XII. PREDAVANJE

SAŽETAK FEYNMANOVOG OPISA ELEKTRODINAMIKE

- QED U 2. REDU RAČUNA SMETNJE
- ELASTIČNO RASPRŠENJE ELEKTRONA NA MIONU
- KRIŽNI PROCES ANIHILACIJE U MIONE

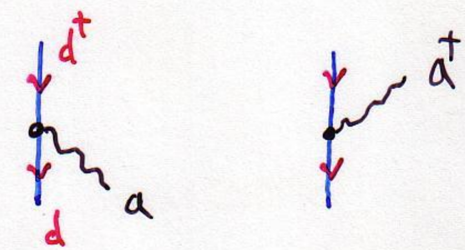
Temelj QED

$$H_I(t) = -\int d^3x\, \mathcal{L}_{int}(\vec{x},t) = \int d^3x\, j^\mu(\vec{x},t)\, A_\mu(\vec{x},t)$$

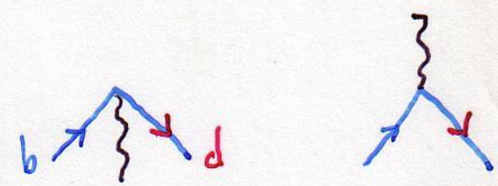
$$= -e \int d^3x \, : \bar{\psi}(\vec{x},t)\, \gamma^\mu \psi(\vec{x},t) : \, A_\mu(\vec{x},t)$$

$$\sim \; : \overset{\text{ač}}{(b^\dagger + d)} \, \overset{\text{ač}}{(b + d^\dagger)} : \, (a + a^\dagger)$$

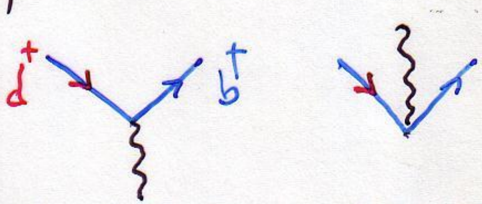
$$= -d^\dagger d\, (a + a^\dagger)$$



$$+ d\, b\, (a + a^\dagger)$$

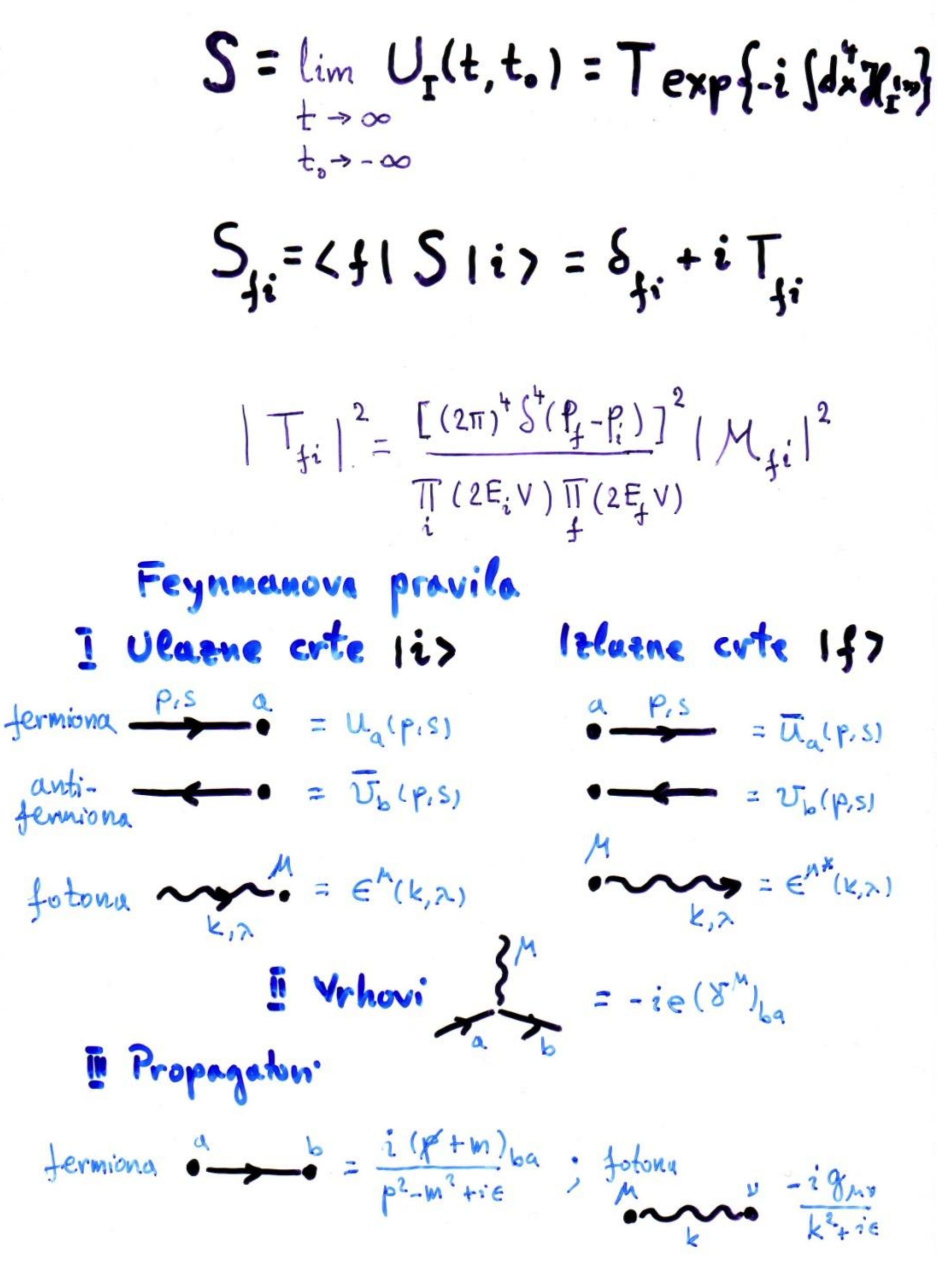


$$+ b^\dagger d^\dagger (a + a^\dagger)$$



$$+ b^\dagger b\, (a + a^\dagger)$$

QED-PROCESI U 2. REDU RAČUNA SMETNJE



INVARIJANTNE AMPLITUDE

&

FEYNMANOVA PRAVILA za postavljanje "*i M*"

QED U 2. REDU RAČUNA SMETNJE

$$S^{(2)} = \frac{(-ie)^2}{2!} \iint d^4x\, d^4y\, T\left(\mathcal{L}_I(x)\, \mathcal{L}_I(y)\right)$$

$$\propto T\left(:\bar{\psi}(x)\gamma^\mu \psi(x)::\bar{\psi}(y)\gamma^\nu \psi(y):\right) T\left(A_\mu(x) A_\nu(y)\right)$$

UZ WICKOV TEOREM ZA KRONOLOŠKE PRODUKTE:

$$T(\phi_1 \phi_2 \cdots \phi_N) = :\phi_1 \cdots \phi_N: + :\overbrace{\phi_1 \phi_2} \cdots \phi_N: + :\overbrace{\phi_1 \cdots \phi_N}:$$

$$+ :\overbrace{\phi_1 \phi_2}\,\overbrace{\phi_3 \phi_4} \cdots \phi_N: + \cdots$$

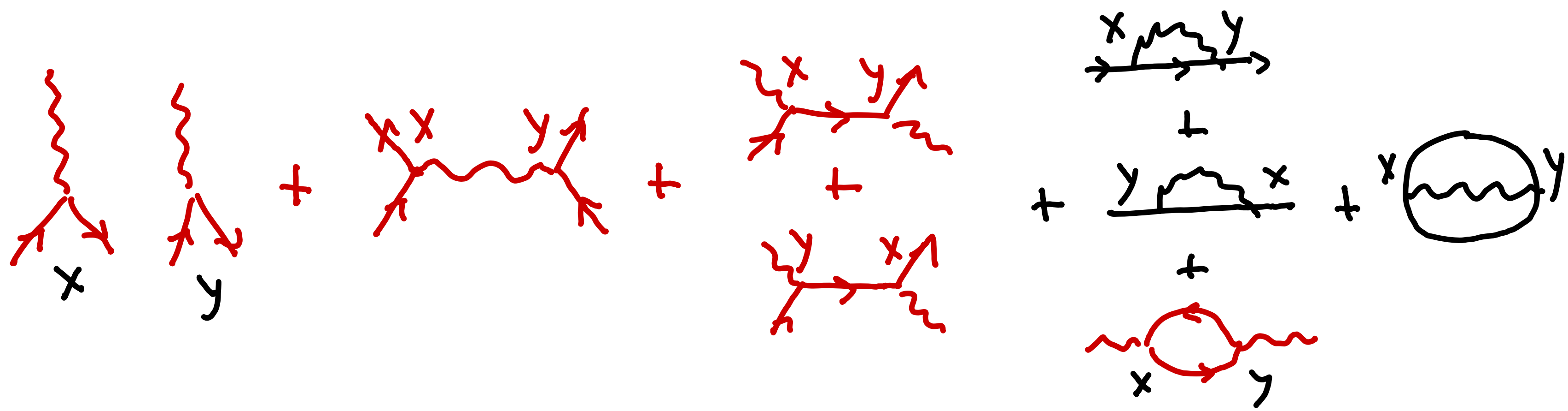
8 članova iz umnoška

$$T\left(A_\mu(x)A_\nu(y)\right) = :A_\mu(x)A_\nu(y): + \overbrace{A_\mu(x)A_\nu(y)}$$

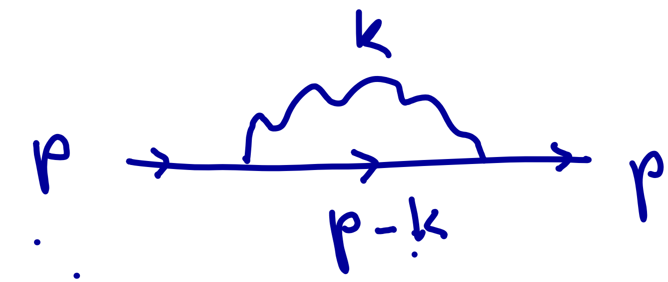
$$T\left(:\bar\psi(x)\gamma^\mu\psi(x)::\bar\psi(y)\gamma^\nu\psi(y):\right) = :\bar\psi(x)\gamma^\mu\psi(x)\bar\psi(y)\gamma^\nu\psi(y):$$

$$+ :\overbrace{\bar\psi(x)\gamma^\mu\psi(x)\bar\psi(y)\gamma^\nu\psi}(y): + :\bar\psi(x)\gamma^\mu\overbrace{\psi(x)\bar\psi}(y)\gamma^\nu\psi(y): +$$

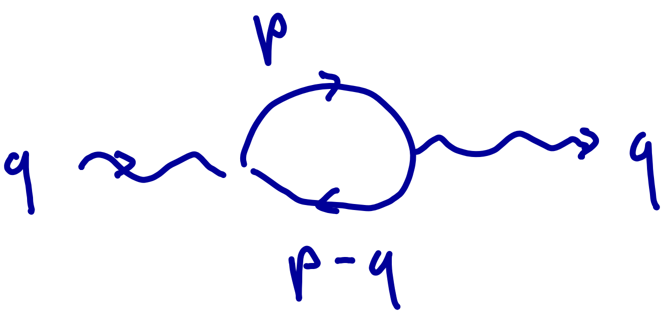
$$+ \overbrace{\bar\psi(x)\gamma^\mu\overbrace{\psi(x)\bar\psi}(y)\gamma^\nu\psi}(y)$$



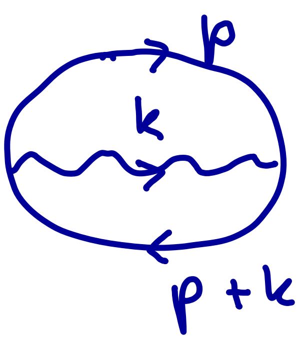
KVANTNE PETLJE



vlastita energija

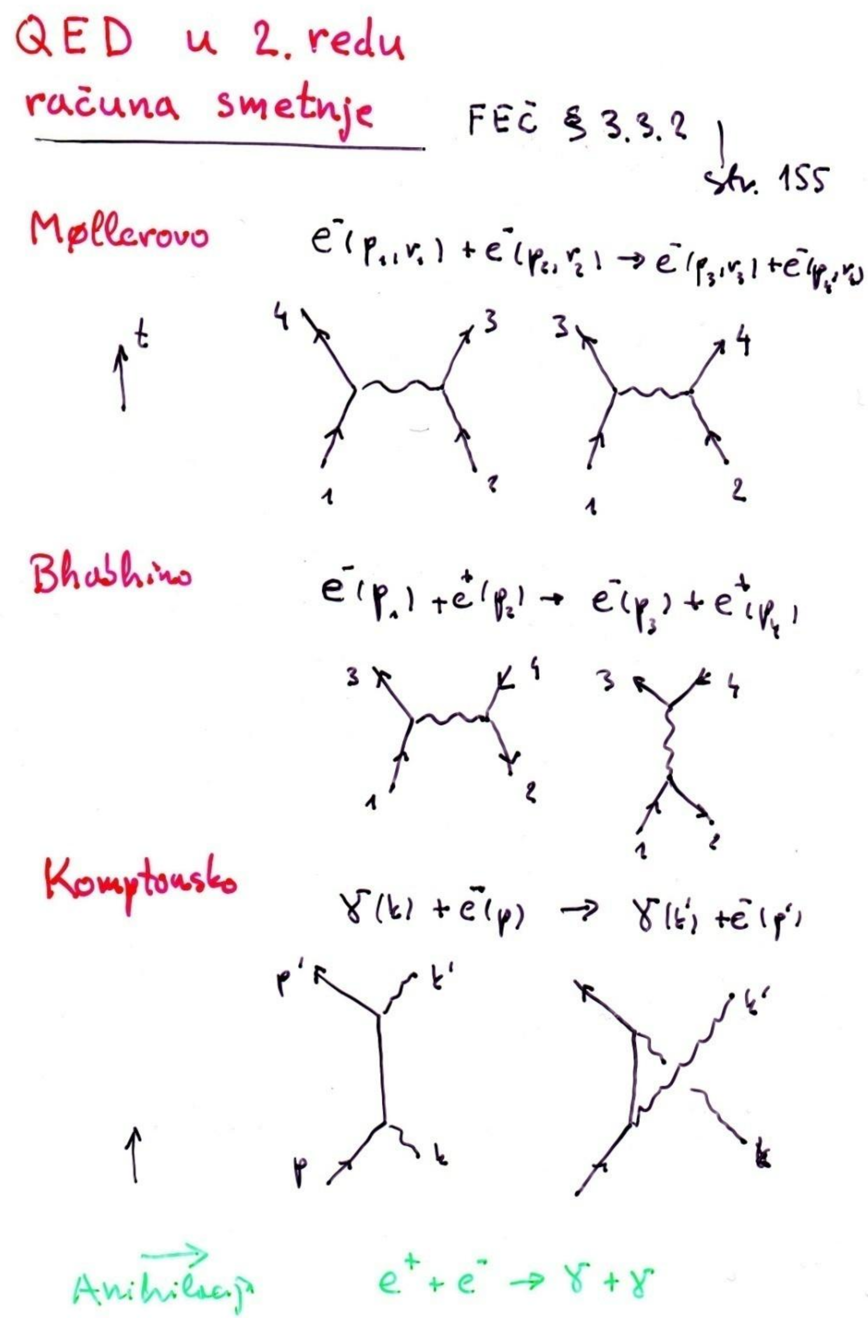


vakuumska polarizacija



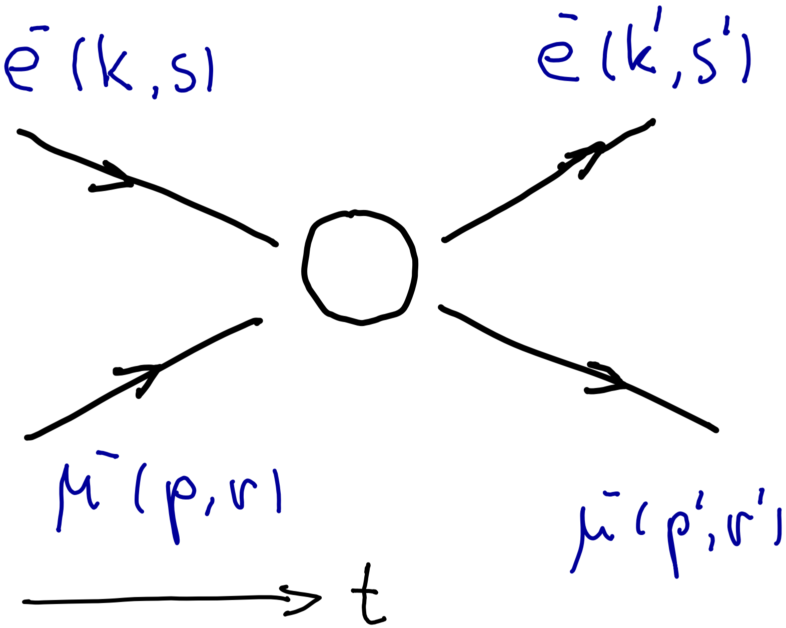
vakuumska petlja

S-matrični element, izborom *f,i*-stanja, vodi na karakteristične elektromagnetske procese



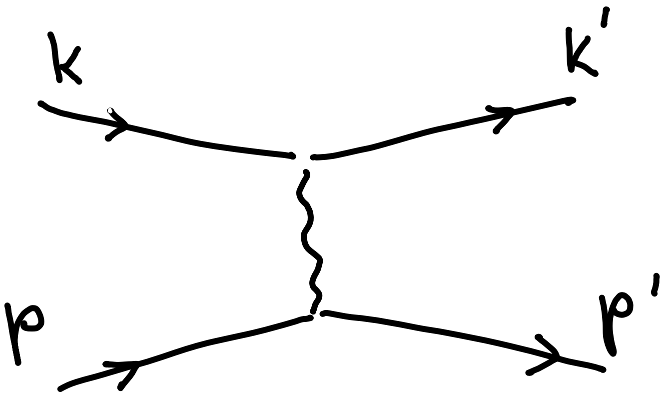
ELASTIČNO RASPRŠENJE ELEKTRONA NA MIONU

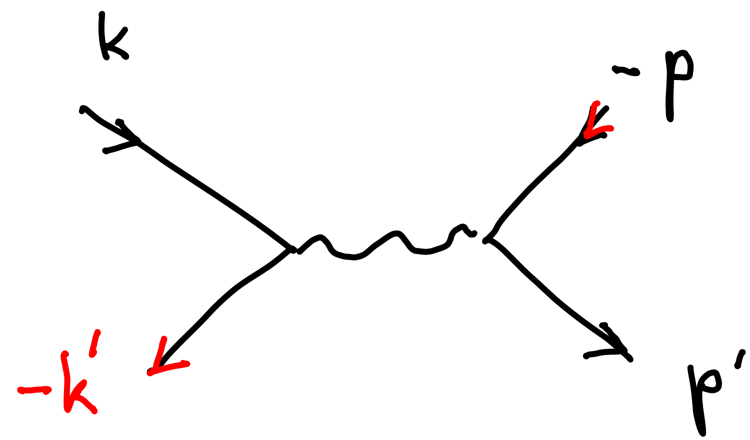
$$\mathcal{L}_I = -e\bar{\Psi}_{(e)} \not{A}\, \Psi_{(e)} - e\bar{\Psi}_{(\mu)} \not{A}\, \Psi_{(\mu)}$$



$$iM = \bar{u}(k',s')(-ie\gamma^\mu)u(k,s)\,\frac{-ig_{\mu\nu}}{q^2}\,\bar{u}(p',r')(-ie\gamma^\nu)u(p,r)$$

PROCES i njemu KRIŽNI





$$\mathcal{M} \sim [\bar{u}(k')\, u(k)][\bar{u}(p')\, u(p)] \quad ; \quad [\bar{v}(k')\, u(k)][\bar{u}(p')\, v(p)]$$

$$(k+p)^2 \equiv s \qquad \longleftrightarrow \qquad (k-k')^2 \equiv t$$

$$(k-k')^2 \equiv t \qquad k' \leftrightarrow -p \qquad (k+p)^2 \equiv s$$

$$\overline{|\mathcal{M}|^2} = 2e^4 \frac{s^2+u^2}{t^2} \quad \longleftrightarrow \quad 2e^4 \frac{t^2+u^2}{s^2}$$

URL granica

$$\left.\frac{d\sigma(e^+e^-\to\mu^+\mu^-)}{d\Omega}\right|_{CM} = \frac{\alpha^2}{4s}(1+\cos^2\vartheta)$$

$$\sigma(e^+e^-\to\mu^+\mu^-) = \frac{4\pi\alpha^2}{3s} \simeq \frac{22\ \mathrm{nb}}{E^2_{snopa}(\mathrm{GeV}^2)}$$