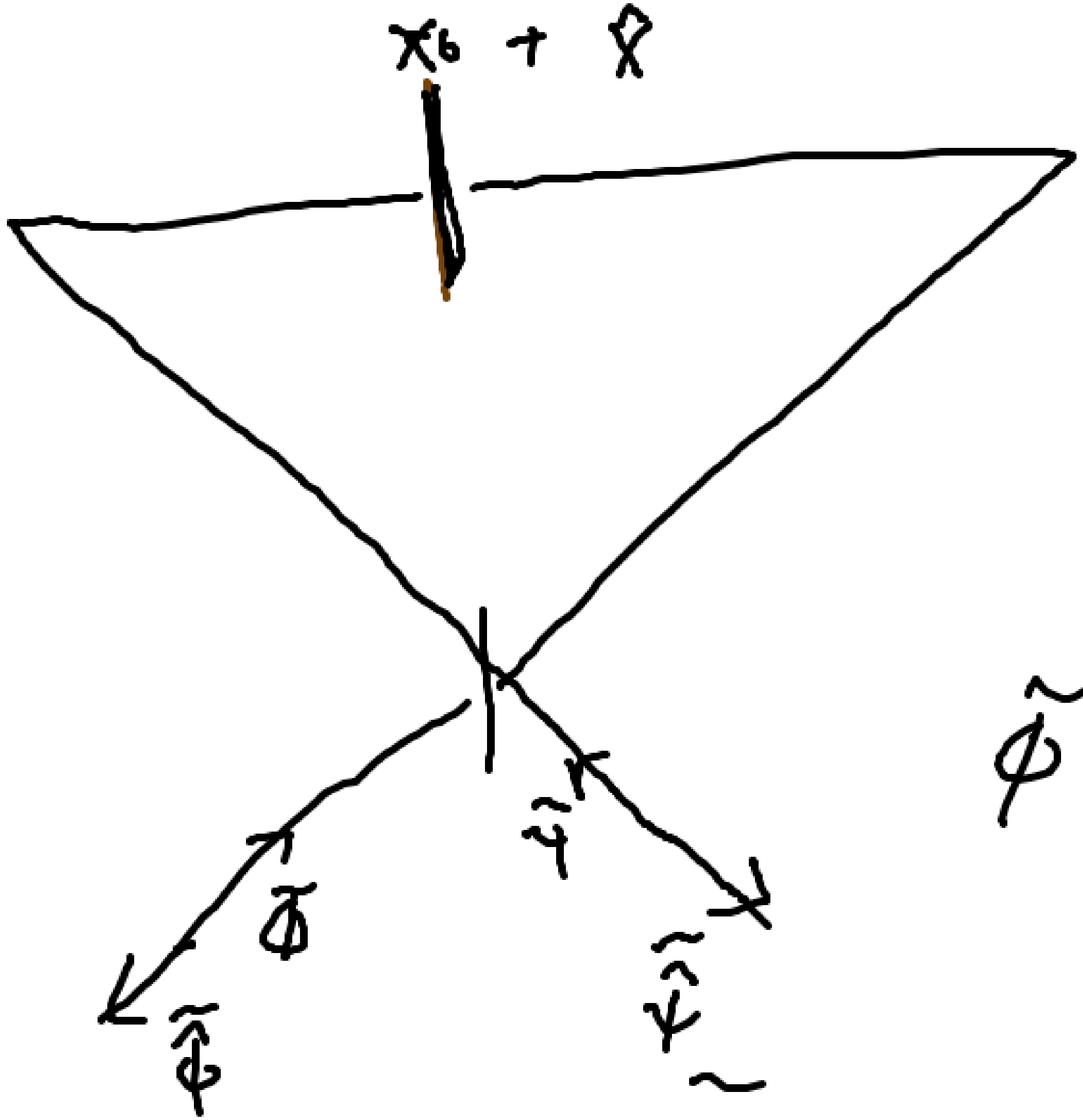

$$\tilde\phi(t) = \cancel{\alpha} A e^{-i\omega(t)}$$
$$+ e^{i\omega t}\int A_- e^{-i\omega t} d\omega$$

$$\tilde\psi(t+y) = \frac{1}{2}\Big(\tilde\phi(t+y-2X(t+y)) - \tilde\phi(t+y+2X)$$
$$+ \tilde\psi(t+y-\cancel{2X}) + \tilde\psi(t+y+\cancel{2X})\Big)$$
$$= \left(\tilde\Psi(t+y) + \dot{\tilde\phi}(t+y)(-2X(t+y))\right)$$

$$\tilde{\hat{\psi}}(t+y) = e^{-i\omega t}\int B_\nu e^{-i\nu t}\, d\nu + \phi \text{ terms}$$

$$\dot{\tilde{\hat{\phi}}} = -i\omega A$$

$$\hat{\tilde{\psi}} = e^{-i\omega t}\Big(\int B_{\dot\nu} e^{-i\nu t}\, d\nu$$

$$+(-i\omega) A(\underset{\sim}{x_0} + \dot{X})\Big)$$

$$= e^{-i\omega t}(-i)\Big(i B_\nu e^{-i\nu t + y} + A(x_0 + \dot{X})\Big)$$

Particle current $= \frac{i}{2}\left(\tilde{\hat{\psi}}^\dagger \partial_x \tilde{\hat{\psi}} + \partial_x \tilde{\hat{\psi}}^\dagger \tilde{\hat{\psi}}\right)$

$$= \frac{\omega}{2\pi}\left(\hat{\psi}^\dagger \hat{\psi}\right)$$

$$\text{Current} = A^2\omega^2 X_0^2 + A^2\omega^2\, 2X_0 \hat{X} + A\omega X_0\, i\int (B_\nu - B_{-\nu}^\dagger)\, e^{-i\nu t}\, d\nu$$

$$M\partial_t^2 \hat{X} = \int \underline{A\omega^2/2\,(B_\nu + B_{-\nu}^\dagger)}\, e^{-i\nu t}\, d\nu + \int F_\nu\, e^{-i\nu t}\, d\nu$$

$$\hat{X}_\nu = \frac{A\omega^2/2\,(B_\nu + B_{-\nu}^\dagger) + F_\nu}{-\underline{M\nu^2}}$$

(Damping neglected as small.)

$$\tilde{\hat{\psi}}_\nu = -i e^{-i\omega t}\Big(iB_\nu + i\omega A\big(X_0 + A\tfrac{\omega^2}{2}(B_\nu + B_{-\nu}^\dagger) + F_\nu\big)$$

$$B_\nu = C, \quad B_{-\nu}^\dagger = D^\dagger$$

$$\tilde{B}_\nu = B_\nu + i K (B_\nu + B_{-\nu}^\dagger)$$

$$= B_\nu (1 + iK) + iK B_{-\nu}^\dagger$$

$$\tilde{B}_\nu \tilde{B}_\nu^\dagger = 1$$

$$\tilde{B}_{-\nu} \tilde{B}_{-\nu}^\dagger = 0$$

Mix $+\nu$ and $-\nu$ channel. to get "amplifier" squeezing.

Amplifier → Squeezing produces noise if both channels are in vacuum state.

Best noise $\tilde{B}_\nu = (1 \pm i K) B_\nu + i K B^\dagger_{-\nu}$

around Vacuum.

$$\tilde{B}_\nu |0\rangle = 0$$

K is freq. dep $\quad K \sim \frac{1}{\nu^2}$

Freq. dep. squeezing.

QUANTUM COMPUTING.

1980's : Benioff, Feynman

N 2 level systems.

Hilbert space 2^N basis vectors.

$N = 200 \quad 10^{60} >$ # particles in galaxy.

$$|\psi\rangle = \sum_{1}^{10^{60}} \alpha_i |i\rangle$$

$10^{10^{77}}$

- Could one simulate a q. system by a simple, well understood q. system?

Build Q Computer for efficient than classical one for calc certain problems?

Grover

Database lookup. → Find item in unstructured Database requires N lookups. (N/2 on average)

Grover Showed → $\sqrt{N}$ lookups. if Quantum system.

Entanglement → Q.C. have to be reversible (No erasures)

Turn Q. system ⟹ Classical/prob. system.

Only Unitary operators allowed.
U have to act only on the system (computer)

$$U^{\dagger} U |\psi\rangle = |\psi\rangle$$

$$\Downarrow$$

Basic Set of Unitary operators.
(operate only on 1, 2, 3 2 level systems at once.)

- Basic of Unitary operations.

1 bit

$$|0\rangle \Rightarrow \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$$

$$|1\rangle \Rightarrow \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)$$

2^N Dimension system.

N Qbits.

$$\underbrace{|0\rangle|0\rangle|1\rangle|0\rangle|1\rangle}_{2^4\quad 2^3\quad 2^2\quad 2^1\quad 2^0} \cdots\cdots$$

$$\frac{1}{\sqrt{2^N}}\sum_{i=1}^{2^N}|i\rangle$$

$\rightarrow |0\rangle|0\rangle|0\rangle|0\rangle \cdots\cdots$

N oper-bits

$\left(\frac{|0\rangle+|1\rangle}{\sqrt{2}}\right)\left(|0\rangle+|1\rangle\right)\cdots\left(|0\rangle+|1\rangle\right)$

ln faster than # states.

$$= \frac{1}{\sqrt{2^N}}\sum_i |i\rangle$$