

3.25 A GeV/c impulsli ^{16}O -to'qnashuvlarida kislorod yadrosi parchalanish kanallarida $A \leq 7$ 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}O -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..

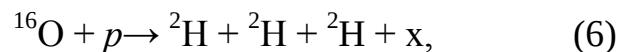
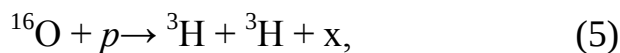
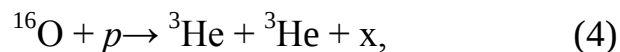
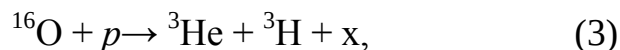
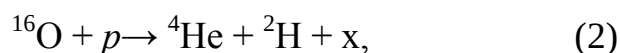
Ключевые слова: много нуклонных, α -кластерные, 6-нуклонные системы, 7-нуклонные системы, сечение, столкновение.

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

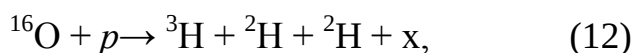
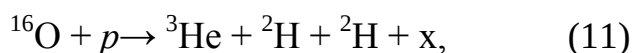
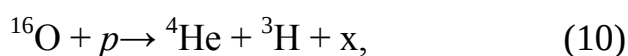
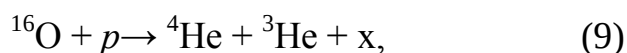
Key words: Multi nucleon, α -cluster, 6-nucleon systems, 7-nucleon systems, cross section, collision.

Abstract. The results of an analysis of the exit cross section in channels from the formation of 6- and 7-nucleon systems in ^{16}O 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}O -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 reaksiyalar tipini:



6-nuklonli tizimlar va yadrolar hosil bo'lishi va



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) reaksiyalarning yig'indi zaryadi (Q) va chiqish kesimi (σ_y)

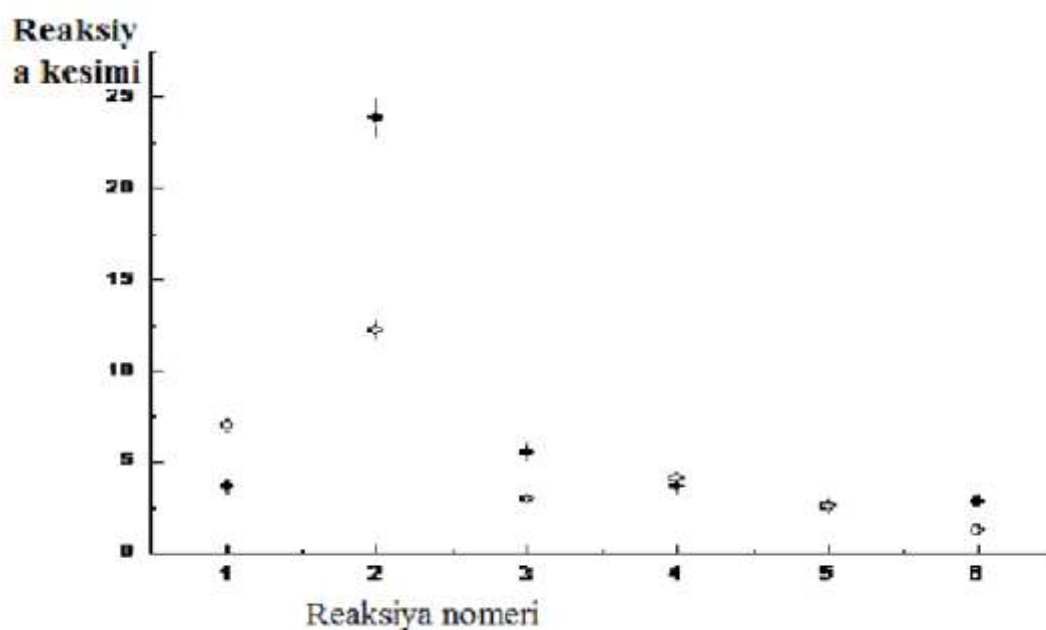
Sistema tipi	Reaksiya tartib nomeri	Yig'indi zaryadi, Q	Reaksiya kesimi σ_y , mbn	
			Eksp.	KFIM
^6Li	1	3	3.67 ± 0.36	7.00 ± 0.33
$^4\text{He} + ^2\text{H}$	2	3	23.83 ± 1.03	12.22 ± 0.44
$^3\text{He} + ^3\text{H}$	3	3	5.55 ± 0.48	2.93 ± 0.21
$^3\text{He} + ^3\text{He}$	4	4	3.67 ± 0.39	4.11 ± 0.25
$^3\text{H}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

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

(7–12) reaksiyalarning yig'indi zaryadi (Q) va chiqish kesimi (σ_y)

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

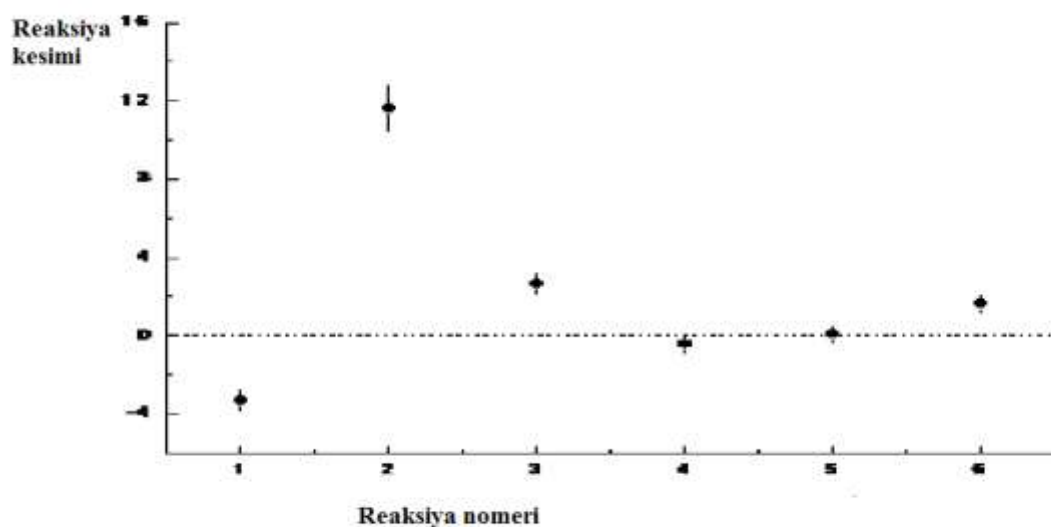
Ko'rilganlarni tasdiqlash maqsadida 1- va 2- rasmlarda reaksiya turlaridan 6- va 7- nuklonli tizim va yadrolar chiqish kesimining eksperiment va KFIM dagi bog'liqligi keltirilgan. 1a -rasmda 6- nuklonli tizim va yadrolar eksperimentdagi va KFIM bo'yicha hisoblangan kesim qiymatlari munosib farqini to'ldirib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



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

1 va 2-jadvallardan ko'rinadiki, 6- va 7-nuklonli tizimlarda maksimal kesim reaksiyalarda ${}^4\text{He}$ 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

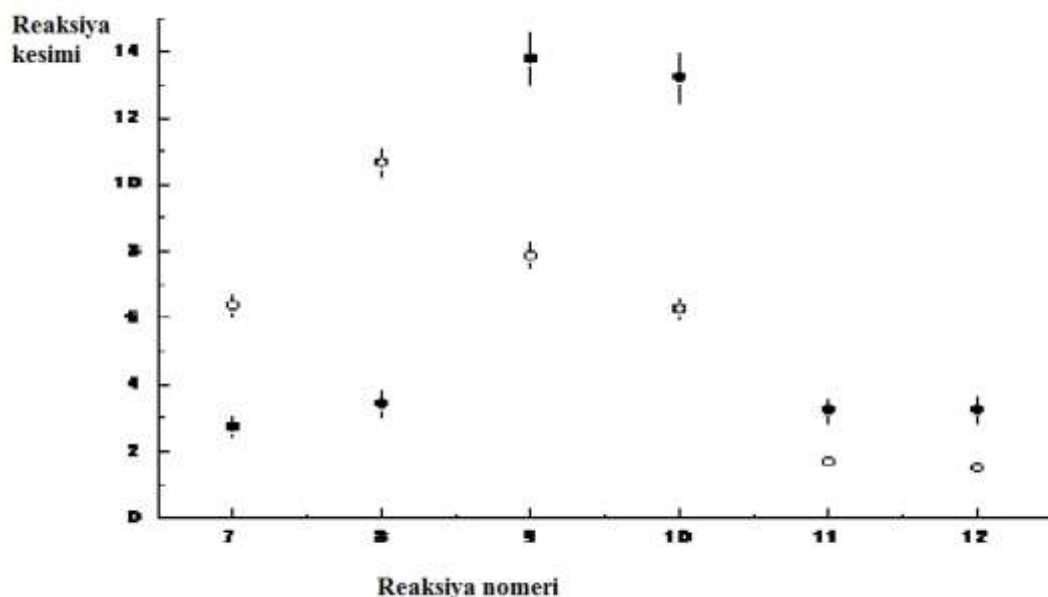
hisoblangan kattaliklar 6-nuklonli tizim uchun 12.22 ± 0.44 mbn va 7-nuklonlilar uchun 14.14 ± 0.49 mbn ni tashkil qiladi, ya'ni eksperimentdagidan KFIMda o'rtacha 1.93 marta kichik. Bu holat, bizning nazarimizda, KFIM-da hisobga olinmaydigan parchalanadigan kislorod yadrosi α -klasterli tuzilishining 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 reaksiyalarning 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 reaksiyalar tipidan bog'liqligi.

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

yadrolarning hosil bo'lishi kanallarida erishadi, bu kislorod yadrosi α -klaster tuzilishining ustunligidan guvohlik beradi. Ayni paytda KFIM da maksimal chiqish kesimi ${}^7\text{Be}$ yadrosi hosil bo'lish kanaliga mos keladi. Bundan tashqari modelda ${}^4\text{He}+{}^3\text{He}$ va ${}^4\text{He}+{}^3\text{H}$ 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) reaksiyalarda 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 (${}^3\text{He} + {}^3\text{He}$) va (${}^3\text{H} + {}^3\text{H}$) uchun o'rinli ekanligini kuzatish mumkin. ${}^4\text{He} + {}^2\text{H}$ tizim va ${}^6\text{Li}$ yadrosi hosil bo'lishi kanallari kesimini taqqoslash qiziqarli bo'ladi. Eksperimentda olingan ${}^4\text{He} + {}^2\text{H}$ tizim va ${}^6\text{Li}$ yadrosi hosil bo'lishi ko'plamchiligi nisbati 6.5 ni tashkil qiladi, bu holda modelda hisoblangani mos ravishda 1.7 ga teng. Agar ${}^6\text{Li}$ yadrosining hosil bo'lishi ${}^4\text{He}$ va ${}^2\text{H}$ yadrolar qo'shilishi hisobiga yuz bersa, u holda koalestsentsii modeli [6-9] doirasida bunday ustunlikni zaruriy nisbiy impulslar hamda ${}^4\text{He}$ va ${}^2\text{H}$ yadrolarning fazoviy yaqinligi kabi faktorlar bilan tushuntirish mumkin. Xuddi shunday mulohazani ${}^7\text{Li}$ yadrosi va ${}^4\text{He} + {}^3\text{H}$ tizimlariga, shuningdek, ${}^7\text{Be}$ yadrosi va ${}^4\text{He} + {}^3\text{He}$ 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 ${}^4\text{He}$ yadrolarning hosil bo'lishi kanallarida erishadi, bu kislorod yadrosi α -klaster

tuzilishining ustunligidan guvohlik beradi. Ayni paytda KFIM da maksimal chiqish kesimi ${}^7\text{Be}$ yadrosi hosil bo'lish kanaliga mos keladi. Bundan tashqari modelda ${}^4\text{He}+{}^3\text{He}$ va ${}^4\text{He}+{}^3\text{H}$ 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 reaksiyalarida kanallar kesimi statistik xatoliklar chegarasida mos kelishini belgilash qiziqarli, xuddi shunday KFIM bo'yicha hisoblangan faqat bir xil zaryadli holatlar ${}^7\text{Li}$ va ${}^4\text{He} + {}^3\text{H}$ hosil bo'lish kesimi mos kelishi, hamda har xil zaryadli ${}^2\text{H} + {}^2\text{H} + {}^3\text{He}$ va ${}^2\text{H} + {}^2\text{H} + {}^3\text{H}$ 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 ${}^6\text{Li}$ va ${}^3\text{He} + {}^3\text{He}$ 6-nuklonli tizimlar shuningdek, ${}^4\text{He} + {}^3\text{He}$ va ${}^4\text{He} + {}^3\text{H}$ 7-nuklonli tizimlar eksperimental chiqish kesimlari mos kelishiga e'tibor qaratamiz[1-8]. Engil parchalanuvchi yadrolar α -klasterli tuzilishini hisobga olish zaruriyati KFIMda ${}^6\text{Li}$, ${}^7\text{Li}$ va ${}^7\text{Be}$ yadrolarning chiqish kesimlari eksperimentga qaraganda sezilarli yuqori bo'lishidan kelib chiqadi[9-13].

Adabiyotlar

1. Olimov K. et al. Formation of multinucleon systems and nuclei with mass numbers of 6 and 7 in ${}^{16}\text{O}$ p-interactions at a momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2009. – T. 72. – №. 4. – C. 596-600.
2. Olimov K. K., Sattarov A. R., Kurbanov A. Correlation effects in production of stable isotopes containing 2-7 nucleons in $\{sup 16\}$ Op-interactions at the momentum 3.25 GeV/s per nucleon; – 2008.
3. Olimov K. et al. Production of mirror nuclei ${}^7\text{Li}$ and ${}^7\text{Be}$ in ${}^{16}\text{O}$ p- interactions at a momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2011. – T. 74. – №. 2. – C. 268-271.
4. Olimov K. et al. Formation of six-nucleon systems and nuclei in ${}^{16}\text{O}$ p- collisions at a momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2014. – T. 77. – №. 3. – C. 325-329.
5. Olimov K. K. et al. ABOUT CROSS-SECTIONS OF YIELD OF EXCITED ${}^6\text{Li}^*$, ${}^7\text{Li}^*$, ${}^9\text{B}^*$ AND ${}^{10}\text{B}^*$ NUCLEI AND THEIR CONTRIBUTIONS TO FORMATION OF MULTINUCLEON SYSTEMS INVOLVING 4 He NUCLEI IN ${}^{16}\text{O}$ p COLLISIONS AT 3.25 A GeV/c //International Journal of Modern Physics E. – 2013. – T. 22. – №. 08. – C. 1350057.

6. Abror Q. Development of Magnetic Characteristics of Power Transformers //Fazliddin, A., Tuymurod, S., & Nosirovich, OO (2020). Use Of Recovery Boilers At Gas-Turbine Installations Of Compressor Stations And Thyristor Controls. The American Journal of Applied sciences. – 2020. – Т. 2. – №. 09. – С. 46-50.
7. Юлдашев Б. С. и др. Некоторые особенности образования зеркальных семинуклонных систем и ядер в ^{16}O -соударениях при 3.25 А ГэВ/с //Узбекский физический журнал. – 2017. – Т. 19. – №. 2. – С. 120-123.
8. Olimov K. et al. Contributions of excited ^6Li and ^7Li nuclei to the production of $^4\text{He}+^2\text{H}$ and $^4\text{He}+^3\text{H}$ systems in ^{16}O p collisions at a momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2013. – Т. 76. – №. 7. – С. 881-882.
9. Kurbanov A. R., Petrov V. I., Yuldashev A. A. The formation seven-nucleon mirror systems and nuclei in ^{16}O p collisions at 3.25 A GeV/c. – 2013.
10. Qurbonov A. 3.25 A GeV/c impulsli ^{16}O -to'qnashuvlarida ko'zguli (^3H , ^3He , ^7Li , ^7Be) yadrolar va mezonlar (π^+ , π^-) ning birgalikda hosil bo'lishi //Физико-технологического образование. – 2020. – №. 1.
- 11.Olimov K. et al. Comparative analysis of properties of channels of deuteron and tritium production in ^{16}O p- collisions at a projectile momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2014. – Т. 77. – №. 12. – С. 1456-1462.
- 12.Olimov K. et al. The formation of six-nucleon systems and nuclei in ^{16}O collisions at 3.25 A GeV/s; Obrazovanie shestinuklonnykh sistem i yader v ^{16}O -soudarennyakh pri 3.25 A GeV/s. – 2013.
- 13.Olimov K. K., Sattarov A. R., Kurbanov A. Correlation effects in formation of stable isotopes with 2-7 nucleons number in ^{16}O p-collisions at 3.25 GeV/s impulse on nucleon. – 2008.
- 14.Olimov K. K. et al. About Transverse Momentum Distributions of Negative Pions in $p^{12}\text{C}$ and $\pi^{-12}\text{C}$ Collisions at High Energies //Ukrainian Journal of Physics. – 2020. – Т. 65. – №. 2. – С. 97-97.
- 15.Olimov K. et al. The formation of six-nucleon systems and nuclei in ^{16}O p collisions at 3.25 A GeV/c. – 2013.
- 16.Olimov K. et al. Contributions of excited [⁶] Li and [⁷] Li Nuclei to the production of [⁴] He+[²] H and [⁴] He+[³] H systems in [¹⁶] Op collisions at a momentum of 3.25 GeV/c per nucleon //Physics of Atomic Nuclei. – 2013. – Т. 76. – №. 7. – С. 881-883.
- 17.Olimov K. et al. Cross sections of semi inclusive channels with formation of 6-and 7-nucleon systems and nuclei's in ^{16}O p-reactions at 3.25 A GeV/s. – 2012.
- 18.Olimov K. et al. Average multiplicities of fragments with $A \leq 3$, associated with formation of 6-and 7-nucleon systems and nuclei in ^{16}O p-collisions at 3.25 A GeV/s. – 2012.

- 19.Olimov K. et al. Disintegration of ^{16}O nuclei with 3.25 A GeV/s impulse in the interactions with protons on light fragments of A= 3 and 4. – 2010.
- 20.Olimov K. et al. Singularities of mirror nuclei ^7Li and ^7Be production in ^{16}O -interactions at 3.25 A GeV/s. – 2009.
- 21.Olimov K. et al. Singularities of mirror nuclei ^7Li and ^7Be production in ^{16}O -interactions at 3.25 A GeV/s. – 2009.