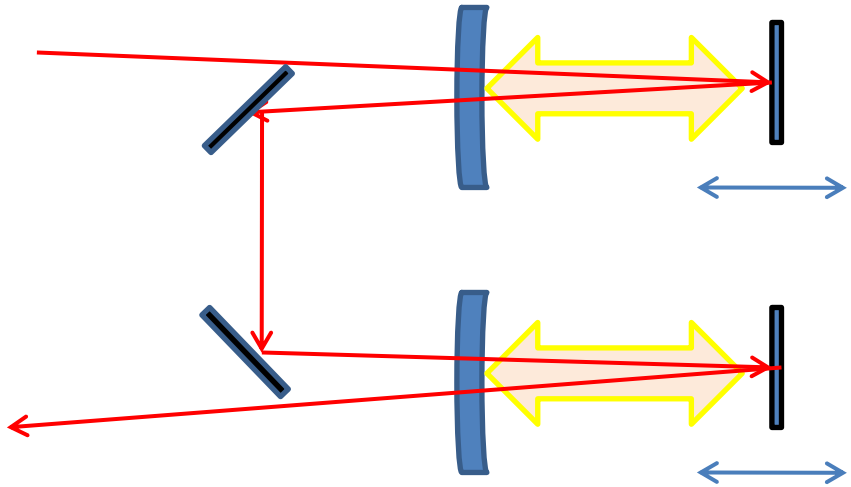
Adiabatic elimination of light: $\dot{\delta a} = 0$ $\left\{ \begin{array}{l} |\Delta| \gg 1 \\ \kappa \gg 1 \end{array} \right.$

Frequency solutions

$$\delta q(t), \delta p(t) = ?$$

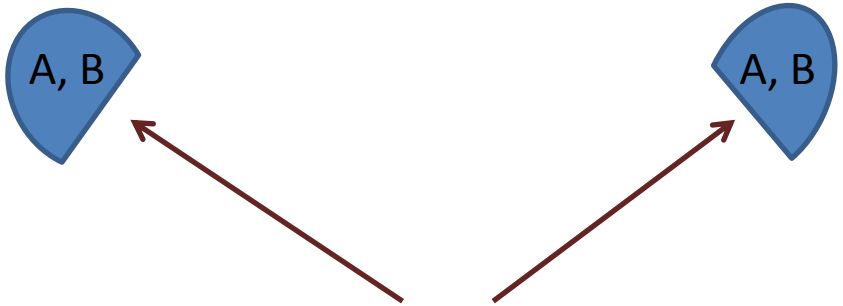
$$\begin{pmatrix} \delta q(t) \\ \delta p(t) \end{pmatrix} = \begin{pmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{pmatrix} \begin{pmatrix} \delta q(0) \\ \delta p(0) \end{pmatrix}$$





Bell inequalities with coherent states - amplification

$$R(\phi)|\alpha\rangle \rightarrow \cos\phi|\alpha\rangle + \sin\phi|-\alpha\rangle$$



$$|\Phi\rangle = |\alpha,\alpha\rangle + |-\alpha,-\alpha\rangle$$

$$S = \langle a_1 b_1\rangle + \langle a_1 b_2\rangle + \langle a_2 b_1\rangle - \langle a_2 b_2\rangle$$

Bell inequalities with coherent states - amplification

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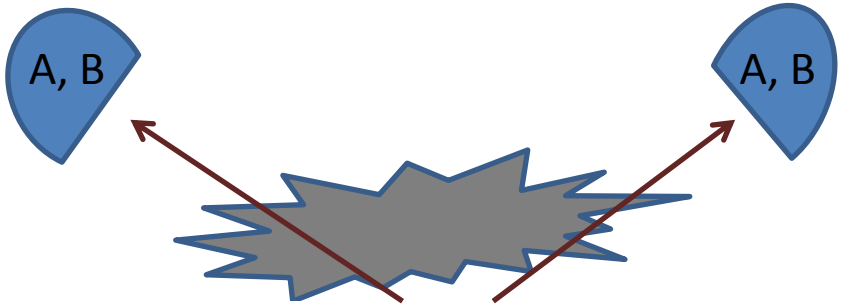

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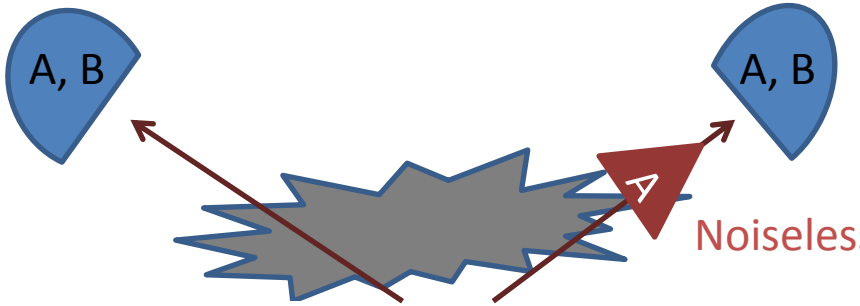
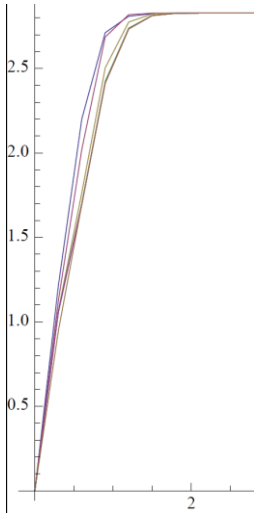


Noiseless amplification

$$|\Phi\rangle = |\alpha,\alpha\rangle + |-\alpha,-\alpha\rangle$$



Thanks for the attention!

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