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## KUCHSIZ O‘ZARO TA‘SIRLASHUVNING FEYNMAN DIAGRAMMASI ORQALI TAVSIFLANISHI

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**Kalit so‘zlar:** *Kuchsiz o‘zaro ta’sirlashuv, elementar zarra, bozon, fermion, Feynman diagrammasi, standart model.*

**Annotatsiya.** *Kuchsiz o'zaro ta'sir nuqtali bitta oraliq bozonini fermion tomonidan nurlanishi va yutilishi bilan amalga oshadi. Standart model ushbu o'zaro ta'sir natijasini Feynman diagrammasi deb nomlangan maxsus texnikadan foydalanib hisoblash imkonini beradi.*

**Ключевые слова:** *Фундаментальные частицы, элементарные частицы, бозон, фермион, диаграмма Фейнмана, стандартное модели.*

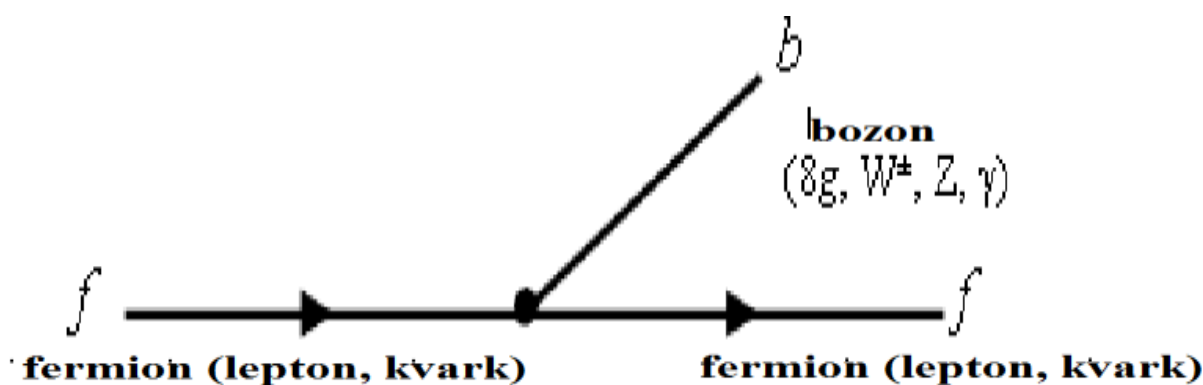
**Аннотация.** *Слабые взаимодействия происходят при облучении и поглощении одиночного промежуточного бозона с фермионом. Стандартная модель позволяет рассчитать результат этого взаимодействия с помощью специальной техники, называемой диаграммой Фейнмана*

**Key words:** *Weak interactions, elementary charged, boson, fermions, diagram Feynman, standards model.*

**Abstract.** *Weak interactions occur during irradiation and absorption of a single intermediate boson with a fermions. The Standart Model allows the outcome of this interaction to be calculated using a special technique called the Feynman diagram.*

Kuchsiz o‘zaro ta‘sirlashuvlarda qatnashadigan zarralar kuchsiz deb ataladigan zaryadga ega - kvarklar va leptonlar hisoblanadi. O‘zaro ta‘sir tashuvchilari  $W^{\pm}$  va  $Z$  massiv oraliq bozonlaridan iborat.

Feynman diagrammalari - bu elementar zarralar o'zgarishining vaqt o'tishi bilan rivojlanishini tasvirlashning elementar o'zaro ta'sirlari nuqtai nazaridan, ushbu jarayonlarning ehtimolini hisoblash algoritmi bilan to'ldirilgan universal grafik usul hisoblanadi.



1-rasm. Kvant nazariyasidagi tegishli o'zaro ta'sirni tavsiflovchi fundamental cho'qqi (Feynman diagrammasining elementar tuguni)

Standart modelda hamma fundamental fermionlar bitta jarayon davomida o'zaro ta'sir tashuvchilardan faqat bittasini chiqarish yoki yutish qobiliyatiga ega. Haqiqatdan ham, qaysidir fundamental fermion oraliq bozonni chiqaradi va yutadi, shunga ko'ra kuchli, kuchsiz va elektromagnit ta'sirlar haqida gap boradi. Ushbu jarayonlarni diagrammalarda tasvirlash uchun ma'lum cho'qqilar kiritiladi, bunda elementar o'zaro ta'sir paydo bo'ladi (1-rasm).

Feynman diagrammalardagi vaqt o'qi chapdan o'ngga yo'naltirilgan deb taxmin qilamiz. Shunday qilib, chap tomonda jarayon boshida mavjud bo'lgan barcha zarralar, o'ng tomonda - cheklangan zarralar to'plami mavjud. Fermionlar uzluksiz chiziq strelka bilan ko'rsatiladi, uning yo'nalishi zarracha yoki antizarrani ko'rsatadi. Fermion chizig'i (oqim) uzluksiz bo'lishi kerak.

Kuchsiz o'zaro ta'sirlashuvlar  $W^\pm$  va  $Z$ -bozonlar orqali amalga oshadi.  $W^\pm$ -bozonlarning elektr zaryadi  $Q=\pm 1e$  elektron zaryadiga, spini  $I=1$  ga va massasi

80.385 ± 0.015 GeVga teng. W<sup>+</sup>-bozonlar quyidagi parchalanish kanallari bo‘yicha parchalanadi:

$$W^+ \rightarrow e^+ \nu_e (10.71 \pm 0.16)\%$$

$$W^+ \rightarrow \mu^+ \nu_\mu (10.63 \pm 0.15)\%$$

$$W^+ \rightarrow \tau^+ \nu_\tau (11.38 \pm 0.21)\%$$

$$W^+ \rightarrow \text{adronlar} (67.41 \pm 0.27)\%$$

W<sup>-</sup>-bozon parchalanishi W<sup>+</sup>-parchalanishi kabi bo‘lib, faqat manfiy zaryadlangan kanallar bo‘ylab sodir bo‘ladi.

1-jadvalda kuchsiz o‘zaro ta‘sirlashuvlarni amalga oshiruvchi oraliq bozonlar keltirilgan.

1 jadval

Kuchsiz o‘zaro ta‘sirlashuv		
W <sup>±</sup> -bozonlar		
Elektr zaryadi	Q	±1e
Spini	I	1
Massasi	m <sub>wc</sub> <sup>2</sup>	80.385 ± 0.015 GeV
To‘liq kengligi	Γ	2.085 ± 0.042 GeV
Z-bozon		
Elektr zaryadi	Q	0
Spini	I	1
Massasi	m <sub>zc</sub> <sup>2</sup>	91.1876 ± 0.0021 GeV
Kengligi	Γ	2.4952 ± 0.0023 GeV

Z-bozon elektr zaryadi Q=0, spini I=1 va massasi m<sub>zc</sub><sup>2</sup>=91.1876 ± 0.0021 GeVga teng. Z<sup>0</sup>-bozonlar quyidagi parchalanish kanallari bo‘yicha parchalanadi:

$$Z \rightarrow e^+ e^- (3.363 \pm 0.004)\%$$

$$Z \rightarrow \mu^+ \mu^- (3.366 \pm 0.007)\%$$

$$Z \rightarrow \tau^+ \tau^- (3.370 \pm 0.008)\%$$

$$Z \rightarrow \text{invisible} (20.00 \pm 0.06)\%$$

$$Z \rightarrow \text{adronlar} (69.91 \pm 0.06)\%$$

Jarayon ehtimoli amplituda moduli kvadrati  $A^2$ -ga proporsional va bir necha omillar bilan aniqlanadi. Avvalo, bu o'zaro ta'sir doimiyligining qiymati, chunki har bir cho'qqi  $\sim \alpha$  –ning ulushini beradi. Ikkinchidan, bu tashuvchi zarrachaning virtuallik darajasi, ya'ni  $E^2 = p^2c^2 + m^2c^4$  munosabatlarning buzilish darajasiga ega bo'ladi. Reaksiya energiyasi ham muhim rol o'ynaydi va qanchalik energetik jihatdan qulay reaksiya bo'lsa, uning ehtimoli shuncha yuqori bo'ladi.

Kuchsiz ta'sirlashuvda neytron parchalanishida saqlanish qonunlari tahlilini 2-jadvaldan ko'rishimiz mumkin:

**2- jadval**

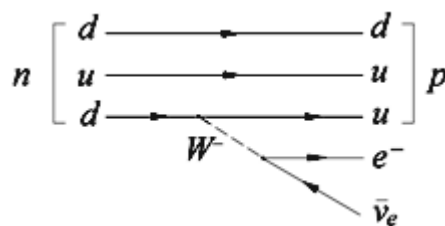
	$n \rightarrow p + e^- + \bar{\nu}_e$	
:	$0 = 1 - 1 + 0$	$\Delta Q = 0$
:	$1 = 1 + 0 + 0$	$\Delta B = 0$
:	$\vec{1}/2 = \vec{1}/2 + 0 + 0$	$\Delta \vec{I} = 0, \vec{I}$
3:	$-1/2 = +1/2 + 0 + 0$	$\Delta I_3 = 1$
e	$0 = 0 + 1 - 1$	$\Delta L_e = 0$

Kuchsiz ta'sirlashuv hisobiga yuz beradigan neytron parchalanishida izospin vektori  $\vec{I}$  va uning proeksiyasi  $I_3$  saqlanmaydi. Parchalanish energiyasini hisoblasak ( $m_p c^2 = 938.27$  MэВ,  $m_e c^2 = 0.511$  MэВ, neytrinoni massasiz deb hisoblasak):

$$Q = m_n c^2 - (m_p + m_e) c^2 = 0.782 \text{ MэВ} > 0.$$

Reaksiya energiyasi noldan katta, parchalanishga ruhsat etiladi. Neytron parchalanish Feynman diagrammasini 2-rasmdan ko'rishimiz mumkin;





2-rasm. Neytron parchalanish Feynman diagrammasi

Fundamental o'zaro ta'sirlarning Feynman diagrammasi orqali tavsiflanishi har bir tasirlashuv o'ziga xos bo'lgan tasirlashuv oraliq zarrasi (bozoni)ga ega bo'ladi. Kuchsiz o'zaro tasirlashuvlar  $W^{\pm}$  hamda Z-bozonlar orqali ta'sirlashuvni amalga oshiraladi. Feynman diagrammasi bilan biz jarayon qanday tasirlashuv orqali borayotgaligini ajratib, jarayonlarni chizmalar orqali tushuntiramiz.

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