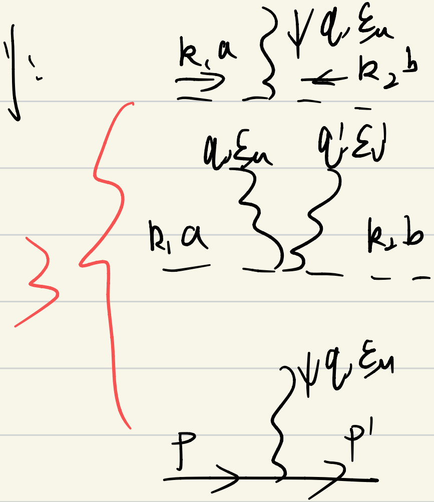
费曼规则:



$e(k_2^\mu - k_1^\mu)\,\varepsilon^{ab3}$ $\quad O(p^2)$

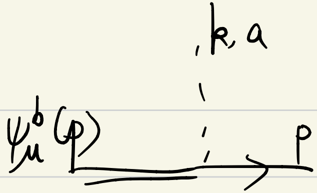
$-2ie^2 g^{\mu\nu}(\delta_{a3}\delta_{b3} - \delta_{ab})$ $\quad O(p^2)$

$ie\,\frac{1+\tau_3}{2}\gamma_\mu$ $\quad O(p^1)$

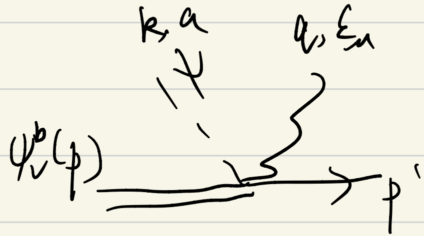
$\frac{e}{4m}\sigma_{\mu\nu}q^\nu\left(c_6(1+\tau_3)+2c_7\right)$ $\quad O(p^2)$

$\frac{e}{2m}(p_\nu+p'_\nu)(q^\nu q^\mu - q^2 g^{\mu\nu})(2d_7+d_8\tau_3)$ $\quad O(p^3)$

含Δ耦合的.

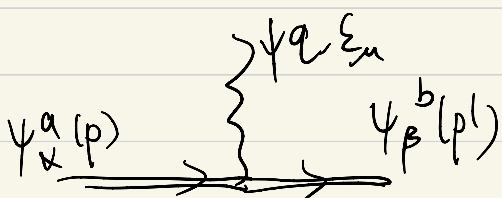


$\frac{h_A}{F} k_\mu \delta_{ab}$ $O(p^1)$



$-\frac{ie h_A}{F} g_{\mu\nu} \varepsilon^{ab3}$ $O(p^1)$

$\frac{ieb_1}{2} q^\alpha (\gamma_\alpha g_{\mu\nu} - \gamma_\nu g_{\mu\alpha}) \gamma^5 \delta_{b3}$ $O(p^2)$



$\frac{e}{2} \varepsilon_{\mu\nu\alpha\beta} \gamma^\nu \gamma^5 (1 + 3\tau_3) \delta_{ab}$

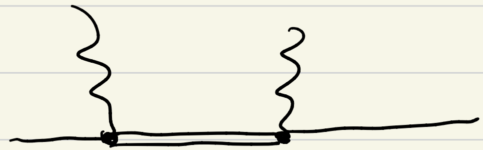
$O(p^1)$

4

$3+4 \Rightarrow 7$个 Feynman rule

只需图：

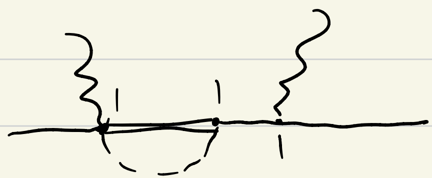
树图：



$2+2-0.5=3.5$

仅一张树图.

圈图：



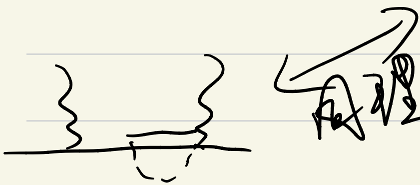
$1+1+1+4-2-0.5-1$

$=3.5.$

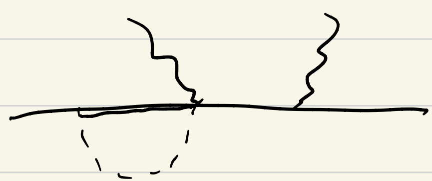
①

顶点都只需要最低阶即可

所以只需一阶顶点.



同理



②

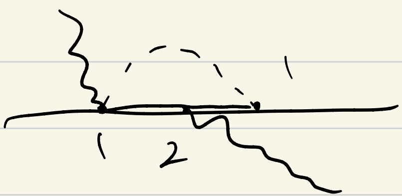
同上 $=3.5$

后面很多图

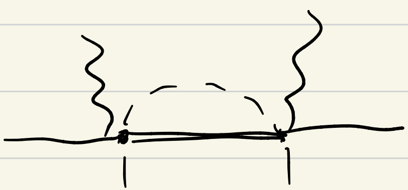
同理存在对称图.

$1+1+2+1+4-2-0.5-0.5-1=4.$ 不需要.

$1+1+2+1+4-2-2-0.5-1=3.5$ ③



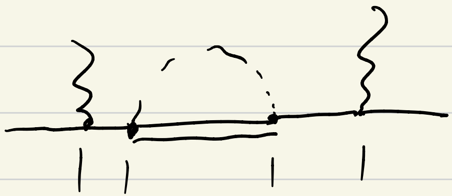
$1+2+1+4-2-0.5-0.5=5$ 不需要.



$1+1+4-2-0.5=3.5$ ④

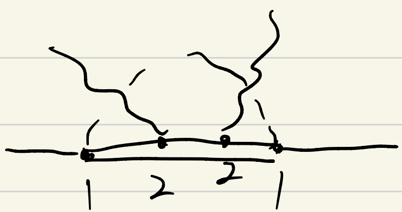
$1+2+1+4-2-2-0.5=3.5$

a

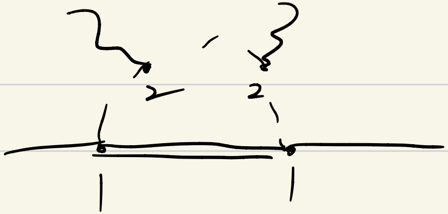


$1+1+1+1+4-2-0.5-1-1=3.5$

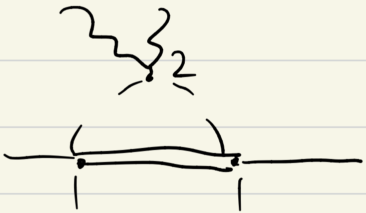
b



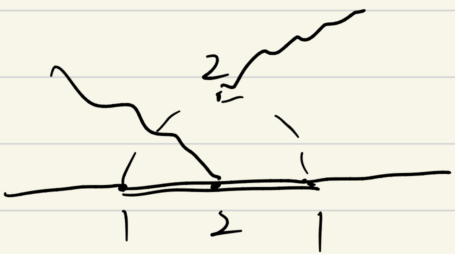
$1+2+2+1+4-2-0.5-0.5-0.5=$ 过大.



$1+2+2+1+4-2-2-2-0.5=3.5$ 7

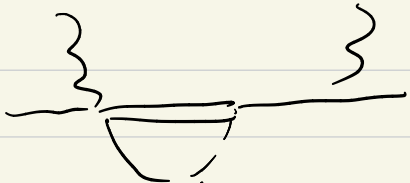


$1+1+2+4-2-2-0.5=3.5$ 8

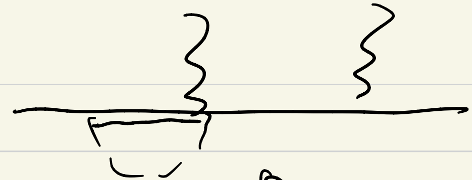


$1+2+1+2+4-2-2-0.5-0.5=5$ 最高.

汇总:



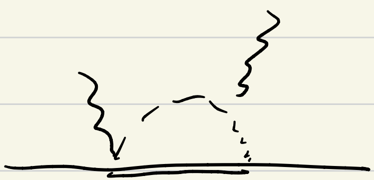
①



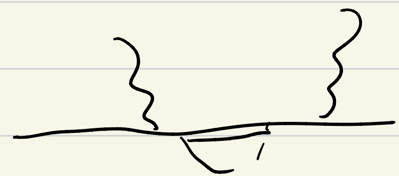
②

③

④

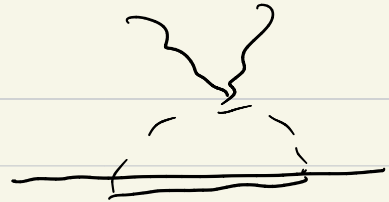


⑤



⑥

⑦



⑧

其中①②③④还存在对称图.

Δ的传播子:

$$G^{\mu\nu}(p) = -\frac{\not{p}+m_\Delta}{p^2-m_\Delta^2}\left(g^{\mu\nu}-\frac{\gamma^\mu\gamma^\nu}{d-1}+\frac{p^\mu\gamma^\nu-\gamma^\mu p^\nu}{(d-1)\,m_\Delta}-\frac{d-2}{d-1}\frac{p^\mu p^\nu}{m_\Delta}\right).$$

或者 $$(P^{3/2})_{\mu\nu} = g_{\mu\nu} - \frac{\gamma^{\mu}\gamma^{\nu}}{d-1} - \frac{d-4}{d-1}\frac{p_\mu p_\nu}{p^2} - \frac{\not{p}\gamma_\mu p_\nu + p_\mu \gamma_\nu \not{p}}{(d-1)p^2}$$

$$(P^{1/2}_{12})_{\mu\nu} = \frac{1}{\sqrt{d-1}}\frac{1}{p^2}\left(p_\mu p_\nu - \not{p} p_\nu \gamma_\mu\right)$$

$$(P^{1/2}_{21})_{\mu\nu} = \frac{1}{\sqrt{d-1}}\frac{1}{p^2}\left(\not{p} p_\mu \gamma_\nu - p_\mu p_\nu\right)$$

$$(P^{1/2}_{22})_{\mu\nu} = \frac{p_\mu p_\nu}{p^2}.$$

$$\Rightarrow G^{\mu\nu}(p) = -\frac{\not{p}+m_\Delta}{p^2-m_\Delta^2}(P^{3/2})_{\mu\nu} - \frac{1}{\sqrt{d-1}}\frac{1}{m_\Delta^2}\left(P^{1/2}_{12}+P^{1/2}_{21}\right)_{\mu\nu}$$

$$+ \frac{d-2}{d-1} \frac{\not{p}+m_\delta}{m_\delta^2} \left(P^{1/2}_{22}\right)_{\mu\nu}$$