9AM $\sigma_z \to -1$

11AM $\sigma_x \to +1$

10AM $\sigma_\theta = \cos\theta\,\sigma_z + \sin\theta\,\sigma_x \Rightarrow ?$

$\sigma_x \Rightarrow \pm 1$

$$\sigma_\theta = \begin{pmatrix} \cos\theta & \sin\theta \\ \sin\theta & -\cos\theta \end{pmatrix}$$

$\lambda_1 + \lambda_2 = 0$

$\lambda_1 \lambda_2 = -1$

$$+1 \Rightarrow \begin{pmatrix} \sin\theta \\ 1-\cos\theta \end{pmatrix} \frac{1}{\sqrt{2-2\cos\theta}}$$

σ_z

$+1$

$\sigma_\theta = +1$ $\qquad$ $\sigma_x = +1$

$\sigma_x = -1$

$\sigma_\theta = -1$

$\sigma_x = +1$

$\sigma_x = -1$

$$P_{\sigma_\theta = +1} \Rightarrow \frac{\#\ \sigma_\theta = +1,\ \sigma_x = +1}{\sigma_x = +1}$$

$$P_{1_z 1_\theta} \quad |\langle 1_z | 1_\theta \rangle|^2 , \quad |\langle 1_\theta | 1_x \rangle|^2 \quad P_{1_\theta 1_x}$$

$$P_{1_z -1_\theta} \quad |\langle 1_z | -1_\theta \rangle|^2 \quad |\langle -1_\theta | 1_x \rangle|^2 \quad P_{-1_\theta 1_x}$$

$$P_{1z|\theta|x} = \frac{|\langle 1z||\theta\rangle|^2 |\langle \theta||x\rangle|^2}{|\langle 1z||\theta\rangle|^2 |\langle \theta||x\rangle|^2 + |\langle 1z|-1\theta\rangle|^2 |\langle -1\theta||y\rangle|^2}$$

$$P|_\theta = \frac{(\sin 2\theta)^2}{4\left(\frac{(\sin 2\theta)^2}{4} + (1-\cos\theta)^2(1-\sin\theta)^2\right)}$$

$|\psi_i\rangle \,, \quad |\psi_f\rangle$

$U(t_i\, t) \qquad U(t, t_f)$

$Q \Rightarrow q$

$$\frac{|\langle\psi_i|q\rangle\langle q|\psi_f\rangle|^2}{\sum_{q'} |\langle\psi_i|\underline{q'\rangle\langle q'|\psi_f}\rangle|^2}$$

$$= \frac{|\langle\psi_f|q\rangle\langle q|\psi_i\rangle|^2}{\sum_{q}}$$

$\langle\psi_i|q\rangle^*$

$\parallel$

$\langle q|\psi_i\rangle$

Q.M., including meas., is
time symmetric
(A, B, C)
conditions may (or may not)
be time asymmetric.

After t final, then: $|\psi_f\rangle$ takes over as initial cond for future pred.

$|\psi\rangle$ rep conditions, but 2 wavefunctns. one from past and one from future determine present.

Measurement

vN $|\psi\rangle\,|0\rangle$

system.   meas app.

$Q \Rightarrow q, |q\rangle$

$|q\rangle \longrightarrow |q\rangle|\phi_q\rangle$

$|\psi\rangle = \sum_q \alpha_q |q\rangle$ $|\psi\rangle|0\rangle \to \sum_q \alpha_q |q\rangle|\phi_q\rangle$

$\langle \phi_q | \phi_{q'} \rangle = \delta_{qq'}$ goodmeas.

Meas meas app to find $|\phi_q\rangle$

after $\Rightarrow |q\rangle|\phi_q\rangle|\psi_{\phi_q}\rangle$

Prob ϕ_q : $\left|\left(\langle\phi_q|\langle q|\right)\left(\sum_{q'}\alpha_{q'}|q'\rangle|\phi_{q'}\rangle\right)\right|^2$

since $\langle\phi_q|\phi_{q'}\rangle = \delta_{qq'}$

$P_{\phi_q} = |\alpha_q|^2 = |\langle q|\psi\rangle|^2$

Prob indep of where in meas chain I stop.

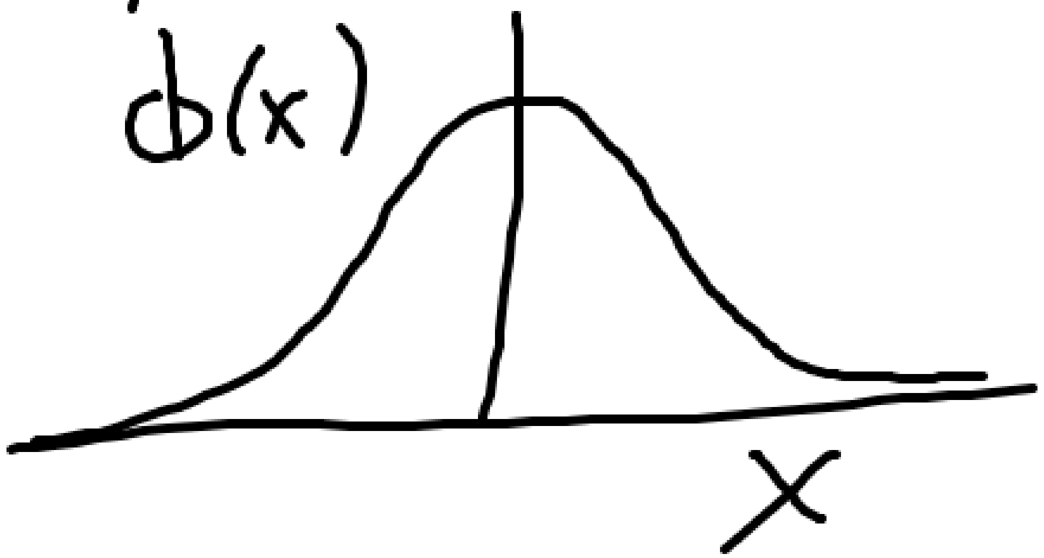
vN cosistancy of mear chain.

$|\phi_q\rangle$ not orthog to each other

Example: particle. $\langle x|\Phi\rangle = \phi(x)$

$|\Phi\rangle \to$

$\phi(x)$



$H = \epsilon\sigma P$

$U = e^{-i\sigma P\epsilon T}$

$H = T\delta(t)\epsilon\sigma P$

$U|+1\rangle|\psi\rangle = |+1\rangle e^{-i1\epsilon TP}|\Phi\rangle$

$e^{i\alpha P}|x\rangle = |x+\alpha\rangle$

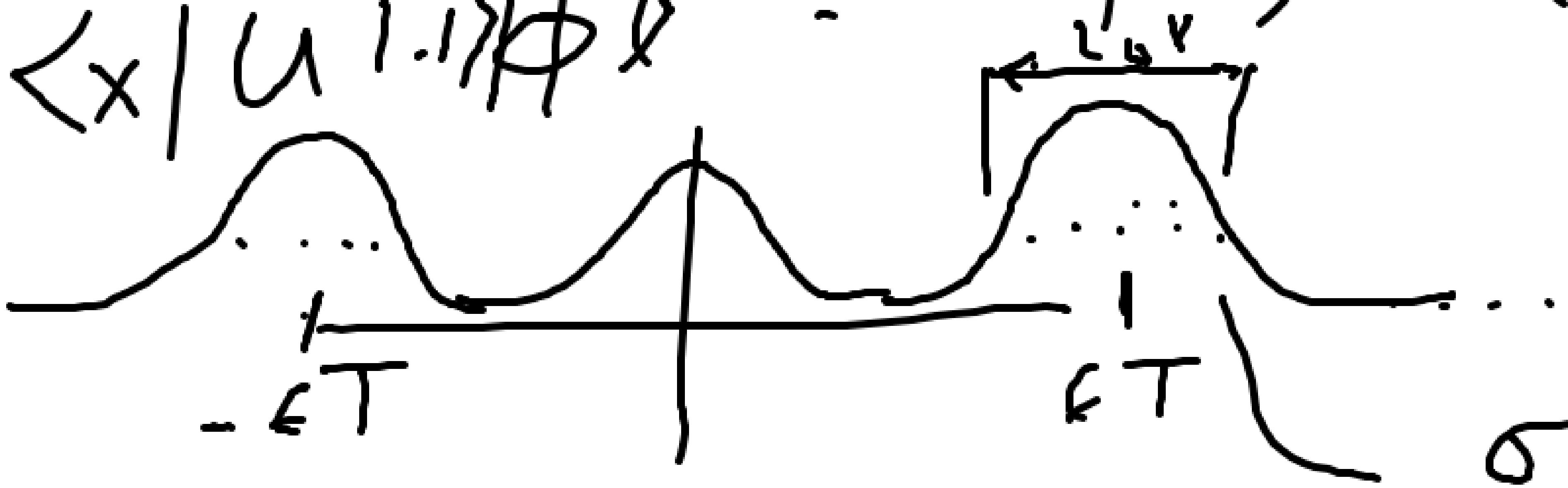
$[\sigma, H] = 0$

$\langle x | U | 1 \rangle | \phi \rangle = \phi(x - \epsilon T)$

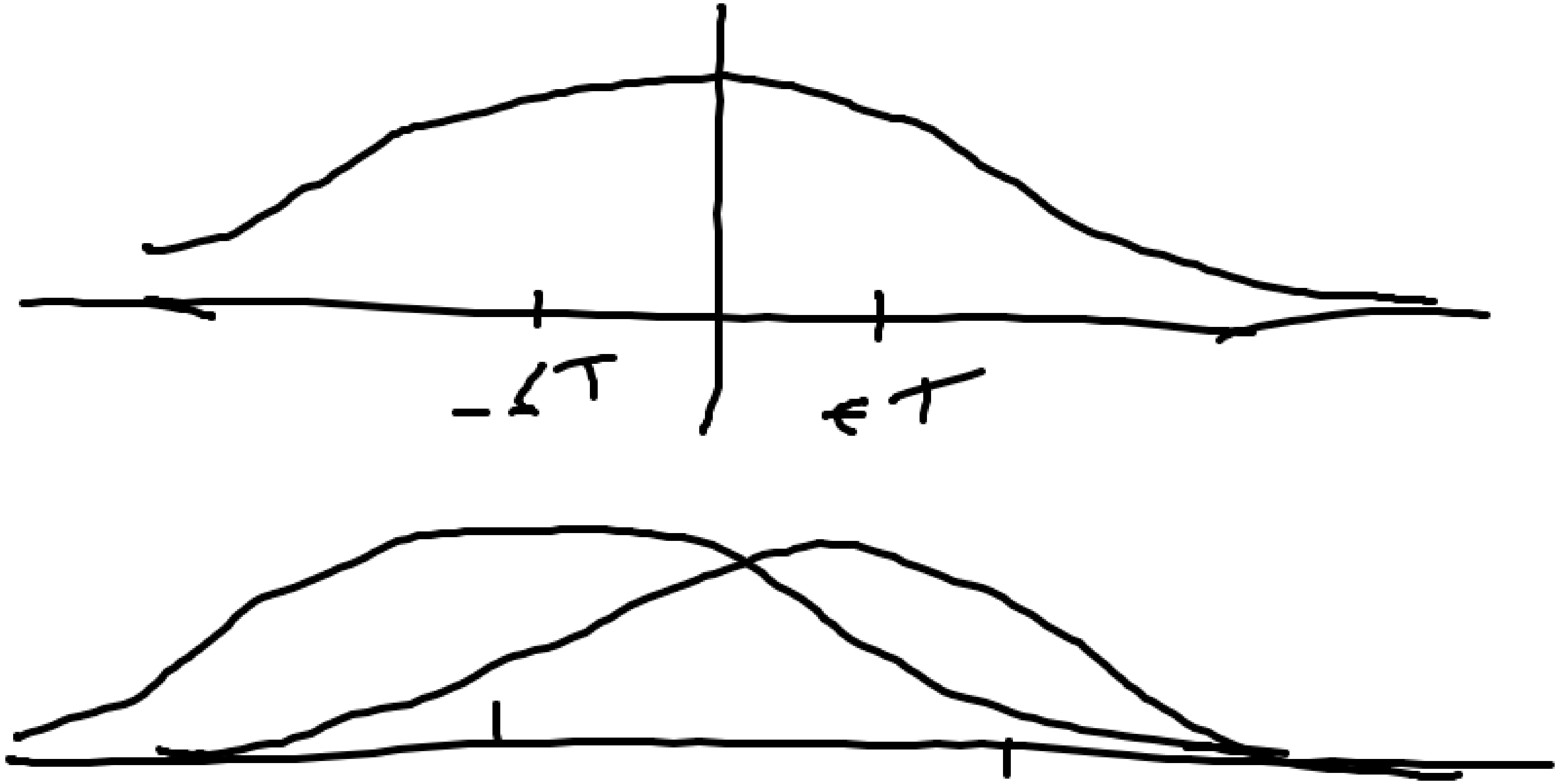
If $\phi(x)$ centered a 0 this centered at ϵT

$|-1\rangle$ in σ_z

$\langle x | U | -1 \rangle | \phi \rangle = |-1\rangle \, \phi(x + \epsilon T)$



$\sigma = \pm 1 \pm \Delta X$



Weak meas.

Bad Meas. with 2 time conditions

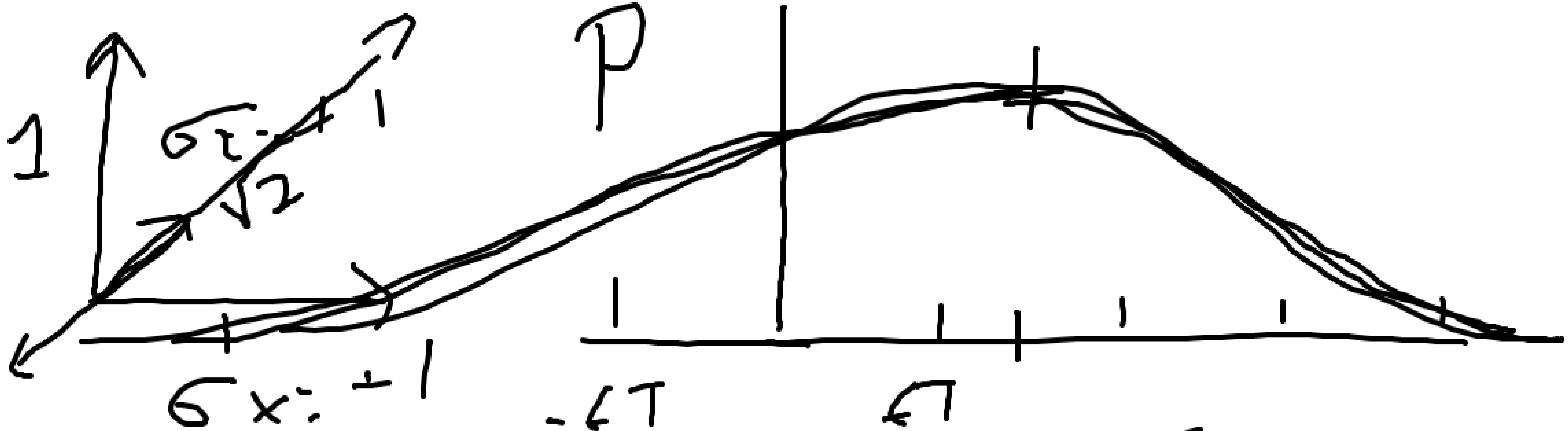
If $\Delta x \gg \epsilon T$

σ_z initial $\Rightarrow +1$

σ_x final $\Rightarrow +1$

intermed is "bad meas (gauss) of $\sigma_{45°}$"

- peak of distr is

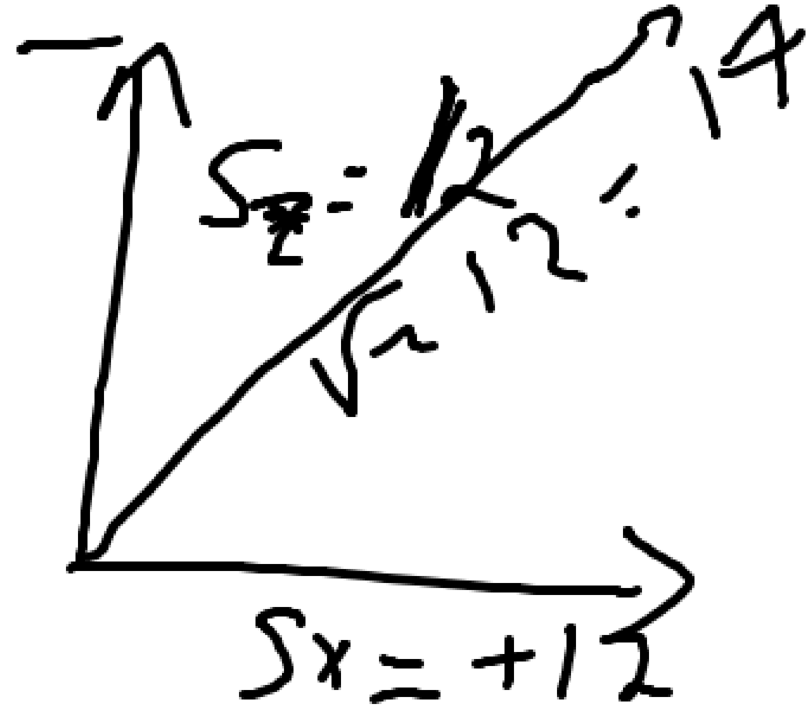


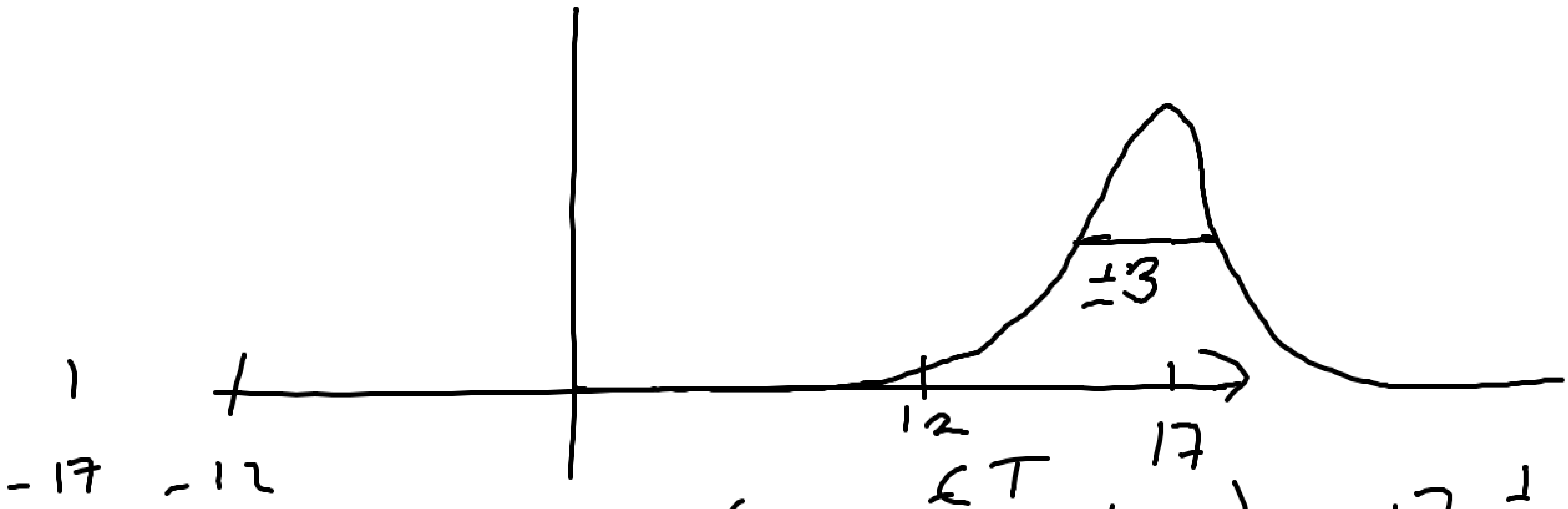
Classical

$S^2 = \frac{3}{4}$

$S^2 = (12)(13)$

gaussian ± 3





Value (Weak value) = 17 ± 3

Weak Meas.