3.25 A GeV/c impulsli ^{16}Op-to'qnashuvlarida kislorod yadrosi parchalanish kanallarida A ≤ 7 massa sonli fragmentlar chiqish kesimi

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Калит сўзлар: *ko'p nuklonli, α-klaster, 6-nuklonli tizimlar, 7-nuklonli tizimlar, ko'ndalang kesimi, to'qnashuv.*

Annotatsiya. *3,25 A GeV/c impulsli ^{16}Op-to'qnashuvlarda 6 va 7-nuklonli sistemalar hosil bo'lgan kanallari chiqish kesimini tahlil qilish natijalari keltirilgan. Eksperimental ma'lumotlar kaskad-parchalanish bug'lanish modelining bashoratlari bilan taqqoslandi..*

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Ключевые слова: *много нуклонных, α-кластерные, 6-нуклонные системы, 7-нуклонные системы, сечение, столкновение.*

Аннотация. *Представлены результаты анализа сечения выхода в каналах с образования 6- и 7- нуклонных систем в ^{16}Op-соударениях при импульсе 3.25 А ГэВ/с. Выполнено сопоставление экспериментальных данных с предсказаниями каскадано фрагментационной испарительной модели.*

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Key words:*. Multi nucleon, α-cluster, 6-nucleon systems, 7-nucleon systems, cross section, collision.*

Abstract. *The results of an analysis of the exit cross section in channels from the formation of 6- and 7-nucleon systems in ^{16}Op collisions at a momentum of 3.25 A GeV/c are presented. The experimental data are compared with the predictions of the cascade-fragmentation evaporation model.*

3.25 A GeV/c impulsli ^{16}Op-to'qnashuvlarida ko'p nuklonli fragmentlar tizimida olti yoki etti nuklonni o'z ichiga olgan voqealar xarakteristikalarini tahlil qilish natijalarini taqdim etadi, ya'ni quyidagi poluinklyuziv reaktsiyalar tipini:

$$^{16}O + p \rightarrow {}^{6}Li + x, \quad (1)$$

$$^{16}O + p \rightarrow {}^{4}He + {}^{2}H + x, \quad (2)$$

$$^{16}O + p \rightarrow {}^{3}He + {}^{3}H + x, \quad (3)$$

$$^{16}O + p \rightarrow {}^{3}He + {}^{3}He + x, \quad (4)$$

$$^{16}O + p \rightarrow {}^{3}H + {}^{3}H + x, \quad (5)$$

$$^{16}O + p \rightarrow {}^{2}H + {}^{2}H + {}^{2}H + x, \quad (6)$$

6-nuklonli tizimlar va yadrolar hosil bo'lishi va

$$^{16}O + p \rightarrow {}^{7}Li + x, \quad (7)$$

$$^{16}O + p \rightarrow {}^{7}Be + x, \quad (8)$$

$$^{16}O + p \rightarrow {}^{4}He + {}^{3}He + x, \quad (9)$$

$$^{16}O + p \rightarrow {}^{4}He + {}^{3}H + x, \quad (10)$$

$$^{16}O + p \rightarrow {}^{3}He + {}^{2}H + {}^{2}H + x, \quad (11)$$

$$^{16}O + p \rightarrow {}^{3}H + {}^{2}H + {}^{2}H + x, \quad (12)$$

7-nuklonli tizimlar va yadrolar hosil bo'lishi. X-sifatida $A \leq 3$ massa sonli bir- yoki ikki-zaryadli fragment, tepki proton yoki pion bo'lishi mumkin. Shunday qilib, ya'ni $A \geq 4$ massa sonli hamroh yadrolar tug'iladigan tizimlar hosil bo'lishi mumkin bo'lgan boshqa kanallar muhokama qilinmagan.

6- va 7-nuklonli tizimlar ko'ndalang kesimi KFIM bo'yicha hisoblanganda 29.98 ± 0.67 mbn va 34.27 ± 0.72 mbn ga tengligi ko'rinadi, xuddi shunday ularning eksperimental qiymati munosib 42.18 ± 1.34 mbn va 39.55 ± 1.30 mbn ga teng bo'ladi. Bu kesimlardagi farq KFIMda 6- hamda 7-nuklonli tizimlar va yadrolar hosil bo'lishi eksperimentga nisbatan etarli darajada baholanmasligini ko'rsatadi. Shuningdek, KFIM da 7- nuklonli tizimlar hosil bo'lishi 6- nuklonlilar bilan solishtirilganda aftidan, ehtimolligi yuqoriligi, xuddi shunday eksperimentda teskari, 6- nuklonli tizimlar hosil bo'lishi ehtimolli yuqoriligi ko'rinadi [16-18].

1-jadval.

(1−6) reaktsiyalarning yig'indi zaryadi (Q) va chiqish kesimi (σ_y)

Sistema tipi	Reaksiya tartib nomeri	Yig'indi zaryadi, Q	Reaktsiya kesimi σ_y, mbn	
			Eksp.	KFIM
^{6}Li	1	3	3.67±0.36	7.00±0.33
$^{4}He+^{2}H$	2	3	23.83±1.03	12.22±0.44
$^{3}He+^{3}H$	3	3	5.55±0.48	2.93±0.21
$^{3}He+^{3}He$	4	4	3.67±0.39	4.11±0.25
$^{3}H+^{3}H$	5	2	2.64±0.36	2.53±0.20
$^{2}H+^{2}H+^{2}H$	6	3	2.81±0.37	1.20±0.13

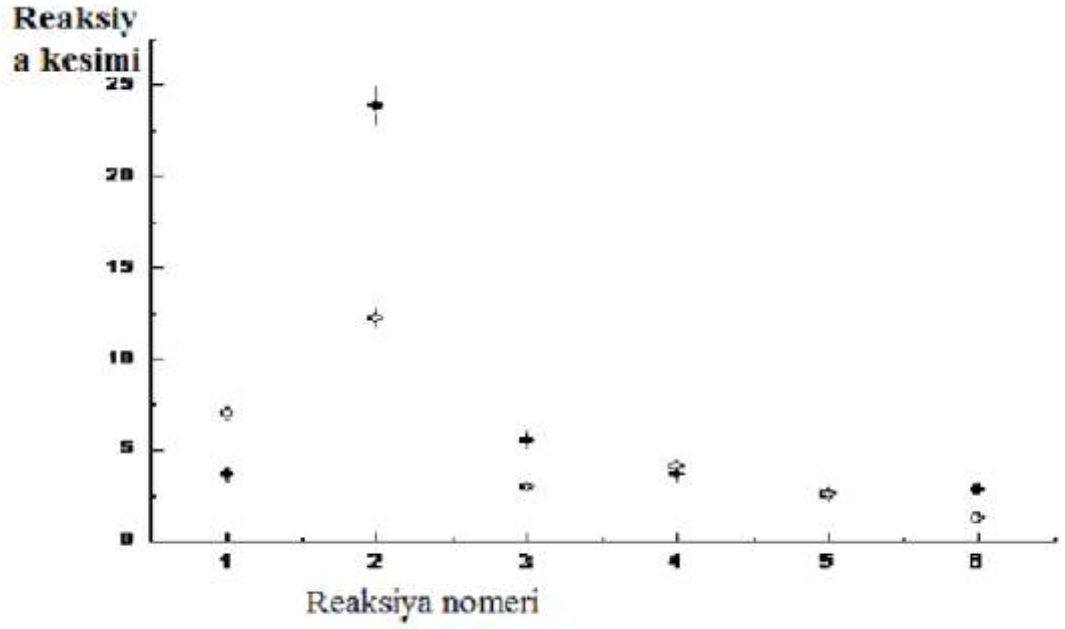
1- va 2- jadvallarda yig'indi zaryad (Q) va ko'ndalang kesimi ($\boldsymbol{\sigma_y}$) mos ravishda (1-6) reaktsiyalar uchun 6 nuklonli tizim va yadro hosil bo'lishi, shuningdek, (7-12) reaktsiyalar uchun esa 7-nuklonli tizim va yadrolar hosil bo'lishi KFIM bashoratlari bilan taqqoslangan holda keltirilgan[19-21].

2-jadval

(7−12) reaktsiyalarning yiqindi zaryadi (Q) va chiqish kesimi (σ_y)

Sistema tipi	Reaksiya tartib nomeri	Yig'indi zaryadi, Q	Reaktsiya kesimi σ_y, mbn	
			Eksp.	KFIM
^{7}Li	7	3	2.72±0.31	6.36±0.31
^{7}Be	8	4	3.43±0.39	10.65±0.41
^{4}He+^{3}He	9	4	13.77±0.26	7.88±0.35
^{4}He +^{3}H	10	3	13.22±0.75	6.26±0.31
^{3}He + ^{2}H+^{2}H	11	4	3.21±0.37	1.69±0.16
^{3}H + ^{2}H+^{2}H	12	3	3.21±0.40	1.43±0.15

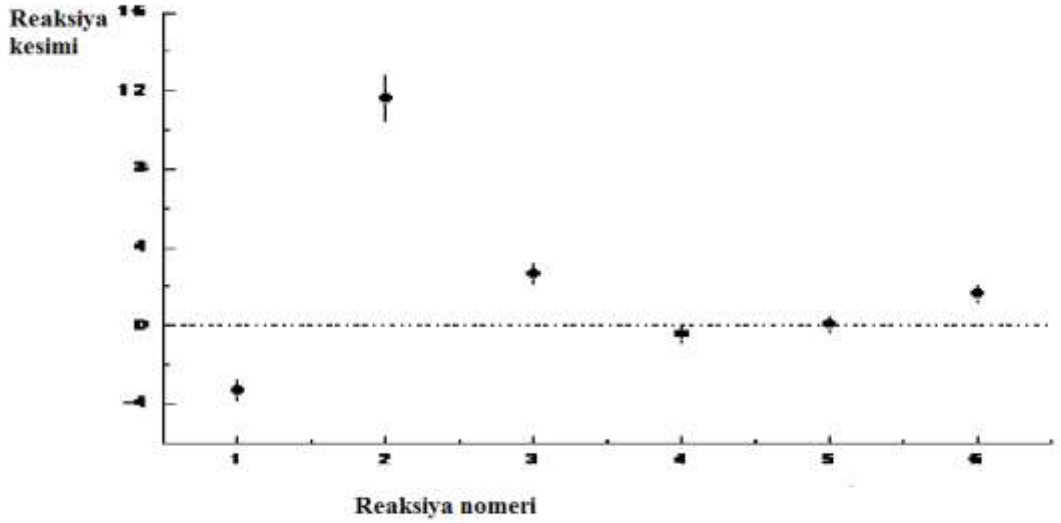
Ko'rilganlarni tasdiqlash maqsadida 1- va 2- rasmlarda reaktsiya turlaridan 6- va 7- nuklonli tizim va yadrolar chiqish kesimining eksperiment va KFIM dagi bog'liqligi keltirilgan. 1a -rasmda 6- nuklonli tizim va yadrolar eksperimentdagi va KFIM bo'yicha hisoblangan kesim qiymatlari munosib farqini to'ldirib ko'rsatilgan.



1 - rasm. (1−6) reaktsiyalarda 6- nuklonli tizimlar chiqish kesimi. Nuqta: ● – eksperiment, ○ –KFIM bo'yicha hisob.

1 va 2-jadvallardan ko'rinadiki, 6- va 7-nuklonli tizimlarda maksimal kesim reaktsiyalarda ^{4}He yadrolarning hosil bo'lishi bilan kuzatiladi. 6-nuklonli tizim uchun eksperimentda α-zarralar hosil bo'lishi kesimi 23.83 ± 1.03 mbn ni tashkil qiladi, 7-nuklonlilar uchun esa 26.99 ± 1.15 mbn. Mos ravishda KFIMda

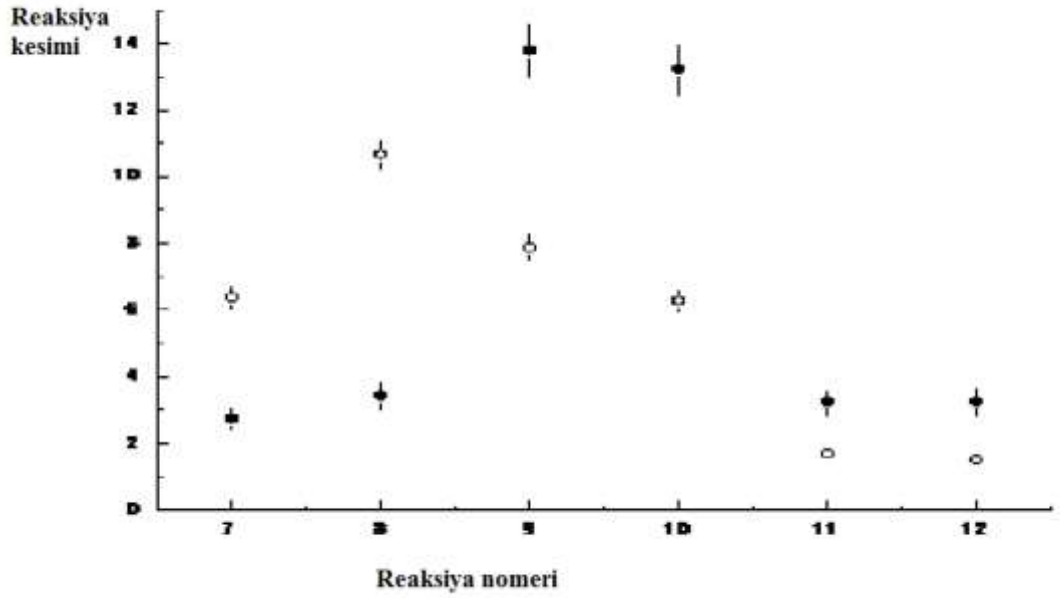
hisoblangan kattaliklar 6-nuklonli tizim uchun 12.22 ± 0.44 mbn va 7-nuklonlilar uchun 14.14 ± 0.49 mbn ni tashkil qiladi, ya'ni eksperimentdagidan KFIMda o'rtacha 1.93 marta kichik. Bu holat, bizning nazarimizda, KFIM-da hisobga olinmaydigan parchalanadigan kislorod yadrosi α-klasterli tuzilishining namoyon bo'lishidan guvohlik beradi. Bu xususiyat eksperiment va KFIM-da 6-nuklonli tizimlar hosil bo'lishi kesimlari qiyosi keltirilgan 1-rasmda yaxshi ko'rinib turibdi. Haqiqatan, eksperiment va KFIM da 6-nuklonli tizim chiqish kesimlaridagi asosiy farq aynan α-zarralar chiqish kanalida kuzatiladi, qolgan reaktsiyalarning chiqish kesimlari yig'indisi esa eksperimentda 18.87 ± 0.85 mbn ni va KFIMda 17.77 ± 0.65 mbnni tashkil qilib, amalda bir-biriga mos keladi[6-9].



1a - rasm. Eksperiment va KFIM bo'yicha hisoblangan kesim qiymatlaridagi farq, poluinklyuziv reaktsiyalar tipidan bog'liqligi.

Belgilaymizki, 6-nuklonli tizimlar hosil bo'lishning eksperiment va hisobdagi kesimlari mos kelishi faqat aynan o'xshash ikkilamchi yadrolar (^{3}He + ^{3}He) va (^{3}H + ^{3}H) uchun o'rinli ekanligini kuzatish mumkin. ^{4}He + ^{2}H tizim va ^{6}Li yadrosi hosil bo'lishi kanallari kesimini taqqoslash qiziqarli bo'ladi. Eksperimentda olingan ^{4}He + ^{2}H tizim va ^{6}Li yadrosi hosil bo'lishi ko'plamchiligi nisbati 6.5 ni tashkil qiladi, bu holda modelda hisoblangani mos ravishda 1.7 ga teng. Agar ^{6}Li yadrosining hosil bo'lishi ^{4}He va ^{2}H yadrolar qo'shilishi hisobiga yuz bersa, u holda koalestsentsii modeli [138] doirasida bunday ustunlikni zaruriy nisbiy impulslar hamda ^{4}He va ^{2}H yadrolarning fazoviy yaqinligi kabi faktorlar bilan tushuntirish mumkin. Xuddi shunday mulohazani ^{7}Li ядроси va ^{4}He + ^{3}H tizimlariga, shuningdek, ^{7}Be yadrosi va ^{4}He + ^{3}He tizimlari chiqish kesimlari o'zaro nisbatiga nisbatan keltirish mumkin. 2 rasmda eksperimentda va KFIM da 7- nuklonli tizimlar va yadrolar chiqish kesimi ko'rsatilgan. 2-rasmdan ko'rinadiki, xuddi shunday 6- nuklonli tizimlar kabi kesimning maksimal qiymatiga ^{4}He

yadrolarning hosil bo'lishi kanallarida erishadi, bu kislorod yadrosi α-klaster tuzilishining ustunligidan guvohlik beradi. Ayni paytda KFIM da maksimal chiqish kesimi ^{7}Be yadrosi hosil bo'lish kanaliga mos keladi. Bundan tashqari modelda ^{4}He+^{3}He va ^{4}He+^{3}H chiqish kesimlaridagi farq kuzatiladi, birinchi tizim chiqish kesimi oxirgisiga nisbatan 1.3 marta katta. Bu, chamasi, shu bilan bog'liqki, modelda engil «ko'zgu» yadrolar shakllanishida proton-nishon zaryadi protonlari ortiqcha bo'lgan yadrolarning kesimini neytronlari ortiqcha yadrolarga nisbatan oshirgan holda ishtirok etadi[1-7].



2 - rasm. (7-12) reaktsiyalarda 7- nuklonli tizimlar chiqish kesimi. Nuqta: ● – eksperiment, ○ –KFIM bo'yicha hisob.

Belgilaymizki, 6-nuklonli tizimlar hosil bo'lishning eksperiment va hisobdagi kesimlari mos kelishi faqat aynan o'xshash ikkilamchi yadrolar (^{3}He + ^{3}He) va (^{3}H + ^{3}H) uchun o'rinli ekanligini kuzatish mumkin. ^{4}He + ^{2}H tizim va ^{6}Li yadrosi hosil bo'lishi kanallari kesimini taqqoslash qiziqarli bo'ladi. Eksperimentda olingan ^{4}He + ^{2}H tizim va ^{6}Li yadrosi hosil bo'lishi ko'plamchiligi nisbati 6.5 ni tashkil qiladi, bu holda modelda hisoblangani mos ravishda 1.7 ga teng. Agar ^{6}Li yadrosining hosil bo'lishi ^{4}He va ^{2}H yadrolar qo'shilishi hisobiga yuz bersa, u holda koalestsentsii modeli [6-9] doirasida bunday ustunlikni zaruriy nisbiy impulslar hamda ^{4}He va ^{2}H yadrolarning fazoviy yaqinligi kabi faktorlar bilan tushuntirish mumkin. Xuddi shunday mulohazani ^{7}Li ядроси va ^{4}He + ^{3}H tizimlariga, shuningdek, ^{7}Be yadrosi va ^{4}He + ^{3}He tizimlari chiqish kesimlari o'zaro nisbatiga nisbatan keltirish mumkin. 2 rasmda eksperimentda va KFIM da 7- nuklonli tizimlar va yadrolar chiqish kesimi ko'rsatilgan. 2-rasmdan ko'rinadiki, xuddi shunday 6- nuklonli tizimlar kabi kesimning maksimal qiymatiga ^{4}He yadrolarning hosil bo'lishi kanallarida erishadi, bu kislorod yadrosi α-klaster

tuzilishining ustunligidan guvohlik beradi. Ayni paytda KFIM da maksimal chiqish kesimi ^{7}Be yadrosi hosil bo'lish kanaliga mos keladi. Bundan tashqari modelda ^{4}He+^{3}He va ^{4}He+^{3}H chiqish kesimlaridagi farq kuzatiladi, birinchi tizim chiqish kesimi oxirgisiga nisbatan 1.3 marta katta. Bu, chamasi, shu bilan bog'liqki, modelda engil «ko'zgu» yadrolar shakllanishida proton-nishon zaryadi protonlari ortiqcha bo'lgan yadrolarning kesimini neytronlari ortiqcha yadrolarga nisbatan oshirgan holda ishtirok etadi.

Eksperimentda 7-nuklonli holatlarda α-zarralar hosil bo'lmaydigan reaktsiyalarida kanallar kesimi statistik xatoliklar chegarasida mos kelishini belgilash qiziqarli, xuddi shunday KFIM bo'yicha hisoblangan faqat bir xil zaryadli holatlar ^{7}Li va ^{4}He + ^{3}H hosil bo'lish kesimi mos kelishi, hamda har xil zaryadli ^{2}H + ^{2}H + ^{3}He va ^{2}H + ^{2}H + ^{3}H uch zarrali tizimlar chiqish kesimi mosligi kelib chiqadi. Oxirgi natijaga ko'ra aftidan, ko'rib chiqilayotgan modelda yadroning α-klaster tuzilishi hisobga olinmaydi. Oxirgi holatda, ko'rinishidan, A = 3 massa sonli engil "ko'zgu" yadrolarning aynan o'xshash shakllanish mexanizmlari bilan bog'liq yig'indi zaryadlari farqlanuvchi ^{6}Li va ^{3}He + ^{3}He 6-nuklonli tizimlar shuningdek, ^{4}He + ^{3}He va ^{4}He + ^{3}H 7-nuklonli tizimlar eksperimental chiqish kesimlari mos kelishiga e'tibor qaratamiz[1-8]. Engil parchalanuvchi yadrolar α-klasterli tuzilishini hisobga olish zaruriyati KFIMda ^{6}Li, ^{7}Li va ^{7}Be yadrolarning chiqish kesimlari eksperimentga qaraganda sezilarli yuqori bo'lishidan kelib chiqadi[9-13].

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