Grose-Vulkenharov kalibracioni model na nivou jedne petlje

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21/09/2013

Grose-Vulkenharov (GV) model

- Nekomutativni prostor:

$$[x^\mu, x^\nu] = i\theta^{\mu\nu}, \qquad \theta^{\mu\nu} = \text{const.}$$

- Dejstvo za Grose-Vulkenharov (Grosse, Wulkenhaar, ’03.) model:

$$S = \int \frac{1}{2}\partial_\mu\phi \star \partial^\mu\phi + \frac{\mu_0^2}{2}\phi \star \phi + \frac{\Omega^2}{4}(\bar{x}\phi) \star (\bar{x}\phi) + \frac{\lambda}{4!}\phi \star \phi \star \phi \star \phi$$

- $\bar{x}_\mu = (\theta_{\mu\nu})^{-1} x^\nu$
- Mojal-Vajlov proizvod:

$$\chi(x) \star \phi(x) = e^{\frac{i}{2}\theta^{\mu\nu}\partial_\mu\partial'_\nu}\chi(x)\phi(x')\Big|_{x'\to x}$$

Klasični kalibracioni model

- Odsečena Hajzenbergova algebra u 3d:

$$[\mu\hat{x}^1, \mu\hat{x}^2] = i\epsilon(1 - \bar{\mu}\hat{x}^3), \qquad [\mu\hat{x}^1, \bar{\mu}\hat{x}^3] = i\epsilon(\mu\hat{x}^2\bar{\mu}\hat{x}^3 + \bar{\mu}\hat{x}^3\mu\hat{x}^2),$$

$$[\mu\hat{x}^2, \bar{\mu}\hat{x}^3] = -i\epsilon(\mu\hat{x}^1\bar{\mu}\hat{x}^3 + \bar{\mu}\hat{x}^3\mu\hat{x}^1)$$

- Jang-Milsovo dejstvo ($\hat{x}^3 = 0$, $\hat{A}_3 = \hat{\phi}$) (Burić, Grosse, Madore, '10.) :

$$\begin{aligned} S_{YM} = & \frac{1}{2} Tr\Big((1-\epsilon^2)(F_{12})^2 - 2(1-\epsilon^2)\mu\hat{F}_{12}\hat{\phi} + (5-\epsilon^2)\mu^2\hat{\phi}^2 \\ & + 4i\epsilon\hat{F}_{12}\hat{\phi}^2 + (D_1\hat{\phi})^2 + (D_2\hat{\phi})^2 \\ & - \epsilon^2\{\hat{p}_1 + \hat{A}_1, \hat{\phi}\}^2 - \epsilon^2\{\hat{p}_2 + \hat{A}_2, \hat{\phi}\}^2\Big) \end{aligned}$$

Kvantizacija

- Prostor konstantne nekomutativnosti: $\theta^{\mu\nu} = \frac{\epsilon}{\mu^2}\epsilon^{\mu\nu}$
- Euklidska signatura: $\tilde{x}_\mu = \epsilon_{\mu\nu} x^\nu$
- Jang-Milsovo dejstvo ($A_\alpha \to iA_\alpha$, $\phi \to i\phi$):

$$
\begin{aligned}
S_{YM} = -\frac{1}{2}\int & + a(F_{12})^2 - 2a\mu F_{12} \star \phi + (4+a)\mu^2 \phi \star \phi \\
& + 4i\epsilon F_{12} \star \phi \star \phi + [p_1 + A_1 \stackrel{\star}{,} \phi]^2 + [p_2 + A_2 \stackrel{\star}{,} \phi]^2 \\
& - \epsilon^2 \{p_1 + A_1 \stackrel{\star}{,} \phi\}^2 - \epsilon^2 \{p_2 + A_2 \stackrel{\star}{,} \phi\}^2,
\end{aligned}
$$

gde su:

$$
a = 1 - \epsilon^2, \qquad \{x^\mu \stackrel{\star}{,} \phi\} = 2x^\mu \phi,
$$

$$
\partial_\alpha \phi = [p_\alpha \stackrel{\star}{,} \phi], \qquad D_\alpha \phi = [p_\alpha + A_\alpha \stackrel{\star}{,} \phi].
$$

- Fiksiranje kalibracije i duhovi:

$$
S_{gf} = \frac{a}{2}\int (\partial_\mu A^\mu)^2, \qquad S_{gh} = -\int \bar{c}\partial_\alpha(\partial^\alpha c + i[A^\alpha \stackrel{\star}{,} c]).
$$

Kvantizacija

- Kvantno dejstvo:

$$S = S_{YM} + S_{gf} + S_{gh} = S_{kin} + S_{int}$$

$$S_{kin} = -\frac{1}{2}\int aA_\alpha \Box A^\alpha + 2a\mu\epsilon^{\alpha\beta}(\partial_a A_\beta)\phi + \phi\Box\phi \\ -(4+a)\mu^2\phi^2 - 4\mu^2 x^\alpha x_\alpha \phi^2 + 2\bar{c}\Box c$$

$$S_{int} = -\frac{1}{2}\int 4\epsilon\epsilon_{\alpha\beta}(\partial^\alpha A^\beta + iA^\alpha \star A^\beta)\star\phi^2 - 2i(\partial_\alpha\phi)[A^\alpha \stackrel{\star}{,} \phi] \\ + 2ia\mu\epsilon_{\alpha\beta}A^\alpha \star A^\beta\phi - 2ia\epsilon_{\alpha\beta}\partial^\alpha A^\beta \epsilon_{\gamma\beta}A^\gamma \star A^\delta \\ + a(\epsilon_{\alpha\beta}A^\alpha \star A^\beta)^2 + [A_\alpha \stackrel{\star}{,} \phi][A^\alpha \stackrel{\star}{,} \phi] - \epsilon^2\{A_\alpha \stackrel{\star}{,} \phi\}\{A^\alpha \stackrel{\star}{,} \phi\} \\ + 2\mu^2\epsilon\epsilon_{\alpha\beta}\{x^\alpha \stackrel{\star}{,} \phi\}\{A^\beta \stackrel{\star}{,} \phi\} - i\bar{c}\partial_\alpha[A^\alpha \stackrel{\star}{,} c]$$

Kvantizacija

- Multiplet polja

$$S_{kin} = -\frac{1}{2}\int (A^\mu \quad \phi)\begin{pmatrix} a\Box\delta_{\mu\nu} & -a\mu\epsilon_{\mu\xi}\partial^\xi \\ a\mu\epsilon_{\nu\eta}\partial^\eta & K^{-1} - a\mu^2 \end{pmatrix}\begin{pmatrix} A^\nu \\ \phi \end{pmatrix} + 2\bar{c}\Box c,$$

$$K^{-1} = \Box - 4\mu^4 x_\alpha x^\alpha - 4\mu^2$$

- Melerov kernel u 2d:

$$K(x,y) = -\frac{1}{8\pi}\int_0^\infty \frac{\omega d\tau}{\sinh\omega\tau} e^{-\frac{\mu^2}{2}((x-y)^2\coth\frac{\omega\tau}{2} + (x+y)^2\tanh\frac{\omega\tau}{2}) - \omega\tau}$$

$$\tilde{K}(p,q) = -\frac{\pi}{4\mu^4}\int_0^\infty \frac{\omega d\tau}{\sinh\omega\tau} e^{-\frac{1}{8\mu^2}((p+q)^2\coth\frac{\omega\tau}{2} + (p-q)^2\tanh\frac{\omega\tau}{2}) - \omega\tau}$$

Propagatori

- Notacija: $p \wedge q = \frac{\epsilon}{\mu^2}\epsilon_{\mu\nu}p^\mu q^\nu, \quad \tilde{p}^\mu = \epsilon^{\mu\nu}p_\nu.$
- Propagatori:

$$\left\langle \phi(r)\phi(s) \right\rangle = K(r,s),$$
$$\left\langle A^\alpha(r)\phi(s) \right\rangle = -i\mu \frac{\tilde{r}^\alpha}{r^2} K(r,s),$$
$$\left\langle A^\alpha(r)A^\beta(s) \right\rangle = (-i\mu)^2 \frac{\tilde{r}^\alpha \tilde{s}^\beta}{r^2 s^2} K(r,s) - \frac{(2\pi)^2}{a}\frac{\delta^{\alpha\beta}\delta(r+s)}{r^2}.$$

- Rekurentne relacije:

$$\left\langle A^\alpha(r)\phi(s) \right\rangle = -i\mu \frac{\tilde{r}^\alpha}{r^2} \left\langle \phi(r)\phi(s) \right\rangle,$$
$$\left\langle A^\alpha(r)A^\beta(s) \right\rangle = -i\mu \frac{\tilde{r}^\alpha}{r^2} \left\langle \phi(r)A^\beta(s) \right\rangle - \frac{(2\pi)^2}{a}\frac{\delta^{\alpha\beta}\delta(r+s)}{r^2}.$$

Propagatori

- Ciklični proizvod Melerovih kernela:

$$K_n(p_1, \dots, p_m | p_{m+1}, \dots, p_{2n}) \\ = \frac{(n-m)!}{n!} \sum_{\pi} K(p_{\pi_1}, p_{\pi_2}) K(p_{\pi_3}, p_{\pi_4}) \cdots K(p_{\pi_{2n-1}}, p_{\pi_{2n}}).$$

- Oznake:

$$P_{FGij} = -\Big\langle F(r) G(s)(i)(j) \Big\rangle ,$$
$$P_{\phi(r)\phi(s)ij} = P_{\phi\phi ij},$$
$$P_{\phi(r)A^{\beta}(s)ij} = P_{\phi A ij},$$
$$P_{A^{\alpha}(r)\phi(s)ij} = P_{A\phi ij},$$
$$P_{A^{\alpha}(r)A^{\beta}(s)ij} = P_{AAij}.$$

Verteksi

$$S_{\text{int}} = (1) + (2) + \ldots + (10)$$

$$(1) = -\frac{2i\epsilon}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \cos\frac{p \wedge q}{2} \tilde{p}^{\mu} A_{\mu}(p) \phi(q) \phi(k)$$

$$(2) = \frac{2i}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \sin\frac{p \wedge q}{2} p^{\mu} \phi(p) \phi(q) A_{\mu}(k)$$

$$(3) = -\frac{4i\epsilon\mu^2}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \cos\frac{p \wedge q}{2} \frac{\partial}{\partial \tilde{p}_{\mu}} \phi(p) \phi(q) A_{\mu}(k)$$

$$(4) = -\frac{a\mu}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \sin\frac{p \wedge q}{2} \epsilon^{\mu\nu} A_{\mu}(p) A_{\nu}(q) \phi(k)$$

$$(5) = \frac{ia}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \sin\frac{p \wedge q}{2} \epsilon^{\mu\nu} \tilde{k}^{\rho} A_{\mu}(p) A_{\nu}(q) A_{\rho}(k)$$

$$(6) = \frac{2i}{(2\pi)^4} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}k\, \delta(p+q+k) \sin\frac{p \wedge q}{2} p^{\mu} \bar{c}(p) c(q) A_{\mu}(k)$$

Verteksi

$$(7) = \frac{2}{(2\pi)^6} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}p' \mathrm{d}q'\, \delta(p+q+p'+q') \sin\frac{p \wedge q}{2} \sin\frac{p' \wedge q'}{2} \delta^{\mu\nu} A_\mu(p)\phi(q)A_\nu(p')\phi(q')$$

$$(8) = \frac{2\epsilon^2}{(2\pi)^6} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}p' \mathrm{d}q'\, \delta(p+q+p'+q') \cos\frac{p \wedge q}{2} \cos\frac{p' \wedge q'}{2} \delta^{\mu\nu} A_\mu(p)\phi(q)A_\nu(p')\phi(q')$$

$$(9) = -\frac{2\epsilon}{(2\pi)^6} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}p' \mathrm{d}q'\, \delta(p+q+p'+q') \sin\frac{p \wedge q}{2} \cos\frac{p' \wedge q'}{2} \times \epsilon^{\mu\nu} A_\mu(p)A_\nu(q)\phi(p')\phi(q')$$

$$(10) = \frac{a}{2(2\pi)^6} \int \mathrm{d}p\, \mathrm{d}q\, \mathrm{d}p' \mathrm{d}q'\, \delta(p+q+p'+q') \sin\frac{p \wedge q}{2} \sin\frac{p' \wedge q'}{2} \times \epsilon^{\mu\nu}\epsilon^{\rho\sigma} A_\mu(p)A_\nu(q)A_\rho(p')A_\sigma(q')$$

Matrica propagatora

$$\hat{P} = \begin{pmatrix} P^{\alpha\beta}_{AA} & P^{\alpha}_{\phi A} \\ P^{\beta}_{\phi A} & P_{\phi\phi} \end{pmatrix}$$

$$P_{\phi\phi} = \sum_{i\leq j\leq 6} (2-\delta_{ij}) P_{\phi\phi ij} + \sum_{7\leq k\leq 10} P_{\phi\phi k}$$

$$P^{\alpha}_{\phi A} = \sum_{i\leq j\leq 6} (2-\delta_{ij}) P^{\alpha}_{\phi A ij} + \sum_{7\leq k\leq 10} P^{\alpha}_{\phi A k} = -i\mu \frac{\tilde{r}^{\alpha}}{r^2} P_{\phi\phi} + P'^{\alpha}_{\phi A}$$

$$P^{\alpha\beta}_{AA} = \sum_{i\leq j\leq 6} (2-\delta_{ij}) P^{\alpha\beta}_{AA ij} + \sum_{7\leq k\leq 10} P^{\alpha\beta}_{AA k}$$

$$= -\mu^2 \frac{\tilde{r}^{\alpha}\tilde{s}^{\beta}}{r^2 s^2} P_{\phi\phi} - i\mu \frac{\tilde{r}^{\alpha}}{r^2} P'^{\beta}_{\phi A} - i\mu \frac{\tilde{s}^{\beta}}{s^2} P'^{\alpha}_{\phi A} + P'^{\alpha\beta}_{AA}$$

Matrični elementi

- Kombinovanje doprinosa:

$$
\begin{aligned}
P_{\phi\phi} = &+ P_{\phi\phi 11} + 2P_{\phi\phi 12} + 2P_{\phi\phi 13} + 2P'_{\phi\phi 15} + P_{\phi\phi 22} + 2P_{\phi\phi 23} \\
&+ 2P'_{\phi\phi 25} + P_{\phi\phi 33} + 2P'_{\phi\phi 35} + P'_{\phi\phi 45} + P'_{\phi\phi 55} + P_{\phi\phi 66} \\
&+ P_{\phi\phi 7} + P_{\phi\phi 8} + P_{\phi\phi 9} + P_{\phi\phi 10}
\end{aligned}
$$

$$P'^{\alpha}_{\phi A} = \quad \text{analogni zbir članova} \quad P'^{\alpha}_{\phi Aij}$$

$$P'^{\alpha\beta}_{AA} = \quad \text{analogni zbir članova} \quad P'^{\alpha\beta}_{AAij}$$

Amputirani propagatori

- Kinetička matrica:

$$\hat{G}^{-1} = -(2\pi)^2 a\delta(p+q)\begin{pmatrix} p^2\delta_{\mu\nu} & i\mu\tilde{p}_\mu \\ i\mu\tilde{q}_\nu & \mu^2 \end{pmatrix} + K^{-1}(p,q)\begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$$

- Matrica amputiranih propagatora:

$$\hat{\Pi}(p,q) = \frac{1}{(2\pi)^4}\int \mathrm{d}r\,\mathrm{d}s\;\hat{G}^{-1}(p,-r)\hat{P}(r,s)\hat{G}^{-1}(-s,q)$$

Propagatori

$$\Pi^{\mu\nu}(p,q) = +\, a^2 p^2 q^2 P'^{\mu\nu}_{AA}(p,q)$$

$$\Pi^{\mu}(p,q) = -\, i a^2 \mu p^2 \tilde{q}_\rho P'^{\mu\rho}_{AA}(p,q) - \frac{a}{(2\pi)^2} p^2 \int \mathrm{d}k\, P'^{\mu}_{\phi A}(p,k) K^{-1}(-k,q)$$

$$\Pi^{\nu}(p,q) = -\, i a^2 \mu q^2 \tilde{p}_\rho P'^{\rho\nu}_{AA}(p,q) - \frac{a}{(2\pi)^2} q^2 \int \mathrm{d}k\, K^{-1}(p,-k) P'^{\nu}_{\phi A}(k,q)$$

$$\begin{aligned}\Pi(p,q) = &-\, a^2 \mu^2 \tilde{p}_\rho \tilde{q}_\sigma P'^{\rho\sigma}_{AA}(p,q) \\ &+ \frac{i a \mu}{(2\pi)^2} \tilde{p}_\rho \int \mathrm{d}k\; P'^{\rho}_{\phi A}(p,k) K^{-1}(-k,q) \;+\; \big(p \longleftrightarrow q\big) \\ &+ \frac{1}{(2\pi)^4} \int \mathrm{d}p' \mathrm{d}q'\, K^{-1}(p,-p') P_{\phi\phi}(p',q') K^{-1}(-q',q)\end{aligned}$$

Amputirani propagator

$$\Pi^{\alpha\beta}(r,s) =$$

$$- 4\delta^{\alpha\beta}\delta(r+s)\int \mathrm{d}p \, \frac{\sin^2 \frac{p\wedge r}{2}}{p^2}$$

$$+ 4a^2(4(r\cdot s)\delta^{\alpha\beta} - 5r^\alpha s^\beta)\delta(r+s)\int \mathrm{d}p \, \frac{\sin^2 \frac{p\wedge r}{2}}{(p-\frac{r}{2})^2(p+\frac{r}{2})^2}$$

$$- 16\delta(r+s)\int \mathrm{d}p \, \sin^2 \frac{p\wedge r}{2} \frac{p^\alpha p^\beta}{(p-\frac{r}{2})^2(p+\frac{r}{2})^2}$$

$$- \frac{16\mu^2}{(2\pi)^2\epsilon}\frac{\epsilon^{\alpha\beta}}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,K(p,q)$$

$$+ \frac{8a\mu^4}{(2\pi)^2\epsilon}\frac{(r+s)^\alpha\tilde{s}^\beta - (r+s)^\beta\tilde{r}^\alpha - \frac{1}{2}(r+s)^2\epsilon^{\alpha\beta}}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{p^2q^2}\,K(p,q)$$

$$+ \frac{8\epsilon}{(2\pi)^2}\frac{(r+s)^\alpha\tilde{s}^\beta - (r+s)^\beta\tilde{r}^\alpha - \frac{1}{2}(r+s)^2\epsilon^{\alpha\beta}}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,K(p,q)$$

$$+ \frac{8a\mu^2}{(2\pi)^2}\tilde{r}^\alpha\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2q^2(p-r)^2}K(p,q)$$

$$- \frac{8a\mu^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{\tilde{p}^\alpha\tilde{q}^\beta}{p^2q^2}K(p,q)$$

$$+ \frac{4a\mu^2}{(2\pi)^2 a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p^\alpha q^\beta}{p^2q^2}\,K(p,q)$$

Amputirani propagator

$$
\begin{aligned}
&-\frac{4}{(2\pi)^2}\delta^{\alpha\beta}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}K(p,q)\\
&-\frac{4\epsilon^2}{(2\pi)^2}\delta^{\alpha\beta}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}K(p,q)\\
&+\frac{16\epsilon\mu^2}{(2\pi)^2}\frac{\epsilon^{\alpha\beta}(r+s)^\mu}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\frac{\partial}{\partial p^\mu}K(p,q)\\
&-\frac{8\epsilon\mu^2}{(2\pi)^4}\frac{(r+s)^\alpha\tilde{s}^\beta-(r+s)^\beta\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}K_2(p,q,k,r+s)\\
&+\frac{8\epsilon^2}{(2\pi)^4}\tilde{r}^\alpha\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}K_2(p,q,p',q')\\
&+\frac{8}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}p^\alpha p'^\beta K_2(p,q,p',q')\\
&+\frac{8a^2\mu^8}{(2\pi)^4\epsilon^2}\tilde{r}^\alpha\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\frac{1}{p^2q^2p'^2q'^2}K_2(p,q,p',q')\\
&-\frac{16a\mu^4}{(2\pi)^4\epsilon}\frac{(r+s)^\alpha\tilde{s}^\beta-(r+s)^\beta\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\frac{1}{(p+q)^2}K_2(p,q,k,r+s)\\
&+\frac{16a\epsilon\mu^4}{(2\pi)^4}\frac{(r+s)^\alpha\tilde{s}^\beta-(r+s)^\beta\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\frac{(p+q)^\mu}{(p+q)^2}\frac{\partial}{\partial p^\mu}K_2(p,q,k,r+s)\\
&+\frac{32\epsilon^2\mu^4}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{\partial^2}{\partial\tilde{p}_\alpha\partial\tilde{p}'_\beta}K_2(p,q,p',q')
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\Big[-\frac{16a\mu^4}{(2\pi)^2\epsilon}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\,\sin\frac{q\wedge s}{2}\,\frac{q^\beta}{p^2q^2(p-r)^2}K(p,q)\\
&+\frac{16\epsilon\mu^2}{(2\pi)^2}\frac{\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial}{\partial p_\beta}K(p,q)\\
&-\frac{8a\mu^2}{(2\pi)^2}\frac{\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\,\frac{\tilde{p}^\beta}{p^2}\,K(p,q)\\
&+\frac{8}{(2\pi)^2}\frac{\tilde{r}^\alpha}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\,\tilde{p}^\beta\,K(p,q)\\
&+\frac{8a\mu^4}{(2\pi)^4}\tilde{r}^\alpha\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,K_2(p,q,p',q')\\
&+\frac{8a\mu^4}{(2\pi)^4\epsilon}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,\frac{p'^\beta}{p^2q^2}\,K_2(p,q,p',q')\\
&+\frac{8\epsilon}{(2\pi)^4}\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,p^\alpha\,K_2(p,q,p',q')\\
&-\frac{16a\mu^6}{(2\pi)^4}\tilde{s}^\beta\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,\frac{1}{p'^2q'^2}\,\frac{\partial}{\partial\tilde{p}_\alpha}K_2(p,q,p',q')\\
&-\frac{16\epsilon^2\mu^2}{(2\pi)^4}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{\partial}{\partial\tilde{p}'_\beta}K_2(p,q,p',q')\\
&-\frac{16\epsilon\mu^2}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,p'^\beta\,\frac{\partial}{\partial\tilde{p}_\alpha}\,K_2(p,q,p',q')\Big]\\
&+\Big[(r,\alpha)\longleftrightarrow(s,\beta)\Big]
\end{aligned}
$$

Amputirani propagator

$$\Pi^{\alpha}(r,s) =$$

$$
\begin{aligned}
&+ \frac{16ia\mu^5}{\epsilon(2\pi)^2}\,\frac{s^{\alpha}}{s^2(r+s)^2}\,\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{p^2}\,K(p,q)\\
&+ \frac{8i\mu}{(2\pi)^2}\,\frac{\tilde{r}^{\alpha}}{s^2(r+s)^2}\,\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\sin\frac{p\wedge q}{2}\,(p\cdot s)\,K(p,q)\\
&+ \frac{4i\mu}{(2\pi)^2}\,\frac{\tilde{s}^{\alpha}}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\sin\frac{p\wedge r}{2}\,\sin\frac{q\wedge s}{2}\,K(p,q)\\
&+ \frac{4i\epsilon^2\mu}{(2\pi)^2}\,\frac{\tilde{s}^{\alpha}}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\cos\frac{p\wedge r}{2}\,\cos\frac{q\wedge s}{2}\,K(p,q)\\
&- \frac{4i\mu}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\sin\frac{p\wedge r}{2}\,\sin\frac{q\wedge s}{2}\,\frac{\tilde{q}^{\alpha}}{q^2}\,K(p,q)
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\frac{4i\epsilon^2\mu}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{\tilde{q}^\alpha}{q^2}\,K(p,q)\\
&-\frac{8i\epsilon\mu}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p^\alpha}{p^2}\,K(p,q)\\
&-\frac{8ia\mu^5}{(2\pi)^2\epsilon}\frac{1}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{p^\alpha}{p^2q^2}\,K(p,q)\\
&-\frac{32i\mu^3}{(2\pi)^2}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{1}{p^2(p-r)^2}\,K(p,q)\\
&+\frac{8i\mu}{(2\pi)^2}(2-a)\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot s}{p^2(p-r)^2}\,K(p,q)\\
&+\frac{8ia\mu}{(2\pi)^2}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2(p-r)^2}\,K(p,q)\\
&-\frac{16ia\mu^3}{(2\pi)\epsilon}\left(\frac{\mu^2}{s^2}+\frac{2}{a}\right)\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{p^\alpha}{p^2(p-r)^2}\,K(p,q)\\
&-\frac{16ia\mu^5}{(2\pi)^2\epsilon}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{p^\alpha}{p^2q^2(p-r)^2}\,K(p,q)\\
&-\frac{32ia\mu^7}{(2\pi)^2\epsilon^2}\frac{\tilde{r}^\alpha}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{1}{p^2q^2(p-r)^2}\,K(p,q)\\
&-\frac{16i\epsilon\mu^3}{(2\pi)^2}\frac{s^\alpha(r+s)^\mu-\tilde{r}^\alpha\tilde{s}^\mu}{s^2(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial}{\partial p^\mu}K(p,q)
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&-\frac{32i\epsilon\mu^3}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p\cdot r}{p^2(p-r)^2}\,\frac{\partial}{\partial q_\alpha}K(p,q)\\
&+\frac{64i\epsilon\mu^3}{(2\pi)}r^\mu\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p^\alpha}{p^2(p-r)^2}\,\frac{\partial}{\partial q^\mu}K(p,q)\\
&-\frac{32i\epsilon\mu^3}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p^\alpha p^\mu}{p^2(p-r)^2}\,\frac{\partial}{\partial q^\mu}K(p,q)\\
&+\frac{16i\mu^3}{(2\pi)^4}\frac{\tilde{r}^\alpha}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,K_2(p,q,p',q')\\
&+\frac{24i\epsilon\mu}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,p^\alpha\,K_2(p,q,p',q')\\
&+\frac{16ia\mu^3}{(2\pi)^4}\frac{1}{s^2}\left(\frac{a}{\epsilon}+\frac{\epsilon}{a}\right)\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,p^\alpha\,K_2(p,q,p',q')\\
&+\frac{32ia\mu^3}{(2\pi)^4}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p'^2}\,K_2(p,q,p',q')\\
&+\frac{16ia\mu^3}{(2\pi)^4}\frac{1+a}{\epsilon}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{p^\alpha}{p'^2}\,K_2(p,q,p',q')\\
&+\frac{24ia\mu^5}{(2\pi)^4}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,K_2(p,q,p',q')
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\frac{16ia\mu^7}{(2\pi)^4\epsilon^2}\frac{\tilde r^\alpha}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,K_2(p,q,p',q')\\
&+\frac{32ia^2\mu^7}{(2\pi)^4\epsilon^2}\tilde r^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2p'^2}\,K_2(p,q,p',q')\\
&-\frac{32i\epsilon^2\mu^3}{(2\pi)^4}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\;\frac{\partial}{\partial\tilde l_\alpha}K_2(p,q,k,l)\Big|_{l=r+s}\\
&-\frac{64ia\mu^5}{(2\pi)^4}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{(p+q)^2}\;\frac{\partial}{\partial\tilde l_\alpha}K_2(p,q,k,l)\Big|_{l=r+s}\\
&-\frac{16i\epsilon\mu^3}{(2\pi)^4}\left[(ar+2s)^\alpha\sin\frac{r\wedge s}{2}-2\epsilon\tilde r^\alpha\cos\frac{r\wedge s}{2}\right]\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\,\frac{p^\mu}{p^2}\;\frac{\partial}{\partial p^\mu}K_2(p,q,k,r+s)\\
&-\frac{48i\epsilon^2\mu^3}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\;\frac{\partial}{\partial\tilde p_\alpha}K_2(p,q,p',q')\\
&-\frac{32i\epsilon^2\mu^5}{(2\pi)^4}\frac{1}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\;\frac{\partial}{\partial\tilde p_\alpha}K_2(p,q,p',q')\\
&-\frac{16i\epsilon^2\mu^3}{(2\pi)^4}\frac{\tilde r^\alpha s^\mu}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\;\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&-\frac{16i\epsilon\mu^3}{(2\pi)^4}(3-2a)\frac{s^\mu}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,p^\alpha\;\frac{\partial}{\partial p'^\mu}K_2(p,q,p',q')\\
&+\frac{32i\epsilon\mu^3}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{p^\alpha p'^\mu}{p'^2}\;\frac{\partial}{\partial p'^\mu}K_2(p,q,p',q')
\end{aligned}
$$

Amputirani propagator

$$+\frac{32i\epsilon^2\mu^3}{(2\pi)^4}\tilde{r}^\alpha\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{p^\mu}{p^2}\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')$$

$$-\frac{32ia\mu^5}{(2\pi)^4}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\frac{1}{p'^2}\frac{\partial}{\partial\tilde{p}_\alpha}K_2(p,q,p',q')$$

$$+\frac{16ia\mu^7}{(2\pi)^4}\frac{\tilde{r}^\alpha s^\mu}{s^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{1}{p^2q^2}\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')$$

$$+\frac{32ia\mu^7}{(2\pi)^4}\tilde{r}^\alpha\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{p'^\mu}{p^2q^2p'^2}\frac{\partial}{\partial p'^\mu}K_2(p,q,p',q')$$

$$-\frac{64i\epsilon^2\mu^5}{(2\pi)^4}\cos\frac{r\wedge s}{2}\int dp\,dq\,dk\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\frac{p^\mu}{p^2}\frac{\partial^2}{\partial p^\mu\partial\tilde{l}_\alpha}K_2(p,q,k,l)\Big|_{l=r+s}$$

$$+\frac{32i\epsilon^2\mu^5}{(2\pi)^4}\frac{s^\mu}{s^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{\partial^2}{\partial\tilde{p}_\alpha\partial p'^\mu}K_2(p,q,p',q')$$

$$-\frac{64i\epsilon^2\mu^5}{(2\pi)^4}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{p'^\mu}{p'^2}\frac{\partial^2}{\partial\tilde{p}_\alpha\partial p'^\mu}K_2(p,q,p',q')$$

$$-\frac{8ia^2\mu^9}{(2\pi)^4\epsilon^2}\tilde{r}^\alpha\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\frac{1}{p^2q^2p'^2q'^2}K_2(p,q,p',q')$$

$$-\frac{32i\epsilon^2\mu^5}{(2\pi)^4}\frac{\tilde{s}_\beta}{s^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\frac{\partial^2}{\partial\tilde{p}_\alpha\partial\tilde{p}'_\beta}K_2(p,q,p',q')$$

Amputirani propagator

$$
\begin{aligned}
&+\frac{16i\epsilon\mu^3}{(2\pi)^2}\,\frac{s^\alpha(r+s)^\mu}{s^2(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial}{\partial p^\mu}K(p,q)\\
&-\frac{8ia\mu^3}{(2\pi)^2}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2q^2(p-r)^2}K(p,q)\\
&+\frac{8ia\mu^3}{(2\pi)^2}\,\frac{\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{\tilde{p}^\alpha\tilde{q}^\beta}{p^2q^2}K(p,q)\\
&-\frac{4ia\mu^3}{(2\pi)^2}\,\frac{\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p^\alpha q^\beta}{p^2q^2}K(p,q)\\
&-\frac{8i\mu}{(2\pi)^4}\,\frac{\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,p^\alpha p'^\beta\,K_2(p,q,p',q')\\
&\qquad+\Bigg[\frac{16ia\mu^7}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,\frac{1}{p'^2q'^2}\,\frac{\partial}{\partial\tilde{p}_\alpha}K_2(p,q,p',q')\\
&\qquad+\frac{8ia\mu^5}{(2\pi)^4}\tilde{r}^\alpha\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,K_2(p,q,p',q')\\
&\qquad-\frac{8ia\mu^5}{(2\pi)^4\epsilon}\,\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,\frac{p'^\beta}{p^2q^2}\,K_2(p,q,p',q')\\
&\qquad+\frac{16ia\mu^5}{(2\pi)^2\epsilon}\,\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{q^\beta}{p^2q^2(p-r)^2}K(p,q)
\end{aligned}
$$

Amputirani propagator

$$+\frac{16i\epsilon^2\mu^3}{(2\pi)^4}\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{\partial}{\partial\tilde{p}'_\beta}K_2(p,q,p',q')$$

$$+\frac{16i\epsilon\mu^3}{(2\pi)^4}\frac{\tilde{s}_\beta}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}p'^\beta\frac{\partial}{\partial\tilde{p}_\alpha}K_2(p,q,p',q')$$

$$-\frac{16i\epsilon\mu^3}{(2\pi)^2}\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial}{\partial p_\beta}K(p,q)$$

$$+\frac{8ia\mu^3}{(2\pi)^2}\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\frac{\tilde{p}^\beta}{p^2}K(p,q)$$

$$-\frac{8i\epsilon\mu}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\sin\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}p^\alpha K_2(p,q,p',q')$$

$$\left.-\frac{8i\mu}{(2\pi)^2}\frac{\tilde{r}^\alpha\tilde{s}_\beta}{s^2(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\tilde{p}^\beta K(p,q)\right]$$

$$+\Big[(r,\alpha)\longleftrightarrow(s,\beta)\Big]$$

Amputirani propagator

$\Pi(r,s) =$

$$+\frac{8}{a}\delta(r+s)\int\frac{\mathrm{d}p}{p^2}$$

$$+4\frac{\mu^2}{r^2}\delta(r+s)\int\mathrm{d}p\,\frac{\sin^2\frac{p\wedge r}{2}}{p^2}$$

$$-8\delta(r+s)\int\mathrm{d}p\,\frac{\cos^2\frac{p\wedge r}{2}}{p^2}$$

$$-8\mu^2\delta(r+s)\int\mathrm{d}p\,\frac{\sin^2\frac{p\wedge r}{2}}{(p-\frac{r}{2})^2(p+\frac{r}{2})^2}$$

$$+16\frac{\mu^2}{r^4}\delta(r+s)\int\mathrm{d}p\,\frac{\sin^2\frac{p\wedge r}{2}}{(p-\frac{r}{2})^2(p+\frac{r}{2})^2}\Big[p^4+\frac{1}{4}p^2r^2-(p\cdot r)^2\Big]$$

$$+\frac{32}{(2\pi)^2}\frac{\mu^2}{(r+s)^2}\Big[1-\frac{4}{a}\frac{\mu^2}{(r+s)^2}\Big]\cos\frac{r\wedge s}{2}\int\mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,K(p,q)$$

$$-\frac{64a\mu^8}{(2\pi)^2\epsilon^2}\frac{1}{r^2s^2(r+s)^2}\,\mathrm{sinx}\,\frac{r\wedge s}{2}\int\mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{p^2}\,K(p,q)$$

$$+\frac{8\mu^4}{(2\pi)^2}\left[\frac{a}{\epsilon^2}\left(\frac{3\mu^4}{r^2s^2}+\frac{4\mu^2}{(r+s)^2}\right)\mathrm{sinx}\,\frac{r\wedge s}{2}+2\left(1+\frac{2\mu^2}{(r+s)^2}\right)\cos\frac{r\wedge s}{2}\right]\int\mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{p^2q^2}\,K(p,q)$$

Amputirani propagator

$$
\begin{aligned}
&-\frac{2}{(2\pi)^2}\left[\epsilon^2\left(\frac{4\mu^2}{(r+s)^2}+\frac{9}{a}-1\right)\cos\frac{r\wedge s}{2}-4\left(\frac{\mu^4}{r^2s^2}-\frac{4\mu^2}{(r+s)^2}+12\left(1+\frac{1}{a}\right)\frac{\mu^4}{(r+s)^4}\right)\mathrm{sinx}\,\frac{r\wedge s}{2}\right]\\
&\qquad\times\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,K(p,q)\\
&+\frac{16\epsilon^2}{(2\pi)^2a}\,\frac{1}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}p^2\,K(p,q)\\
&-\frac{8\epsilon^2\mu^2}{(2\pi)^2}\,\frac{1}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{(p\cdot q)^2}{p^2q^2}\,K(p,q)\\
&+\frac{8}{(2\pi)^2}\,\frac{(r-s)^\mu}{(r+s)^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\,p_\mu\,K(p,q)\\
&+\frac{4\mu^2}{(2\pi)^2}\left[\frac{r^\mu}{r^2}-\frac{s^\mu}{s^2}\right]\left[1-\frac{2a\mu^2}{(r+s)^2}\right]\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\,\frac{p_\mu}{p^2}\,K(p,q)\\
&+\frac{4\epsilon^2\mu^2}{(2\pi)^2}\left[\frac{r^\mu}{r^2}+\frac{s^\mu}{s^2}\right]\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{p_\mu}{p^2}\,K(p,q)\\
&-\frac{64\mu^6}{(2\pi)^2}\,\frac{(r+s)^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{p_\mu}{p^4q^2}\,K(p,q)\\
&+\frac{32\epsilon^2}{(2\pi)^2a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,K(p,q)
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\frac{16\epsilon^2}{(2\pi)^2 a}\left(r^2+s^2+\epsilon^2 r\cdot s\right)\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{1}{(p-r)^2}\,K(p,q)\\
&+\frac{4\epsilon^2\mu^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2q^2}\,K(p,q)\\
&-\frac{32a\mu^8}{(2\pi)^2\epsilon^2}\,\frac{1}{r^2s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{1}{p^2q^2}\,K(p,q)\\
&+\frac{96a\mu^8}{(2\pi)^2\epsilon^2}\left[\frac{1}{r^2}+\frac{1}{s^2}\right]\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{1}{p^2q^2(p-r)^2}\,K(p,q)\\
&+\frac{8\mu^4}{(2\pi)^2}\,\frac{1}{r^2s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{(p\cdot r)(q\cdot s)}{p^2q^2}K(p,q)\\
&+\frac{4\mu^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2q^2}\,K(p,q)\\
&-\frac{8a\mu^4}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{p^2q^2(p-r)^2}K(p,q)\\
&-\frac{8a}{(2\pi)^2}(r\cdot s)\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{1}{(p-r)^2}\,K(p,q)\\
&-\frac{8a}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\,\frac{p\cdot q}{(p-r)^2}\,K(p,q)\\
&+\frac{8\epsilon\mu^2}{(2\pi)^2}\left(1+\frac{1}{a}\right)\frac{(\tilde{r}-\tilde{s})^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\,\frac{\partial}{\partial p^\mu}K(p,q)
\end{aligned}
$$

Amputirani propagator

$$+\frac{32}{(2\pi)^2}\frac{\mu^2}{(r+s)^2}\left[-\frac{\mu^4}{r^2s^2}(r+s)^\mu \,\mathrm{sinx}\,\frac{r\wedge s}{2}+\frac{4\epsilon^2}{a}\frac{\mu^2}{(r+s)^2}(r+s)^\mu\cos\frac{r\wedge s}{2}-\frac{\epsilon^3}{4a}(\tilde r-\tilde s)^\mu\sin\frac{r\wedge s}{2}+\epsilon\mu^2\left(\frac{\tilde r^\mu}{r^2}-\frac{\tilde s^\mu}{s^2}\right)\sin\frac{r\wedge s}{2}\right]$$
$$\times\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial}{\partial p^\mu}K(p,q)$$
$$+\frac{8\epsilon\mu^2}{(2\pi)^2}\left(1-\frac{3}{a}\right)\frac{1}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\tilde p^\mu\,\frac{\partial}{\partial p^\mu}K(p,q)$$
$$-\frac{8\epsilon\mu^2}{(2\pi)^2}\left(7-\frac{9}{a}\right)\frac{1}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\tilde q^\mu\,\frac{\partial}{\partial p^\mu}K(p,q)$$
$$+\frac{32\mu^6}{(2\pi)^2}\frac{(r+s)^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{p^2q^2}\,\frac{\partial}{\partial p^\mu}K(p,q)$$
$$-\frac{64\epsilon^2\mu^4}{(2\pi)^2a}\frac{1}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\,\frac{\partial^2}{\partial p^\mu\partial p_\mu}K(p,q)$$
$$-\frac{16\epsilon^2\mu^2}{(2\pi)^4}\left[\frac{2a}{\epsilon^2}\frac{\mu^2}{(r+s)^2}\,\mathrm{sinx}\,\frac{r\wedge s}{2}+\cos\frac{r\wedge s}{2}\right]\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\,K_2(p,q,k,r+s)$$
$$-\frac{32a\mu^4}{(2\pi)^4}\left[\frac{2a}{\epsilon^2}\frac{\mu^2}{(r+s)^2}\,\mathrm{sinx}\,\frac{r\wedge s}{2}+\cos\frac{r\wedge s}{2}\right]\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{(p+q)^2}\,K_2(p,q,k,r+s)$$
$$-\frac{32\epsilon^2\mu^2}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,K_2(p,q,p',q')$$
$$-\frac{64a\mu^6}{(2\pi)^4}\frac{1}{r^2s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,K_2(p,q,p',q')$$

Amputirani propagator

$$
\begin{aligned}
&- \frac{128a^2\mu^6}{(2\pi)^4\epsilon^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2p'^2}\,K_2(p,q,p',q') \\
&- \frac{8a^2\mu^{10}}{(2\pi)^4\epsilon^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2p'^2q'^2}\,K_2(p,q,p',q') \\
&- \frac{32\epsilon^2\mu^4}{(2\pi)^4}\,\frac{(r+s)^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\,\left.\frac{\partial}{\partial l^\mu}K_2(p,q,k,l)\right|_{l=r+s} \\
&- \frac{64a\mu^6}{(2\pi)^4}\,\frac{(r+s)^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\frac{1}{(p+q)^2}\,\left.\frac{\partial}{\partial l^\mu}K_2(p,q,k,l)\right|_{l=r+s} \\
&- \frac{64\epsilon^2\mu^4}{(2\pi)^4}\left[\frac{a}{\epsilon^2}\,\frac{\mu^2}{(r+s)^2}\,\mathrm{sinx}\,\frac{r\wedge s}{2}+\cos\frac{r\wedge s}{2}\right]\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\,\frac{p^\mu}{p^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,k,r+s) \\
&- \frac{64\epsilon^2\mu^6}{(2\pi)^4}\,\frac{(r+s)^\mu}{(r+s)^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}k\,\delta(p+q+k)\cos\frac{p\wedge q}{2}\,\frac{p^\nu}{p^2}\,\left.\frac{\partial^2}{\partial l^\mu\partial p^\nu}K_2(p,q,k,l)\right|_{l=r+s} \\
&- \frac{128\epsilon^2\mu^6}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\mathrm{d}q'\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{p^\mu p'^\nu}{p^2p'^2}\,\frac{\partial^2}{\partial p^\mu\partial p'^\nu}K_2(p,q,p',q')
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\Big[-\frac{4\mu^2}{(2\pi)^2}\frac{1}{r^2}\sin\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge q}{2}\frac{p\cdot r}{p^2}K(p,q)\\
&-\frac{4\epsilon^2\mu^2}{(2\pi)^2}\frac{1}{r^2}\cos\frac{r\wedge s}{2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge q}{2}\frac{p\cdot r}{p^2}K(p,q)\\
&+\frac{16\mu^4}{(2\pi)^2}\frac{1}{r^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\frac{1}{p^2}K(p,q)\\
&+\frac{64\mu^2}{(2\pi)^2 a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\frac{1}{(p-r)^2}K(p,q)\\
&+\frac{16\epsilon^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\frac{p\cdot r}{(p-r)^2}K(p,q)\\
&-\frac{8a}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\frac{p\cdot s}{(p-r)^2}K(p,q)\\
&+\frac{8(2-a)}{(2\pi)^2}\mu^2\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\frac{p\cdot s}{p^2(p-r)^2}K(p,q)\\
&+\frac{8a\mu^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\sin\frac{q\wedge s}{2}\frac{p\cdot q}{p^2(p-r)^2}K(p,q)\\
&-\frac{32\mu^4}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\frac{1}{p^2(p-r)^2}K(p,q)\\
&-\frac{32a\mu^8}{(2\pi)^2\epsilon^2}\frac{1}{r^2 s^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\frac{1}{p^2(p-r)^2}K(p,q)
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&-\frac{128\mu^4}{(2\pi)^2}\left(1+\frac{1}{a}\right)\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\,\mathrm{sinx}\,\frac{q\wedge s}{2}\,\frac{1}{(p-r)^4}\,K(p,q)\\
&-\frac{32\epsilon\mu^2}{(2\pi)^2}\left(1-\frac{2}{a}\right)\tilde{r}^\mu\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{1}{(p-r)^2}\,\frac{\partial}{\partial p^\mu}K(p,q)\\
&+\frac{32\epsilon\mu^2}{(2\pi)^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{\tilde{p}^\mu}{(p-r)^2}\,\frac{\partial}{\partial p^\mu}K(p,q)\\
&-\frac{64\epsilon^2\mu^2}{(2\pi)^2 a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{(p-r)^\mu}{(p-r)^2}\,\frac{\partial}{\partial p^\mu}K(p,q)\\
&+\frac{128\epsilon^2\mu^4}{(2\pi)^2 a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{(p-r)^\mu}{(p-r)^4}\,\frac{\partial}{\partial p^\mu}K(p,q)\\
&+\frac{64\mu^6}{(2\pi)^2}\frac{r^\mu}{r^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\,\mathrm{sinx}\,\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{1}{p^2(p-r)^2}\,\frac{\partial}{\partial q^\mu}K(p,q)\\
&-\frac{32\epsilon\mu^4}{(2\pi)^2}\frac{\tilde{r}^\mu}{r^2}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\sin\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{p\cdot r}{p^2(p-r)^2}\,\frac{\partial}{\partial q^\mu}K(p,q)\\
&-\frac{64\epsilon^2\mu^4}{(2\pi)^2 a}\int \mathrm{d}p\,\mathrm{d}q\,\delta(-r-s+p+q)\cos\frac{p\wedge r}{2}\cos\frac{q\wedge s}{2}\,\frac{1}{(p-r)^2}\,\frac{\partial^2}{\partial p^\mu\partial p_\mu}K(p,q)\\
&-\frac{64a\mu^4}{(2\pi)^4}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2}\,K_2(p,q,p',q')\\
&-\frac{32\mu^6}{(2\pi)^4}\frac{2+a}{1+a}\frac{1}{s^2}\int \mathrm{d}p\,\mathrm{d}q\,\mathrm{d}p'\,\mathrm{d}q'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2}\,K_2(p,q,p',q')
\end{aligned}
$$

Amputirani propagator

$$
\begin{aligned}
&+\frac{16a\mu^6}{(2\pi)^4}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,K_2(p,q,p',q')\\
&+\frac{32a^2\mu^8}{(2\pi)^4\epsilon^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2p'^2}\,K_2(p,q,p',q')\\
&-\frac{32\mu^6}{(2\pi)^4}(2-3a)\frac{r^\mu}{r^2s^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&-\frac{64\epsilon^2\mu^4}{(2\pi)^4}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{p^\mu}{p^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&+\frac{32a\mu^6}{(2\pi)^4}\frac{r^\mu}{r^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{1}{p'^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&+\frac{16a\mu^6}{(2\pi)^4}\frac{r^\alpha}{r^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\sin\frac{p'\wedge q'}{2}\,\frac{1}{p'^2q'^2}\,\frac{\partial}{\partial p^\alpha}K_2(p,q,p',q')\\
&+\frac{16a\mu^8}{(2\pi)^4}\frac{s^\mu}{s^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\,\mathrm{sinx}\,\frac{p\wedge q}{2}\cos\frac{p'\wedge q'}{2}\,\frac{1}{p^2q^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&-\frac{128a\mu^6}{(2\pi)^2}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{p^\mu}{p^2p'^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\\
&+\frac{32a\mu^8}{(2\pi)^4}\int dp\,dq\,dp'\,dq'\,\delta(-r+p+q)\delta(-s+p'+q')\cos\frac{p\wedge q}{2}\,\mathrm{sinx}\,\frac{p'\wedge q'}{2}\,\frac{p^\mu}{p^2p'^2q'^2}\,\frac{\partial}{\partial p^\mu}K_2(p,q,p',q')\Bigg]
\end{aligned}
$$

$$
+\Big[r\longleftrightarrow s\Big]
$$