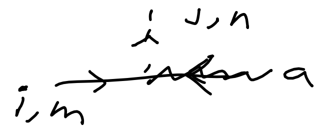
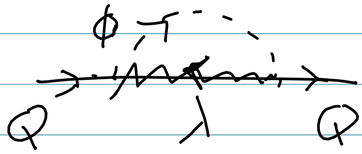
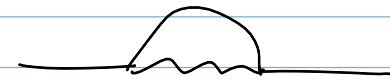
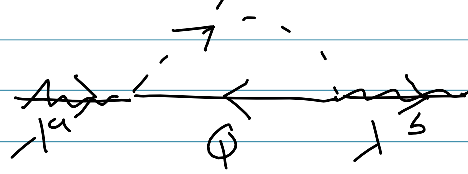
$y^{jm}_{im,a} = \sqrt{2}g\,(T^a)^n_m\,\delta^j_i =$ 

$Y_2(Q) =$ 

$= \sqrt{2}g\, T^{an}_{m}\, \sqrt{2}g\, T^{ak}_{n}$

$\Rightarrow 2g^2$ 

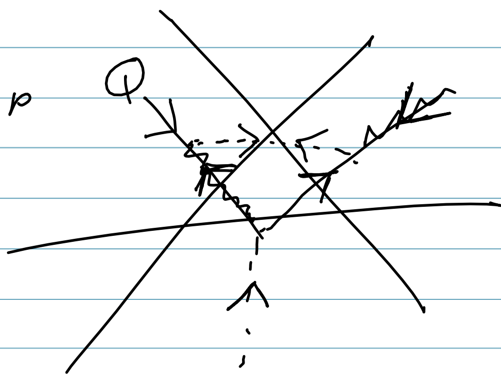
$= 2g\; C_2(\square)\,\delta^k_m$

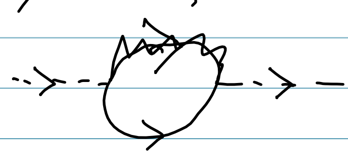
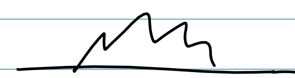
$Y_2(\lambda) =$ 

$\to 2g^2$ 

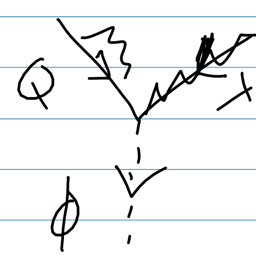
$= 2g^2\, 2F\, T(\square)\,\delta^{ab}$

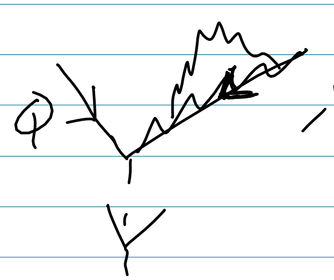
$= 2g^2 F\; \delta^{ab}$

$Y^p\, Y^{k\dagger}\, Y^p$ 

$\mathrm{Tr}\; Y^\dagger Y$  $\to 2g^2$ 

$= 2g^2\; C_2(\square)$

$\{C_2(F), Y\} =$ 

$+$ 

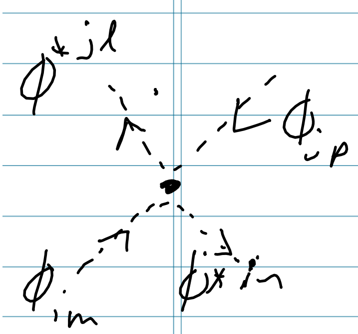
$= C_2(\square)\sqrt{2}g\,T^a + C_2(Ad)\sqrt{2}g\,T^a$

$$(4\pi)^2\beta_y = \frac{1}{2}\left(2g^2 C_2(\Box)\sqrt{2}g + \sqrt{2}g\, 2g^2 F\right)$$
$$+ 2g^2 C_2(\Box)\sqrt{2}g$$
$$-3g^2\left(C_2(\Box)\sqrt{2}g + \sqrt{2}g N\right)$$
$$= \sqrt{2}g^3\begin{pmatrix} C_2(\Box) + F + 2C_2(\Box) \\ -3C_2(\Box) - 3N \end{pmatrix}$$
$$= -\sqrt{2}g^3(3N - F)$$
$$= \sqrt{2}\,(4\pi)^2\beta_g$$

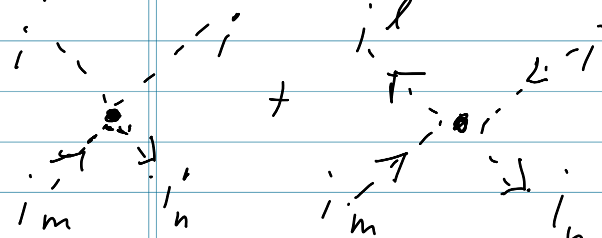
The D-term coupling

quartic $\lambda = g^2$?

$$D^a = g\left(\phi^{*in}(T^a)_n^m\phi_{mi} - \bar\phi^{in}(T^a)_n^m\bar\phi^*_{mi}\right)$$
$$V = \frac{1}{2}D^aD^a = \frac{g^2}{2}\left(\phi^{*i}T^a\phi_i - \bar\phi^iT^a\bar\phi_i^*\right)\left(\phi^{*j}T^a\phi_j - \bar\phi^jT^a\bar\phi_j^*\right)$$

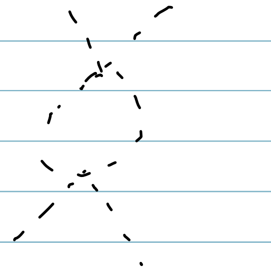


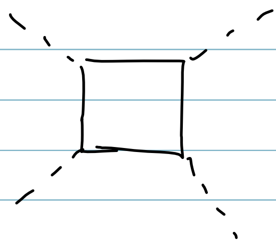
$$= -ig^2\,(T^a)_n^m\,(T^a)_l^p$$

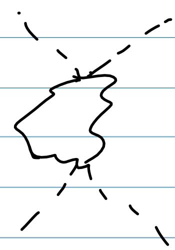


$$= -ig^2\left((T^a)_n^m(T^a)_l^p + (T^a)_l^m(T^a)_n^p\right)$$

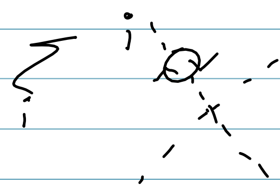
$$(4\pi^2)\beta_\lambda = \Lambda^2 - 4H + 3A + \Lambda^4 - 3\Lambda^5$$

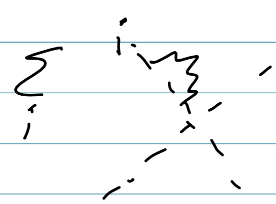
$\Lambda^2 \sim$ 

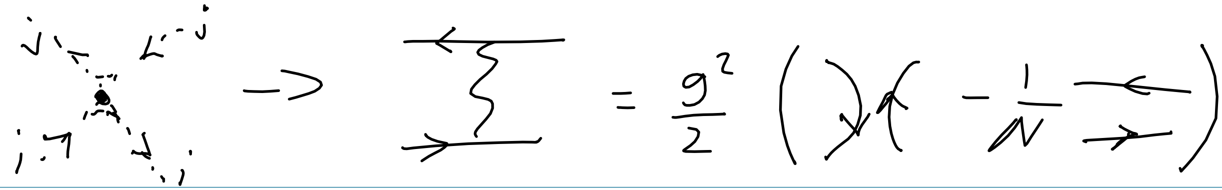
$H \sim$ 

$A \sim$ 

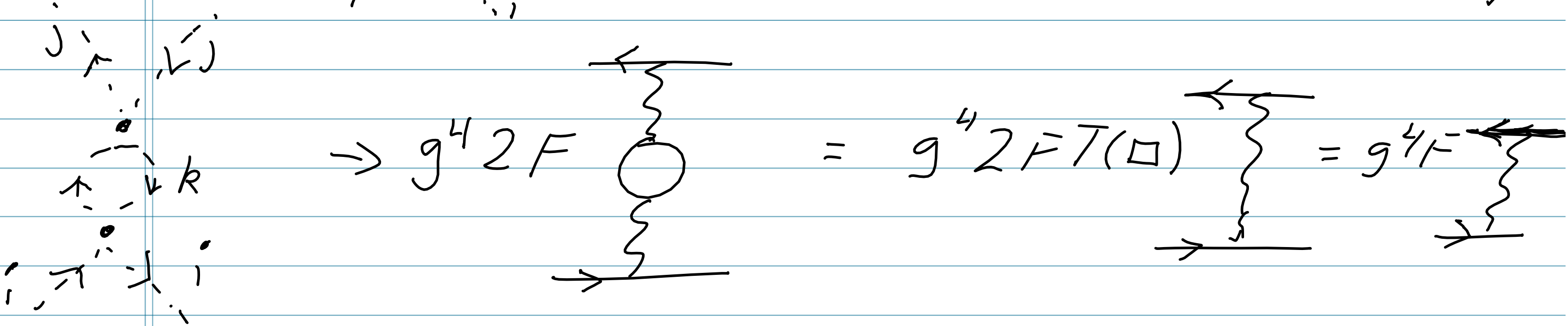
$4T^a/5$

$\Lambda^4 \sim$ 

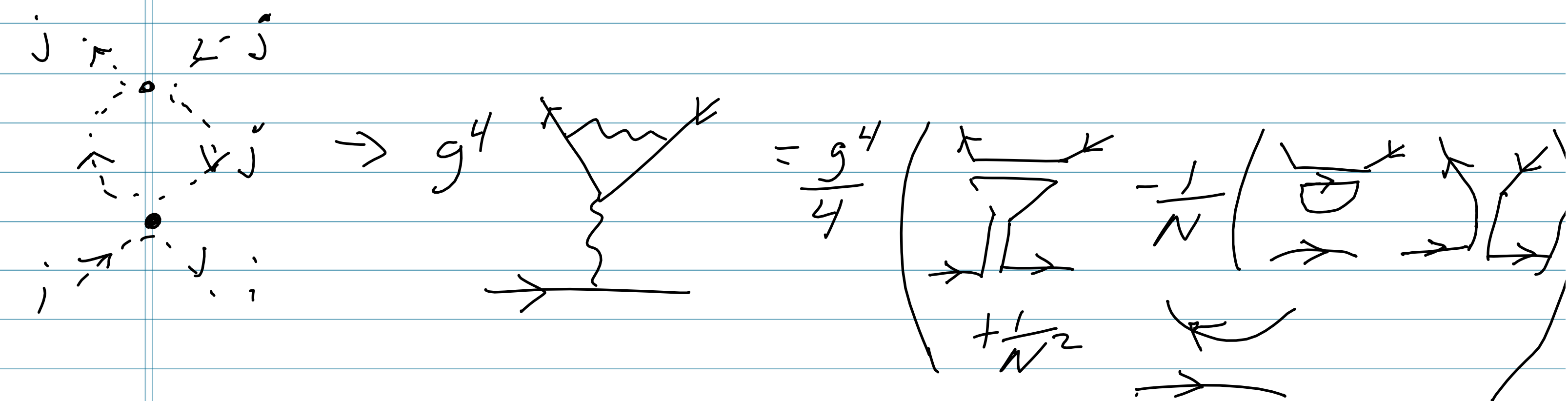
$\Lambda^5 \sim$ 



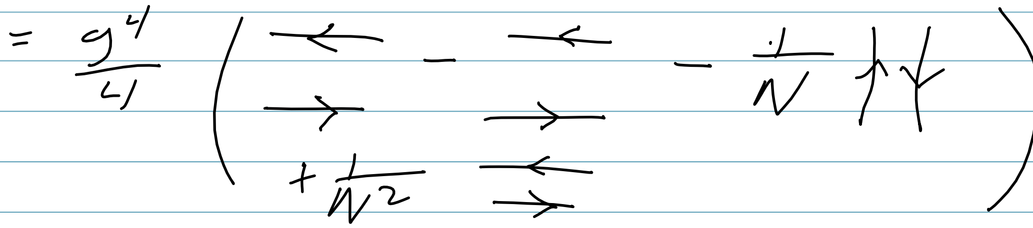
j
j
i
$=\frac{g^2}{2}$
$-\frac{1}{N}$



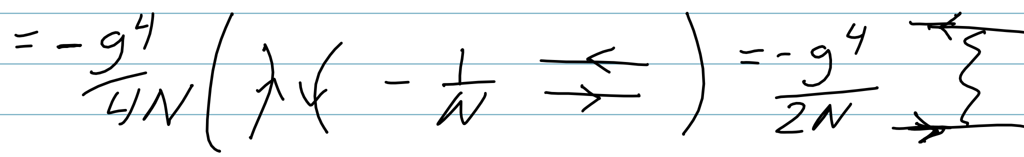
j
j
k
i
$g^4 2F$
$= g^4 2F T(\square)$
$= g^4 F$



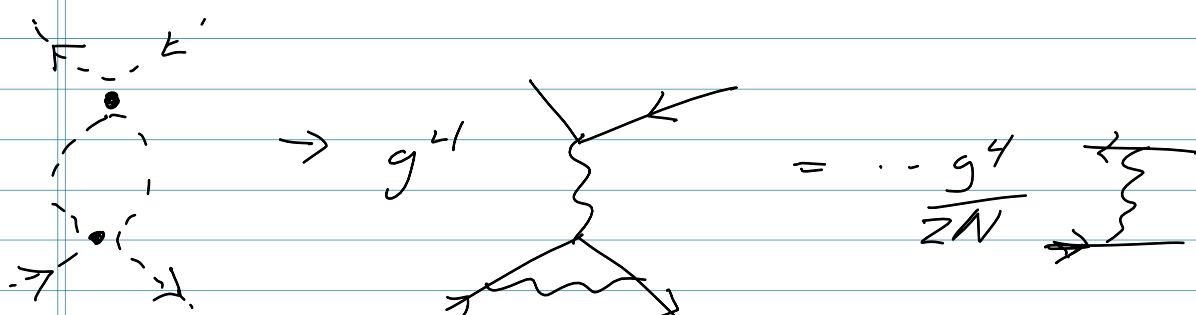
j
j
j
i
g^4
$=\frac{g^4}{4}$
$-\frac{1}{N}$
$+\frac{1}{N^2}$



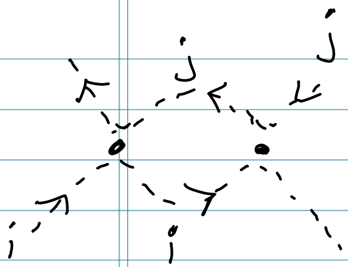
$=\frac{g^4}{4}$
$-\frac{1}{N}$
$+\frac{1}{N^2}$



$=-\frac{g^4}{4N}$
$-\frac{1}{N}$
$=-\frac{g^4}{2N}$



g^4
$= -\frac{g^4}{2N}$

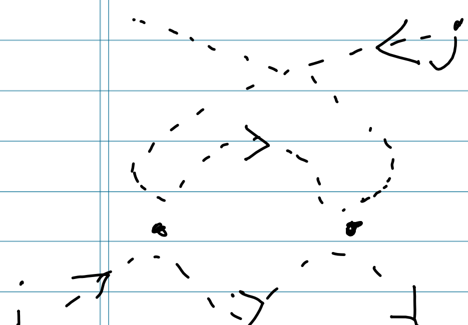


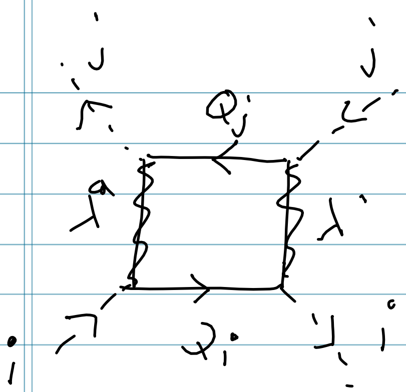
$$\to g^4 \quad = \frac{g^4}{4}\left(\quad - \frac{1}{N}\left(\quad + \quad \right) + \frac{1}{N^2} \quad \right)$$

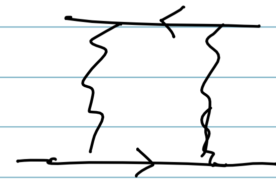
$$= \frac{g^4}{4}\left(N \uparrow\downarrow - \frac{2}{N} \uparrow\downarrow + \frac{1}{N^2} \rightleftarrows \right)$$

$$= \frac{g^4}{4}\left(\frac{N^2-2}{N}\left(2 \quad + \frac{1}{N} \rightleftarrows \right) + \frac{1}{N^2} \rightleftarrows \right)$$

$$= g^4 \left(\frac{N^2-2}{2N} \quad + \frac{1}{4}\left(1 - \frac{1}{N^2}\right) \rightleftarrows \right)$$

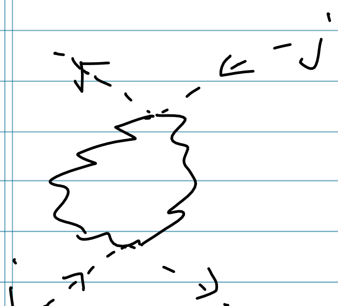


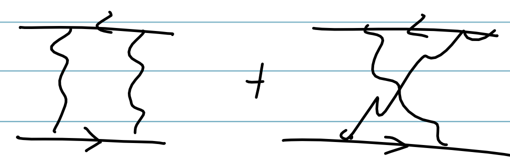


$\to (\sqrt{2}\, g)^4$ 

$$= 4g^4\left(\frac{1}{2}\left(\frac{N^2-2}{N}\right) + \frac{1}{4}\left(1-\frac{1}{N^2}\right)\right)$$

$$= g^4\left(2\left(\frac{N^2-2}{N}\right) + \left(1-\frac{1}{N^2}\right)\right)$$



$\to g^4\, 2\,($  $)$

$$= g^4\, 2\left(\frac{1}{2}\left(\frac{N^2-2}{N}\right) + \frac{1}{4}\left(1-\frac{1}{N^2}\right) + \frac{-1}{N} + \frac{1}{4}\left(1-\frac{1}{N^2}\right)\right)$$

$$= g^4\left(\frac{N^2-4}{N} + \left(1-\frac{1}{N^2}\right)\right)$$

Factor of 2

$$\lambda^2 = \; = \; g^4\left(2F - \frac{2}{N} + \frac{N^2-2}{N} - \frac{2}{N}\right) + \left(1-\frac{1}{N^2}\right)$$

$$-4H = -8g^4\left(\frac{N^2-2}{N}\right) - 4g^4\left(1-\frac{1}{N^2}\right)$$

$$3A = \; = 3g^4\left(\frac{N^2-4}{N}\right) + 3g^4\left(1-\frac{1}{N^2}\right)$$

$$\lambda^4 = \; = 4 \; = 4(\sqrt{2}g)^2 C_2(\square)\, g^2 = 4g^4\left(\frac{N^2-1}{N}\right)$$

$$-3\lambda^5 = -3 \; = -3\cdot 4 g\, C_2(\square)\, g^2 = -6g^4\left(\frac{N^2-1}{N}\right)$$

$$(4\pi)^2\beta_\lambda = g^4\left(2F + N - \frac{6}{N} - 8N + \frac{16}{N} + 3N - \frac{12}{N} + 4N - \frac{4}{N} - 6N + \frac{6}{N}\right)$$

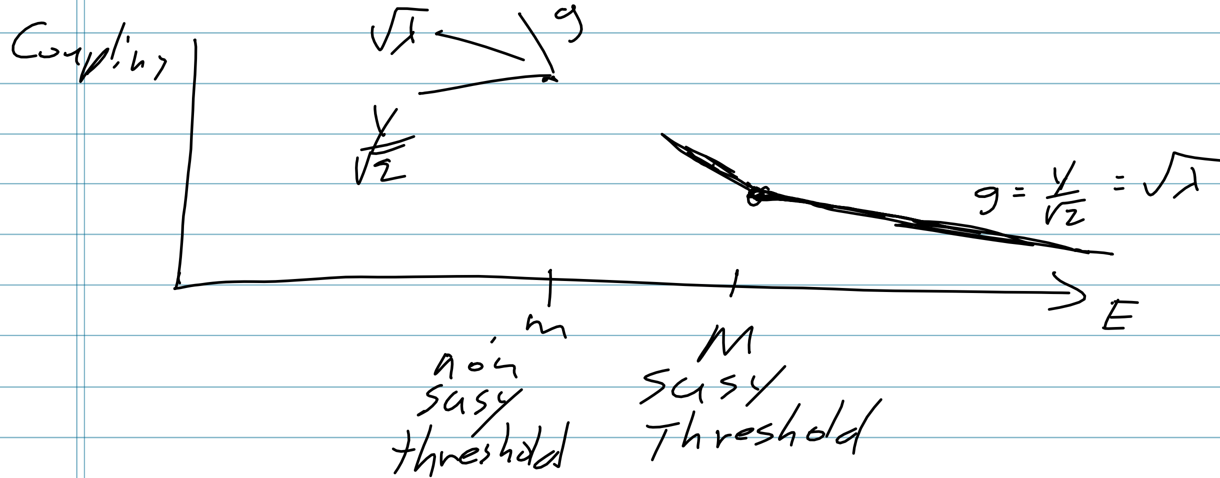
$$+ \; g^4\left(1-\frac{1}{N^2} - 4\left(1-\frac{1}{N^2}\right) + 3\left(1-\frac{1}{N^2}\right)\right)$$

$$= g^4\left(2F - 6N\right)$$

$$\beta_\lambda = \beta_{g^2} = 2g\beta_g$$

SUSY is not anomalous at one-loop

Add SUSY masses and SUSY breaking masses:



scalar mass will have quad div.

$\propto m^2$

this is why we can't dim 4 SUSY breaking terms without re-introducing quad. div.

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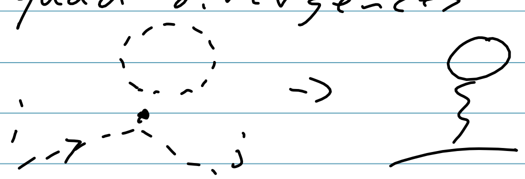
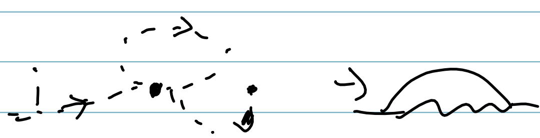
quad divergences from gauge interactions



$= 0$ since $T^{an}_n = 0$



$$= -ig^2 T^{ap}_n T^{am}_p \int \frac{d^4k}{(2\pi)^4} \frac{i}{k^2}$$

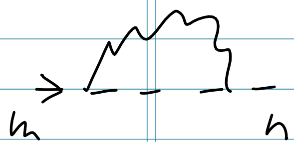
$$= -\frac{ig^2 C_2(\square) d^n_n}{16\pi^2} \int_0^{\Lambda^2} \frac{k^2\, dk^2}{k^2}$$

$$T^a\left(\phi^* \epsilon^{\alpha\beta}\psi_\beta \lambda^a_\alpha + \phi\, \epsilon^{\dot\alpha\dot\beta}\lambda^{\dagger a}_{\dot\alpha}\psi^\dagger_{\dot\beta}\right)$$

$$= (-i\sqrt{2}g)^2\, T^{ap}_n T^{am}_p (-1)\int \frac{d^4k}{(2\pi)^4}\, \mathrm{Tr}\, \frac{i}{\not k}\epsilon \frac{i}{\not k}\epsilon^T$$

$$= -2g^2 \frac{C_2(\square)}{16\pi^2}\delta^m_n \int_0^{\Lambda^2} dk^2\, \mathrm{Tr}\,\frac{\not k}{k^4}\epsilon \not k \epsilon^T$$

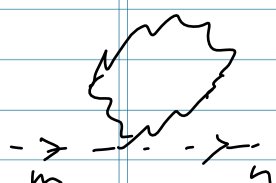
$$= 4ig^2 \frac{C_2(\square)}{16\pi^2}\delta^m_n\int_0^{\Lambda^2}dk^2$$



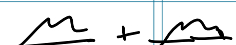
$$= (ig^2)\, C_2(\square)\,\delta^m_n \int\frac{d^4k}{(2\pi)^4}\frac{i}{k^2}\, k^\mu (-i)\frac{\left(g_{\mu\nu}+(\xi-1)\frac{k_\mu k_\nu}{k^2}\right)}{k^2} k^\nu$$

$$= -g^2 C_2(\square)\,\delta^m_n\int\frac{d^4k}{(2\pi)^4}\frac{\left(k^2+(\xi-1)k^2\right)}{k^4}$$

$$= ig^2\xi\,\frac{C_2(\square)}{16\pi^2}\,\delta^m_n\int_0^{\Lambda^2}dk^2$$



$$= ig^2\left(\tfrac{1}{2}\right)(T^aT^b+T^bT^a)\,\delta^{ab} g^{\mu\nu}\int\frac{d^4k}{(2\pi)^4}(-i)\frac{\left(g_{\mu\nu}+(\xi-1)\frac{k_\mu k_\nu}{k^2}\right)}{k^2}$$



$$= g^2 C_2(\square)\,\delta^m_n\int\frac{d^4k}{(2\pi)^4}\left(\frac{4+(\xi-1)}{k^2}\right)$$

$$= -i\frac{g^2}{16\pi^2}\, C_2(\square)\,\delta^m_n\,(3+\xi)\int_0^{\Lambda^2}dk^2$$

$$= \left(-1+4+\xi\, \cancel{\xi} -(3+\xi)\right)\frac{ig^2}{16\pi^2}\, C_2(\square)\,\delta^m_n\int_0^{\Lambda^2}dk^2$$

$$= 0$$