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DETERMINATION OF ANGULAR MOMENTA IN THE INCOMPLETE-FUSION CHANNELS OF THE REACTIONS Ta+^{22}Ne AND Ir+^{12}C

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1. INTRODUCTION

At present a large amount of experimental data on the inclusive spectra of light charged particles, e.g., hydrogen, helium, lithium and other isotopes, produced by heavy-ion reactions, has been accumulated. We have established that the end-point energies of these particles are close to the kinematic limit equal to the energy release in a given reaction under the assumption of the two-body character of the interaction process [1]. The nature of the emission of these particles is not clear yet. There are several assumptions concerning the mechanism of their formation [2,3]. Theoretical papers successfully describe experimental data pertaining, as a rule, to isolated parts of spectra. Attempts to describe spectra in the entire range of particle energies encounter some difficulties associated with insufficient experimantal data from correlation experiments involving the unambiguous separation of reaction channels.

The understanding of the mechanism of fast particle formation is substantially connected with the determination of the input angular momenta of their formation reaction. Such studies have been carried out using the technique of γ-ray multiplicity measurements in reactions involving light charged particle emission for nuclei of the rare-earth elements [4] and for nuclei with $A \sim 70$ [5]. In relevant papers a conclusion has been made that incomplete-fusion reactions involving light charged particle emission are characterized by input angular momenta close to the critical ones of complete fusion reactions. However these data relate to particle energies far from the kinematic limit.

In the present paper the average values of the input angular momenta ℓ_i were determined for the channels of α particle and Li nuclei emission in the reaction $Ta + {}^{22}Ne$ as a function of the energy of these particles. The choice of the given reaction is explained by the fact that it was investigated in detail earlier with the aim of obtaining experimental information about the inclusive energy spectra of emitted light particles. The channel involving the emission of α particles in the reaction ${}^{nat}Ir + {}^{12}C$, which, in the case of incomplete fusion, was expected to lead to the same residual nuclei (Tl) as in the incomplete-fusion channel of the reaction ${}^{181}Ta + {}^{22}Ne$, was also studied. For determining the $\bar{\ell}_i$ values measurements were carried out of the average γ-ray multiplicities $\langle M_\gamma \rangle$ in correlation with charged particles and KX-rays due to the residual nuclei.

2. EXPERIMENTAL ARRANGEMENT

Experiments were carried out using an external beam from the U-200 cyclotron of the JINR Laboratory of Nuclear Reactions. The experimental setup was designed taking into account the results of our earlier experiments for the reaction Ta + ^{22}Ne [6]. A schematic view of the experimental setup is shown on Fig.1. A collimator, 6 mm in diameter, was placed at the entrance of the chamber. Beam monitoring was performed using a thin gold foil with a thickness of 250 μg/cm^2 glued upon the collimator. The ions scattered at an angle of 22° were detected by a surface-barrier Si-detector. The ions bombarded a metallic target placed at the center of the chamber. Charged particles (α, Li) were registered at an angle θ = 0° with respect to the direction of the ion beam by a $\Delta E - E$ Si-detector telescope subtending a solid angle of 0.13 sr. Fission fragments and secondary particles were recorded by an annular surface-barrier detector and a $\Delta E - E$ detector telescope, placed in the backward hemischere. The annular detector subtended the angular range $160° \le \theta_k \le 170°$; and the detector telescope, a solid angle of 10^{-2} sr. Around the target NaI(Tl) scintillation γ-ray detectors were arranged having an almost constant counting efficiency Ω = 0.6% each in the range 200 keV $\le E_\gamma \le$ 2.0 MeV. The number of γ detectors N, was varied from 1 to 5 depending on the geometry and the purpose of the experiment.

The experiments were carried out at ^{22}Ne ion energies of 145, 155 and 165 MeV and at a ^{12}C ion energy of 100 MeV with a beam intensity of several nanoamperes. A thick, 50 μm, or a thin, ≈2.3 mg/cm^2, tantalum target was placed depending on the experimental conditions. In the case of using the thick target the information obtained for two ion energies was processed in such a way that the particle spectra should correspond to thin working layer at the target surface corresponding to an incident ion energy loss of 20 MeV, i.e., the average ion energy was 155 MeV. The iridium target with natural isotopic composition had a thickness of 10 mg/cm^2.

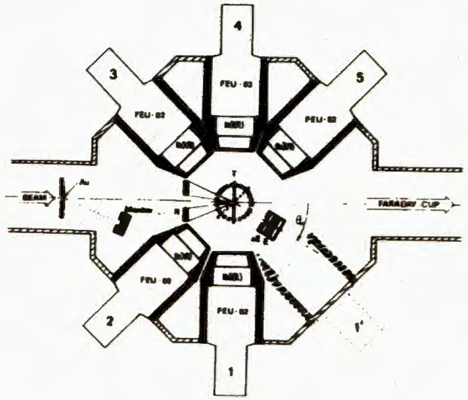


Fig.1. Schematic view of the reaction chamber.

A Ge(intr.) X-ray detector with an energy resolution of approximately 650 eV under experimental conditions and an efficiency of ≈1% for KX-rays due to elements from Ta to Bi was positioned at a distance of 4 cm from the target centre perpendicularly to the location of the plane of the scintillation detectors.

The electronic circuit was built using CAMAC modules and was based on the principle of detecting pulses arriving from the X-ray detector or the fission fragment detector in coincidence with a trigger pulse from the $\Delta E - E$ telescope. For estimating a contribution coming from random events time-amplitude analysis was performed for all pairs of coincident pulses. The time resolutions of the coincidences were not worse than 15 ns. The online data aquisition and processing were performed using a SM-3 mini-computer.

The $\langle M_\gamma \rangle$ values were determined from the particle spectra of different-fold coincidences with γ-rays by using the technique described in ref. [13].

3. EXPERIMENTAL RESULTS

Inclusive Spectra of the Reaction Ta + ^{22}Ne

In ref. [1] it was noted that when charged particles are emitted in the forward direction with energies close to the kinematic limit, the reaction occurs mainly via the only channel - incomplete fusion. Therefore it was of interest to measure the γ-multiplicity for this case especially as the yield of the forward emitted light particles is a maximal one [1].

Such measurements were carried out at θ = 0° using a thick tantalum target or a thin target and a degrader foil stopping the beam entirely. The characteristic bumps of the particle spectra, observed in the region of E_α = 40-50 MeV (Fig.2) are due to the contribution from α particles produced by the background reaction on a carbon and oxygen admixture. Special studies have shown that this contribution grows with increasing α particle energy and decreases with increasing projectile energy (Fig.3). The multiplicity of γ-ray accompanying α-particles in the background reaction was measured to be equal to 2.5±1.0 and almost constant in the α particle energy rang from 20 to 70 MeV. The background reaction contribution substantiaally depends on the purity of the target surface, on the exposure time, etc. There data were taken into account in the processing of the inclusive α particle spectra. Fig.4 shows the E_α dependence of the γ-multiplicity, $\langle M_\gamma \rangle$, measured for an inclusive particle spectrum (open points) at a ^{22}Ne ion energy

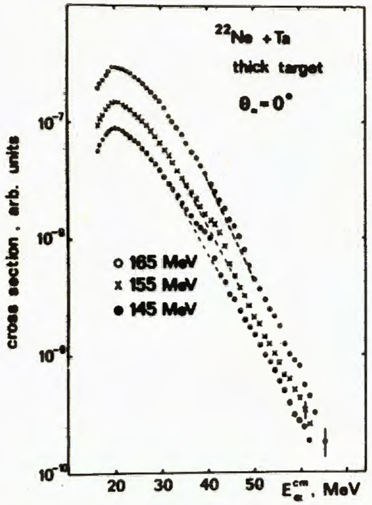


Fig.2. Inclusive α-particle spectra.

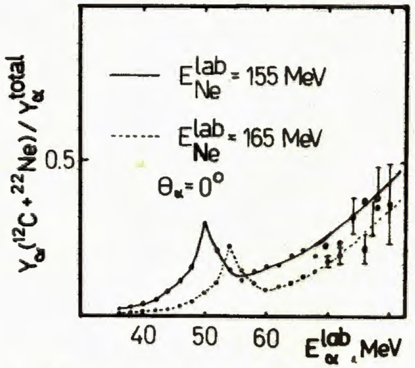


Fig.3. The contribution of background α-particles from a carbon admixture into the inclusive α-spectra of the reaction Ta + ^{22}Ne, for two neon ion energies.

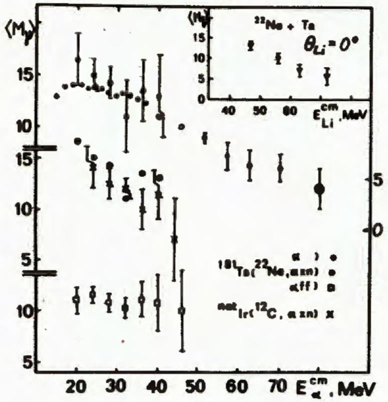


Fig.4. The α-energy dependence of $\langle M_\gamma \rangle$ for various channels of the reactions Ta + ^{22}Ne and Ir + ^{12}C. The inset shows the dependence of $\langle M_\gamma \rangle$ on the energy E_{Li} for the inclusive spectrum of Li nuclei produced in the reaction Ta + ^{22}Ne.

of 155 MeV. The smoother decrease of $\langle M_\gamma \rangle$ with increasing E_α, compared with that shown in ref. [6], is due to the inclusion of the background reaction contribution.

The γ-ray multiplicity measured for the channel of Li nuclei emission is given in the inset of Fig.4. For this reaction channel it was difficult to take into account the contribution from the background reaction effects to the experimental spectra. Based on the results of background reaction studies one can only note that this contribution should be several times smaller than in the case of α particle emission. Also, based on the

results of ref. [20], we cannot exclude some contribution from ^8Be (i.e. 2α) to the Li-yield measured for both the Ta + ^{22}Ne and the background reactions.

The measured values of $\langle M_\gamma \rangle$ corresponding to the inclusive particle spectrum are associated with many reaction channels, such as αf, αxn, the breakup of the projectile, etc., for each E_α value in the region of low and medium α particle energies. Therefore experiments were carried out to investigate different reaction channels.

Fission and Secondary Particle Emission

Measurements of α particle spectra were carried out in the reaction Ta + ^{22}Ne in coincidence with secondary particles using a $\Delta E - E$ detector telescope placed at an angle of 155°. 60-70% of the secondary particles were identified as protons, the rest being α-particles. The yield of secondary particles decreases sharply with increasing E_α (see Fig.5). Coincidences between α-particles and fission fragments were measured at fission fragment angles of 95° and 165°. All these data for E_{Ne} = 155 MeV are given in Fig.5. The angular distribution of fission fragments can be calculated using the technique described in ref. [7].

Using the expression

$$W_f(\theta) \sim \bar{\ell}_f (2\bar{\ell}_f + 1) \exp\left(-\frac{\bar{\ell}_f^2 \sin^2\theta}{4K_o^2}\right) I_o\left(\frac{\bar{\ell}_f^2 \sin^2\theta}{4K_o^2}\right), \qquad /1/$$

where $K_o^2 = \frac{1}{h^2} T_f J_{eff}$, one can obtain the values of residual angular momenta ℓ_f of the fissioning nuclei following α particle emission, as a function of E_α, from the experimental values of the ratio of the fission fragment yields measured in coincidence with α particles of different energies, P_{ff} = $W_f(165°)/W_f(95°)$, (see fig.6). In eq./1/ K_o^2 is the halfwidth of the distribution of the angular momentum projection into the fission axis, T_f is the nuclear temperature, J_{eff} is the effective momentum of inertia of the nucleus at the saddle. The calculation was made assuming T_f = 2 MeV, J_{sph}/J_{eff} = 1.5 (ref. [7]). The thus calculated values of $\bar{\ell}_f$ are given in Fig.9.

The γ-ray multiplicites, $\langle M_\gamma^f \rangle$, measured in coincidence with secondary particles or fission fragments are presented in Fig.4. The multiplicity $\langle M_\gamma^f \rangle$ can be considered to be constant within experimental errors in a wide range of α particle energies.

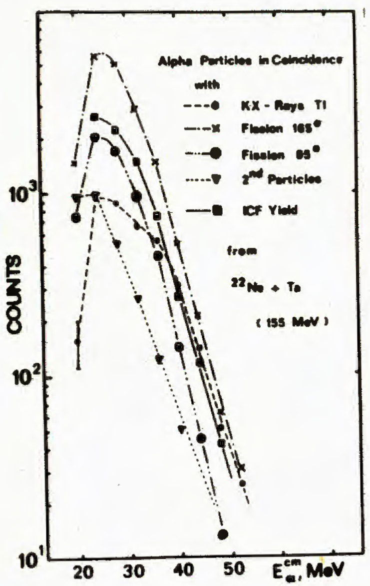


Fig.5. The spectra of α-particles detected in coincidence with the reaction products in different exit channels for the reaction Ta+ ^{22}Ne at 155 MeV.

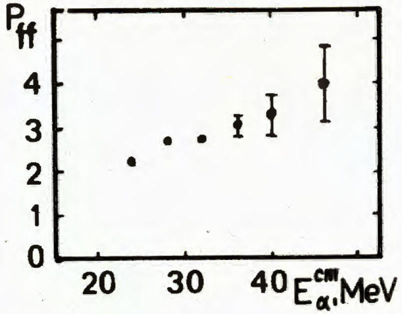


Fig.6. The E_α dependence of the ratio of the yields of fission fragments detected in coincidence with α particles at two laboratory angles (see the text).

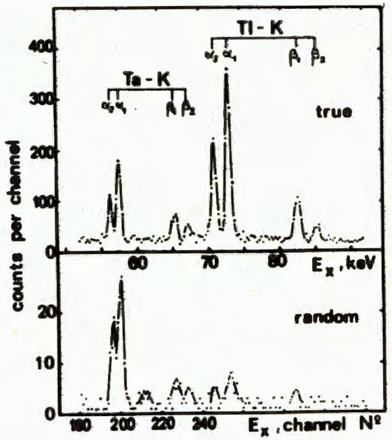


Fig.7. The X-ray spectra of true and random coincidences with α-particles for the reaction Ta+ ^{22}Ne.

KX-Rays

The spectra of α particles were measured in coincidence with KX-rays from residual nuclei, too. The observed $K_{\alpha_{1,2}}$ and $K_{\beta_{1,2}}$ transitions served for identification of the atomic number Z_o of the residual nucleus. Figure 7 shows the X-ray spectra of true and random coincidences with α particles measured at an angle $\theta = 0°$ for the reaction Ta+ ^{22}Ne. Similar spectra were observed in the reaction Ir+ ^{12}C. From the analysis of these spectra it follows that the emission of α particles is mostly

correlated with KX-rays from Tl isotopes. In coincidence with Tl KX-rays, the dependence of the γ-ray multiplicity on the α particle energy was measured for the two reactions. These data are presented in Fig.4.

As is pointed out in ref. /8/, for the nuclei of the transient region of deformation, to which Tl nuclei belong, several highly converted M1-transitions correspond to the γ-transition chain in the de-excitation of residual nuclei. As a consequence, several KX-rays with an average multiplicity $\langle M_x \rangle$ should be emitted per decay. In accordance with ref. /8/ a value of $\langle M_x \rangle \approx 3$ can be assumed for the isotope $^{199,198...}$Tl provided that $l_\gamma > 20\hbar$ and $E_o^* > 55$ MeV, and $\langle M_x \rangle < 3$ in the case where these conditions regarding l_γ and the thermal excitation energy E_o^* of the residual nucleus are not satisfied. Therefore the average value of the residual angular momentum of the nucleus following the emission of a charged particle should be calculated from the experimental value of $\langle M_\gamma \rangle$ taking into account $\langle M_x \rangle$, i.e.,

$$\bar{\ell}_\gamma = \langle M_\gamma \rangle \cdot \bar{\lambda}_\gamma + \langle M_x \rangle , \qquad /2/$$

where $\bar{\lambda}_\gamma$ is the average multipolarity of γ-transitions in the de-excitation of the residual nucleus. In order to determine the $\bar{\lambda}_\gamma$ value in coincidence with Tl KX-rays the angular distribution of γ-radiation produced in the reaction Ta(^{22}Ne, αxn) was measured. The data obtained for the γ-ray detection angles θ_γ = 0°, 90° and 135° are presented in Fig.8. The rough analysis of these results using the technique given in ref. /9/ has shown that the value of the average multipolarity is confined within the limits $1.0 \le \bar{\lambda}_\gamma \le 1.5$.

The spectra of charged particles emitted at the laboratory angle of 165° were also measured in coincidence with KX-rays. The ratio between the yields of particle-Tl-KX-ray coincidences detected at 165° and 0° was 0.15 ± 0.1. This is in agreement with the α particle angular distribution measured experimentally in ref. /1/ if the growing anisotropy of α particles with increasing bombarding energy is taken into account.

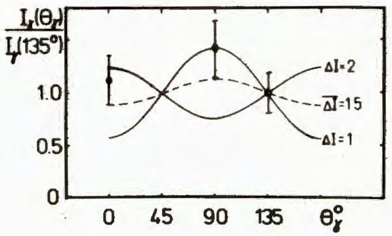


Fig.8. The relative γ-radiation yield detected in coincidence with α-particles ($\theta_\alpha = 0°$) and with Tl KX-rays, as a function of the detection angle. The calculated curves are obtained for different values of λ_γ = 1.0, 1.5 and 2.0, according to ref. /9/.

4. ANALYSIS OF EXPERIMENTAL DATA

The sum of the α particle spectra in coincidence with KX-rays of Tl, secondary particles and fission fragments taking into account their measured anisotropy is shown as a full curve (ICF yield) in Fig.5. The effective temperature of this spectrum T_{eff} = 3.5 MeV exceeds by a factor of 2-3 the temperature of compound nuclei, indicating the preequilibrium character of α particle emission in the reaction under study. Therefore, the analysis of the experimental data given in the present paper was carried out under the main assumptions, that (i) the population of angular momenta in the entrance channel occurs in a localized region corresponding to fast particle emission and (ii) their emission from the nuclear surface has tangential character. These assumptions were made in refs. /11,12/ to explain the set of data obtained in the studies of heavy-ion induced incomplete fusion reactions involving the emission of light charged particles. According to these assumptions, for the Li x n reaction channel the average value of the input angular momentum $\bar{\ell}^{in}_{ixn}$ can be obtained using the following relation:

$$\bar{\ell}^{in}_{ixn} = \bar{\ell}_\gamma + \bar{\ell}_n + \bar{\ell}_i + \Delta I_o \,, \qquad /3/$$

where $\bar{\ell}_n$ is the total angular momentum carried off by the neutrons evaporated from the residual nucleus after the emission of the i-particle, ΔI_o is the spin difference between the states of the final and initial nuclei. The $\bar{\ell}_n$ value was calculated assuming that each neutron carries away an angular momentum equal to about two units of $\hbar$, and the number of neutrons, x, is connected with the thermal excitation energy E^*_o of the residual nucleus through the relation $E^*_o \geq \sum_i (B_n + 2T_n)$, were B_n is the j-th neutron binding energy, T_n is the temperature of the nucleus. For the calculations we took T_n = 1.5 MeV (ref./10/).

The angular momentum carried away by the particle can be calculated using the following relation /11/

$$\ell_i = (r_o/\hbar)[2\mu(E^{cms}_i - V^{cms}_i)]^{1/2}, \quad r_o = 1{,}07\,(A_i^{1/3} + A_o^{1/3}) + 3{,}0 \text{ fm}, \qquad /4/$$

where V^{cms}_i is the Coulomb energy of the interaction between the particles and the residual nucleus, $\mu = A_i A_o/(A_i + A_o)$. For the reaction Ta + ^{22}Ne the V^{cms}_α value can be taken on the basis of the systematics of output Coulomb barrier values /19/: V^{cms}_α = 18 MeV. Using the relations /2/, /3/, /4/ it is possible to obtain the average values of input angular momenta. Fig.9 shows the dependence $\bar{\ell}^{in}_{xn}(E)$ calculated for the reaction Ta(^{22}Ne, αxn) at $\bar{\lambda}_\gamma$=1.0 and $\bar{\lambda}_\gamma$=1.5 (curves a and b, respectively).

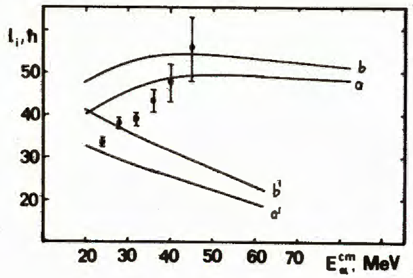
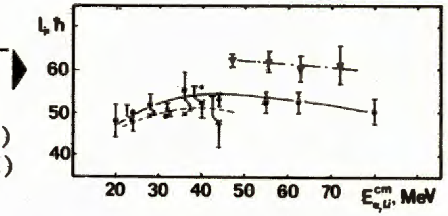


Fig.9. The α-energy dependence of calculated input angular momenta for various channels of the reaction Ta + ^{22}Ne. The points are the experimental values of $\bar{\ell}_{\alpha f}$ (see the text).

Fig.10. The dependence of the input angular momentum values on the energy of charged particles for the reactions: Ta(^{22}Ne, αxn) (●); Ir(^{12}C, αxn) (×); Ta(^{22}Ne, Li X) (∇).



In fig.10 the dependence of the input angular momenta (λ_γ = 1.5) on the energy of the emitted particles are compared for the αxn and Lixn channels of the reaction Ta + ^{22}Ne and for the αxn channel of the reaction Ir + ^{12}C. From this comparison one can draw the following conclusions.

In the region of E_α = 25-60 MeV the input angular momenta remain constant within the experimental accuracy. The value of $\bar{\ell}^{in}_{xn}$ for the energy $E_\alpha \simeq$ 80 MeV (close to the kinematic limit) was derived from the $\langle M_\gamma \rangle$ data for the inclusive particle spectrum (Fig.4) and lies on the general curve. For the Ne ion energy of 155 MeV the kinematic limit on the α particle energy lies at 105 MeV. Thus one can expect $\bar{\ell}^{in}_{xn}$ to remain at a level of ~ 50ħ at high α particle energies as well.

In the case of Li nuclei emission the values of input angular momenta lie above those corresponding to the αxn-channel of the same reaction. This fact qualitatively agrees with the predictions of the model developed in ref./15/, which leaves angular momentum "windows": $59\hbar \leq \ell^{in} \leq 63\hbar$ for the αxn-reaction channels and $63\hbar \leq \ell^{in} \leq 66\hbar$ for the Li x n-channels of the reaction Ta + ^{22}Ne. It is noteworthy, however, that for this reaction the $\bar{\ell}^{in}_{\alpha xn}$ values lie below the values of the critical angular momentum ℓ_{cf} for the complete fusion channel /14/, ℓ_{cr}(Ta + ^{22}Ne) = 59ħ. At the same time the $\bar{\ell}^{in}$ values for the αxn-channel of the reaction Ir + ^{12}C, leading to the same residual nuclei as in the reaction Ta(^{22}Ne, αxn), exceed considerably the calculated value of ℓ_{cr} = 39ħ obtained using the calculational technique of ref./14/, and they nearly agree with the $\bar{\ell}^{in}$ values for the reaction Ta(^{22}Ne, αxn). This indicates that the input angular momentum values corresponding to the incomplete-fusion channel are determined mainy by the properties of the system in the exit channel (see also ref.[11]).

The results of ref.[16] confirm the assumption that the input angular momentum distribution on the case of the reaction Ta + ^{22}Ne is nearly the same both in the αxn- and αf-channels. Hence, it is possible to calculate the $\bar{\ell}_{\alpha f}$ values using the following relation $\bar{\ell}_{\alpha f} = \bar{\ell}^{in}_{\alpha xn} - \bar{\ell}_{\alpha}$. The dependences $\bar{\ell}_{\alpha f}(E_\alpha)$ for $\lambda_\gamma = 1.0$ and $\lambda_\gamma = 1.5$ are shown in Fig.9 (the curves a' and b', respectively). Accordingly one can expect that the angular momenta of the residual nuclei, after α particle emission in the fission channel, should lie between the curves a' and b'. However this conclusion is valid only for the $\bar{\ell}_{\alpha f}$ values obtained using formula /1/ from the P_{ff} values for $20 \le E_\alpha \le 30$ MeV (Fig.9). At $E_\alpha > 30$ MeV $\bar{\ell}_{\alpha f}$ exceeds considerably the expected values. This contradiction arises under the assumption of the tangential character of the charged particle emission from the nuclear surface, irrespective of the reaction channel observed, and it can be removed if we assume that the particles are emitted at different angles relative to the nuclear surface. This assumption can be justified in terms of the existing models, for example, the "hot spot" model[17]. In this case the tangentially emitted particles carry away the maximum possible angular momentum ℓ_i and radial particles carry off considerably smaller momentum. Thus, for the residual nuclei, the ratio between the probabilities of fission and of neutron or secondary charged particle evaporation varies depending on the particle emission engle.

From the above consideration it also follows that for the αf reaction channel the lifetime of the system before emitting α particles detected at $\theta = 0°$ should be comparable with the rotation period $\tau \sim 10^{-20}$ s of the system at $\bar{\ell}^{in} \sim 45\text{-}50\hbar$, considerably exceeding the typical times $10^{-21}\text{-}10^{-22}$ s needed for direct reactions to occur.

However one cannot deny entirely the possibility of the existence of two mechanisms of α particle emission: one involving relatively large angular momenta increasing with E_α and leading to the fission of residual nuclei, and the other acting at smaller input angular momenta and corresponding to the αxn-channel of the reaction. It should be noted, however, that for α particle energies $E_\alpha > 45$ MeV in the reaction Ta + ^{22}Ne the main part of the ICF yield is due to the αxn reaction channel. According to ref.[18], a decrease in J_{sph}/J_{eff} with the increasing angular momentum of the fissioning nucleus can also effect the results of calculations using eq./1/, although taking this dependence into account cannot change the qualitative conclusions concerning an increase of $\bar{\ell}_{\alpha f}$ with increasing E_α.

Further progress in understanding the mechanism of charged particle emission is apparently associated with studies of reactions involved in other target-projectile combinations, in which reaction channels would be separated by observing KX-ryas, the γ-spectra of residual nuclei and fission fragments.

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REFERENCES

1. Borcea C. et al. Nucl.Phys., 1982, A391, p.520.
2. Borcea C. et al. JINR, E7-83-440, Dubna, 1983.
2. Bunakov V.E., Zagrebaev V.I. In: Abstracts, XXXIII Conf. on Nuclear Spectroscopy and Nuclear Structure, Moscow, 1983. "Nauka", Leningrad, 1983.
3. Kerman A.K., Mevoy K.V. Ann.Phys.(N.Y.), 1979, 122, p.197; Udagawa T., Tamura T. Phys.Rev.Lett., 1980, 45, p.1311.
4. Siwek-Wilczynska K. et al. Phys.Rev.Lett., 1979, 42, p.1599.
5. Robinson R.L. et al. Phys.Rev., 1981, 24, p.2084.
6. Kamanin V.V. et al. JINR, 7-81-726, Dubna, 1981.
7. Chaudhry R., Vandenbosch R., Huizenga J.R. Phys.Rev., 1962, 126, p.220; Karamyan S.A. et al. JINR, P7-3105, Dubna, 1967.
8. Karwowski H.J.et al. Phys.Rev., 1982, C25, p.1355.
9. Sie S.H. et al. Nucl.Phys., 1981, A352, p.279.
10. Kamanin V.V., Karamyan S.A. Yad.Fiz., 1981, 33, p.978.
11. Zolnowski D.R. et al. Phys.Rev.Lett., 1978, 41, p.92.
12. Inamura T. et al. Phys.Lett., 1979, 84B, p.71.
13. Ockels W.J. Z.Phys.A, 1978, 286, p.181.
14. Bochev B. et al. Yad.Fiz., 1976, 23, p.520.
15. Wilczynski J. et al. Phys.Rev.Lett., 1980, 45, p.606.
16. Utsunomiya H. et al. Phys.Lett., 1981, 105B, p.135.
17. Awes T. et al. Phys.Rev., 1982, C25, p.2361.
18. Tsang M.B. et al. Preprint MSUCL-412, Michigan, 1983; Phys. Lett., 1983, 129B, p.18.
19. Alexander J.M., Guerreau D., Vaz L.C. Z.Phys.A, 1982,305, p.313.
20. Arnell S.E. et al. Phys.Scripta, 1983, T5, p.199.

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Определение угловых моментов в каналах неполного слияния реакций Ta + ^{22}Ne, Ir + ^{12}C

С помощью техники измерения множественности γ-лучей были проведены эксперименты с целью определения входных угловых моментов ℓ^{in}, соответствующих реакциям неполного слияния с тяжелыми ионами с вылетом быстрых заряженных частиц. В реакции ^{181}Ta + ^{22}Ne при средней энергии ионов неона 155 МэВ исследовались каналы эмиссии α-частиц и ядер Li, в реакции ^{ест}Ir + ^{12}C при E_c=100 МэВ - канал эмиссии α-частиц. Для выделения каналов реакции использовался спектрометр X-лучей. Проводились измерения углового распределения осколков деления в реакции ^{181}Ta(^{22}Ne, αf). Полученные данные свидетельствуют о том, что входные угловые моменты лежат для канала эмиссии Li около 60$\hbar$, для канала эмиссии α-частиц - около 50$\hbar$ и практически не зависят от энергии частиц. Для α-канала величины ℓ^{in} в пределах погрешностей эксперимента совпадают для обеих изученных реакций. Получена оценка времени жизни системы взаимодействующих ядер мишени и бомбардирующего иона до эмиссии α-частицы - 10^{-20} с.

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Determination of Angular Momenta in the Incomplete-Fusion Channels of the Reactions Ta + ^{22}Ne and Ir + ^{12}C

By using the γ-ray multiplicity technique, experiments were carried out to determine the input angular momenta ℓ^{in} corresponding to the heavy ion-induced incomplete-fusion reactions involving the emission of fast charged particles. The channels of α particle and Li nuclei emission were investigated in the reaction ^{181}Ta + ^{22}Ne at the average Ne ion energy of 155 MeV and the α particle emission channel in the reaction ^{nat}Ir + ^{12}C at E=100 MeV. The separation of the reaction channels was carried out using an X-ray spectrometer. The angular distributions of the fission fragments were measured in the reaction ^{181}Ta(^{22}Ne, αf). The obtained data indicate that the input angular momenta are equal to about 60$\hbar$ and 50$\hbar$ for the channels of Li emission and α emission, respectively, being practically independent of the particle energy. For the α-emission channel the ℓ^{in} values are the same for both the reactions within experimental errors. The lifetime of the system of the interacting target and projectile nuclei, prior to the emissions of an α particle, has been estimated to be equal to 10^{-20} s.

The investigation has been performed at the Laboratory of Nuclear Reactions, JINR.

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