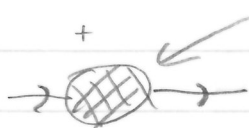
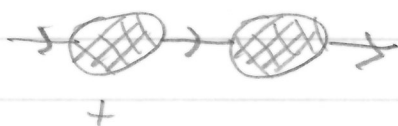


NOT all so include $\Delta(p)$ here $\Sigma 2$

$$\Pi(p) = \rightarrow$$



IPI = one-particle irreducible



etc

Defⁿ IPI diagrams are truncated diagrams (no external legs) which can not be cut into two pieces by cutting one (internal) line

Symbol  = $\Gamma(x_1, x_2, \dots, x_n)$

e.g. SYTH
2pt IPI $\Sigma = \text{diagram with shaded loop} = \text{diagram A} + \text{diagram B} + O(g^4)$

$$\Pi(p) = \Delta + \Delta \Sigma \Delta + \Delta \Sigma \Delta \Sigma \Delta + \dots$$

$$= \Delta \left(\sum_{n=0}^{\infty} (\Sigma \Delta)^n \right)$$

$$= \frac{\Delta}{1 - \Sigma \Delta}$$

$$\left(\sum_{n=0}^{\infty} x^n = \frac{1}{1-x} \right)$$

$$\Pi(p) = \frac{1}{\Delta^{-1} - \Sigma}$$

Suppose change H_{int}

Now physical mass in propagator

$$\mathcal{L}_0 = (\partial_\mu \psi)^\dagger (\partial^\mu \psi) - M_{phys}^2 \psi^\dagger \psi + \mathcal{L}_{int}$$

$$\mathcal{L}_{int} = -g \psi^\dagger \psi \phi - \underbrace{(M^2 - M_{phys}^2)}_{\delta M^2} \psi^\dagger \psi$$

COUNTER TERM
- Treat as $O(g)$

$$H_{int} = -\partial_\mu^3 - \mathcal{L}_{int}$$

$\Rightarrow$ New vertex
(Two legs)

$\rightarrow p_1 \leftarrow p_2$

$$\rightarrow \text{X} \rightarrow = -i(\delta M^2) \delta^4(p_e)$$

& new propagator

$$\Delta_{phys}(p) = \frac{i}{p^2 - M_{phys}^2 + i\epsilon}$$

Full Propagator now $\Pi(p) = (\Delta_{phys}^{-1} - \Sigma^{NEW})$
Where now

$$\Sigma^{NEW} = \text{diagram with loop} + \text{diagram with X} + \dots$$

However we want $(\Pi(p^2 = M_{phys}^2))^{-1} = 0$

$$\Rightarrow \Sigma^{NEW}(p^2 = M_{phys}^2) = 0$$

$$\Rightarrow \delta M^2 = -\Sigma_A$$

$$\Rightarrow M^2 = M_{phys}^2 - \Sigma_A = \infty !$$

Now $\Pi(p)$ is finite to $O(g^2)$
 $\Sigma(p)$ " " " "

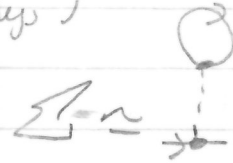
But $\Pi(p) \sim \frac{i}{p^2 - M_{\text{phys}}^2}$

at $p^2 = M_{\text{phys}}^2$
 c.f. solⁿ of K.G.
 $p^2 = M_{\text{phys}}^2$ defⁿ
 of particle
 mass.

$$\Rightarrow [\Pi(p^2 = M_{\text{phys}}^2)]^{-1} = 0$$

$$\Rightarrow 0 = -i(M_{\text{phys}}^2 - M^2) - \Sigma(p^2 = M_{\text{phys}}^2)$$

Consider only diagram (A)
 (Large N approximation)



$$\Rightarrow \Sigma(p) = \Sigma \text{ ind of } p^2$$

$$\begin{aligned} \Rightarrow \Sigma(p) &= \Sigma_A = -ig \cdot \frac{+i}{0 - M^2 + i\epsilon} \cdot -ig \int d^4k \frac{i}{k^2 - M^2 + i\epsilon} \\ &= +i \frac{g^2}{M^2} \Delta(0) \sim \frac{g^2}{M^2} \Lambda^2 \left\{ \Delta_4(x=0) \right\} \\ &\quad \text{if } i \int d^4k \frac{i}{k^2 - m^2} \end{aligned}$$

Note Σ here is independent of momentum

$$\Rightarrow 0 = M_{\text{phys}}^2 - M^2 - i\Sigma_A$$

$$\Rightarrow M_{\text{phys}}^2 = M^2 + i\Sigma_A$$