$$i\frac{\partial|\Psi\rangle}{\partial t} = (H_F + H_I)|\Psi\rangle$$

$$|\Psi\rangle = U_F|\tilde{\Psi}\rangle$$

$$U_F = e^{-iH_F t}$$

$$\cancel{U_F H_F}|\tilde{\Psi}\rangle + U_F i\partial_t|\tilde{\Psi}\rangle = (\cancel{H_F} + H_I)U_F|\tilde{\Psi}\rangle$$

$$i\partial_t|\tilde{\Psi}\rangle = U_F^\dagger H_I U_F|\tilde{\Psi}\rangle$$

$$H_I = H(\Phi, \pi, \sigma)$$

$$H(U_F^\dagger \Phi U_F, U_F^\dagger \pi U_F, U_F^\dagger \sigma U_F)$$

$U_F^\dagger \, Op \, U_F$: Heisenberg soln for Op with H_F.

$\Phi(t,x)$, $\Pi(t,x)$, $\sigma_x, \sigma_y\ \sigma_z$

$$H_I = \int \epsilon\ \Phi(t,\vec{x})\ \sigma_x(t)\ \delta^3(\vec{x})\, d^3x$$

$$\sigma_x = \sigma_- e^{-iEt} + \sigma_+ e^{iET}$$

<u>Pert Theory.</u> ϵ small + expand in powers of ϵ.

$$|\psi\rangle = |\psi_0\rangle + \delta|\psi, t\rangle$$

$$i\partial_t\, \delta|\psi, t\rangle = H_I\, |\psi_0\rangle$$

If $|0\rangle|\downarrow\rangle = |\Psi_0\rangle$

$$\phi_{\vec{k}}(t,x) = \frac{e^{-i(\omega t - \vec{k}\cdot\vec{x})}}{\sqrt{(2\pi)^3|\omega|}} \qquad \omega^2 = k^2 + m^2$$

$$\Phi = \int \left(A_{\vec{k}}\,\phi_k + A_k^\dagger\,\phi_k^*\right) d^3k$$

$$\Pi = \int \left(A_k\,\pi_k + A_k^\dagger\,\pi_k^*\right) d^3k$$

$$\partial_t \phi_k = \pi_{\vec{k}}$$

$$\delta|\psi, t) = \int^{t} -i\, H_I(t)\, dt \;\; |0\rangle|\downarrow\rangle$$

$$= \int^{t} \underline{\Phi(t', 0)}\; e^{iEt'}\; \underline{|0\rangle}\,|\uparrow\rangle\, dt'$$

$$\underbrace{\int e^{-i\omega t}\, e^{iEt}\, dt \ldots}_{\simeq 0}$$

$$\delta|\psi, t\rangle = 0$$

$$\mathrm{Prob}_{\uparrow} = 0$$

$$|\psi_0\rangle = A_\phi^+ |0\rangle |\downarrow\rangle$$

ϕ is the norm mode made up only of ϕ_k (no ϕ_k^*)

$$\delta|\psi, t\rangle = |\uparrow\rangle\, i\epsilon \int_0^t e^{-iEt}\, \underline{\phi(t, \vec{0})}\, |0\rangle$$

$$\text{Prob}\,|\uparrow\rangle = \epsilon^2 \left| \int^t e^{iEt'} \phi(t', \vec{0})\, dt' \right|^2$$

This is a reasonable model for a particle detector.

Emission

Start detector $|\uparrow\rangle |0\rangle$

$$\sigma_- \quad e^{-iEt} \qquad |\uparrow\rangle \to e^{-iEt} |\downarrow\rangle$$

$$\int \Phi \, e^{-iEt}$$

$$\int A^+_k \frac{e^{i\omega t - k\cdot\vec{x}}}{\sqrt{(2\pi)^3 |\omega|}} e^{-iEt} \, dt$$

$$\sim \delta(\omega - E)$$

$\longrightarrow$ produces 1 particle state.

Uniform motion

$$e^{-i(\omega t - k\cdot x)} =$$

$$= e^{-i(\omega t - k_x x - k_y y - k_z z)}$$

$$e^{-i((\omega\gamma - k_x v\gamma t) - k_x\gamma x + \gamma v\omega x}$$

$$\gamma = \frac{1}{\sqrt{1-v^2}}$$

$$\omega > |k_x| \qquad \gamma(\omega - v k_x) > 0$$

$$\omega = \sqrt{k_x^2 + \underbrace{k_y^2 + k_z^2 + m^2}} > \sqrt{k_x^2}$$

If static detector sees nothing neither will the moving one.

Acceleration

$$t = \frac{1}{a}\sinh a\tau$$

$$x = \frac{1}{a}\cosh a\tau$$

Near $\tau = 0$

$$t \simeq \tau$$

$$x \simeq \frac{1}{a} + \frac{1}{2}\frac{1}{a}a^2\tau^2 + O\left((a\tau)^4\right)$$

$$\simeq \frac{1}{a} + \frac{1}{2}at^2$$

$$\bar{t} = \gamma(t - v x) \qquad \bar{x} = \gamma(x - v t)$$

$$\gamma = \frac{1}{\sqrt{1 - v^2}}$$

$$\gamma^2 - v^2\gamma^2 = 1$$

$$\cosh^2 r - \sinh^2 r = 1$$

$$\cosh r = \gamma, \qquad \sinh r = v\gamma$$

$$\bar{t} = \cosh r \, t - \sinh r \, x \qquad x = \cos\theta - \sin\theta\, y$$

$$\bar{x} = \cosh r \, x - \sinh r \, t \qquad y = \cos\theta\, y + \sin\theta\, x$$

$$\bar{t} = \cosh r \left(\frac{1}{a} \sinh a\tau\right) - \sinh r \left(\frac{1}{a} \cosh a\tau\right)$$

$$= \frac{1}{a} \sinh\left(\frac{\tau - ar}{a}\right) \; ; \quad \bar{x} = \frac{1}{a} \cosh \frac{\tau - ar}{a}$$

This is a curve of constant relativistic acceleration

Dector : $H: \frac{E\sigma_z}{2}$

$$\sigma_x = \sigma_- e^{-iE\tau} + \sigma_+ e^{(iE\tau)}$$

$$\Phi(t, x, \underbrace{y, z}_{\vec{0}}) = \Phi(\underbrace{\tfrac{1}{a}\sinh a\tau, \tfrac{1}{a}\cosh a\tau,} 0, 0)$$

Mess

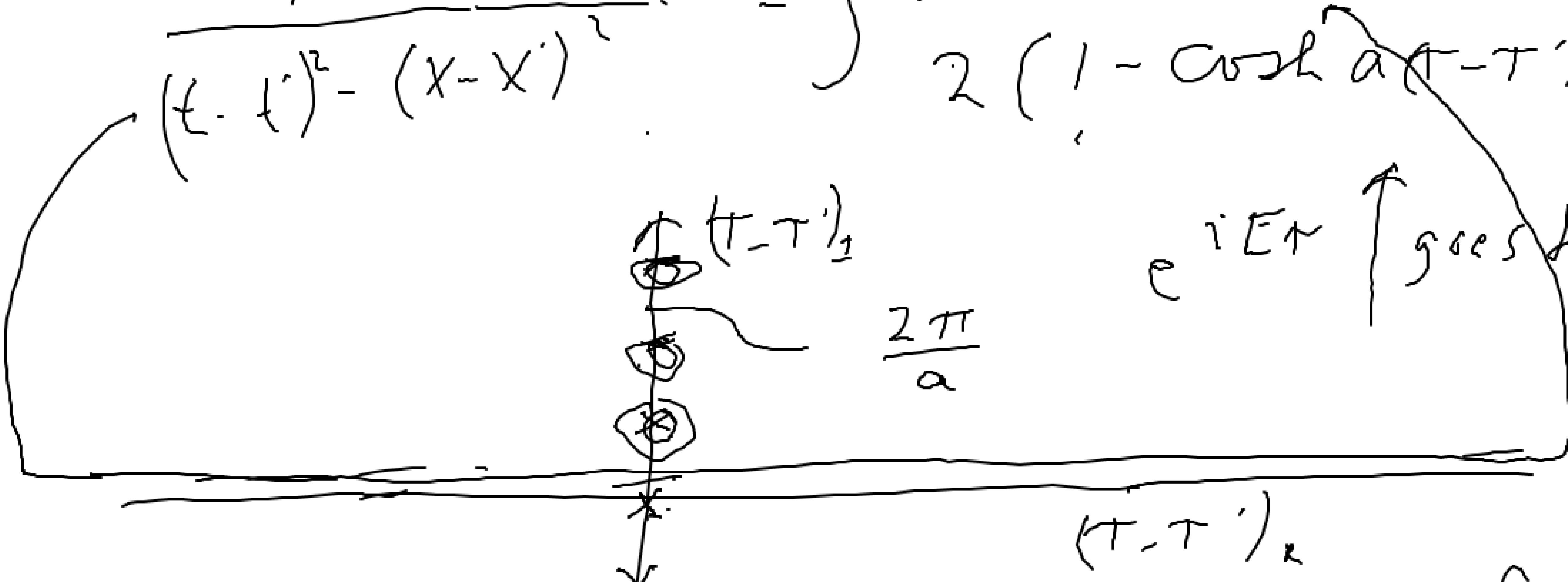
$$e^{-i(\omega t - k_x x - k_y y - k_z z)}\, e^{iE\tau})\,d\tau$$

$$= \int e^{-i\left(\frac{\omega}{a}\sinh a\tau - \frac{k_x}{a}\cosh a\tau\right)}\, e^{iE\tau}\, d\tau$$

$$\text{Prob}\uparrow = \int e^{iE(\tau' - \tau'')} \overbrace{\langle 0|\Phi(t(\tau'), x(\tau'))\,\Phi(t(\tau''), x(\tau''))|0\rangle}^{W}$$

$$W(t, \vec{x}, t', \vec{x}') \propto \frac{1}{(t-t')^2 - (\vec{x}-\vec{x}')^2}$$

$$\frac{1}{(t-t')^2-(x-x')^2} = \int \frac{a^2}{2(1-\cosh a(\tau-\tau'))} e^{iE\tau} \, d\tau$$



Fourier Transf of Weightman functn.

Detector excites even in vacuum

$$\sum_{n=1}^{\infty} e^{-\frac{2\pi n}{a}E} = \frac{e^{-2\pi E/a}}{1-e^{-2\pi E/a}}$$

Fourier Transform of
Weightman function
is thermal. $\frac{a}{2\pi}$

$e^{-E/kT}$

Accel dector behaves as if in
thermal bath temp $= \boxed{\frac{a}{2\pi}\left(\frac{\hbar}{k_0 c}\right)}$

$1°K \simeq 10^{22}\ cm/s^2$