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TRAPPING OF Λ° HYPERONS FOLLOWING A K^- CAPTURE

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The trapping of Λ° hyperons following a K^- capture in emulsion nuclei is studied through computer simulation. The K^- meson is assumed to be absorbed on the nuclear surface, in $(0-10)\%$ and $(0-25)\%$ density regions of the nuclear matter, and uniformly throughout the nuclear volume. The Λ° trapping probability and the production rates of hyperfragments and cryptofragments are estimated and compared with the corresponding experimental results. An estimate of the rate of formation of heavy hypefragments (– 10 %) is also presented. Further, the agreement of the experimental estimates of the Λ° trapping probability with the corresponding simulated results for the surface absorption and their disagreement with similar results for the volume absorption can be taken as a further evidence in support of the surface absorption of K^- mesons.

I. INTRODUCTION

The nuclear capture of a K^- meson can produce a hyperon from processes like $K^- + N \to \Sigma$ or $\Lambda^\circ + \pi$ and $K^- + NN \to \Sigma$ or $\Lambda^\circ + N$. The Σ hyperon may further interact within the nucleus and produce a Λ° hyperon via the reaction $\Sigma + N \to \Lambda^\circ + N$. The Λ° hyperon produced directly from a K^- capture or indirectly from the Σ conversion may be emitted from the parent nucleus or trapped within it leading to the production of a spallation [1] hyperfragment (HF).

The trapping probability of Λ° hyperons and the rate of production of HFs following a K^-capture have long been estimated from studies in nuclear emulsion [2–8]: more recently, the rate of the Λ° trapping has been estimated from heavy liquid bubble chambers [9–16] also. Both these media contain two groups (light and heavy) of complex nuclei which differ considerably in size, mass and charge. The early studies of Abeledo et al. [4] indicated that the HFs produced from K^- caputres in nuclear emulsion originated mostly from the light (CNO) nuclei though the trapping of a Λ° hyperon is expected to be more probable in the heavy (Ag Br) nuclei. Davis et al. [5] found that $\sim 30\ \%$ of K^- captures result in the trapping of Λ° hyperons which produce cryptofragments (CFs), i.e. HFs whose production and decay stars are indistinguishable and which, therefore, do not have a visible track. From propane-freon bubble chamber studies of K^-captures, Knight et al. [9] have reported that the formation of HFs predominantly occurs in the heavy nuclei. It is now established that visible HFs are also produced from heavy nuclei and that their range is generally $< 3\ \mu$m.

The results of Davis et al. [5] are derived from a study of the emission frequency of neutral hyperons. For this, the decay of the emitted Λ° hyperons has to be detected and associated with its parent K^- capture star. Nuclear emulsion is not a suitable medium for this kind of work. Perhaps because of this the results of Cester et al. [6] and Filipokowski et al. [7] differ appreciably from those of Davis et al. [5] and to some extent from one another. Though the decays of Λ° hyperons can be easily observed in bubble chambers, these are not suitable, due to a poor resolving power to detect short ranges of HFs (and most of the heavy HFs, as already mentioned, have short ranges). Only the total rate of formation of HFs and CFs or the trapping probability of Λ° hyperons can be and, therefore, has been estimated from studies in bubble chambers.

The experimentally estimated rates of a Λ° trapping and HF and CF production are presented in Table 1.

We study K^- capture in emulsion nuclei by computer simulation and obtain results free from the uncertainties and limitations of experimental work. It must, however, be mentioned that the results of computer simulation studies depend on the chosen model of interaction, the accuracy of input parameters and the procedure of simulation. In this paper, we present our estimates of the trapping probability of Λ° hyperons and the rates of HF and CF formation.

II. PROCEDURE OF COMPUTER SIMULATION

We give the procedure of simulation here only in short as its details and information on input parameters are given separately [17, 18].

All the capture interactions of K^- mesons with single and two nucleons, whose branching ratios are given by Nikolic [19], are simulated. Since the branching ratios are given for conjugate nuclei, we simulate the K^- absorption interactions in three emuslion nuclei, carbon, bromine and silver, and two fictitious conjugate heavy nuclei, one having the mass of bromine and the other that of silver. The simulation in fictitious nuclei is done only to check whether the results otained from conjugate and non-conjugate nuclei but with the use of the same branching ratios, valid for conjugate nuclei, compare

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Table 1

Experimentally estimated rates of Λ° grapping and HF and CF production following K^- captures

Rate of Λ° trapping (%)	Rate of production (%)		Medium	Reference	Remarks
	HF	CF			
—	5 ± 1	30 ± 7	emulsion	2	for all K^-captures
—	7 ± 1	41 ± 7	emulsion	2	for K^- captures producing Λ° hyperons
—	—	30 ± 7	emulsion	5	for all nuclei
—	—	15	emulsion	6	the rate is an upper limit
—	—	$22\pm{}^{22}_{24}$	emulsion	7	the rate becomes $13\pm{}^{17}_{19}$ after correction
—	6.5 ± 0.2	—			
8 ± 2	—	—	emulsion	8	for all nuclei
58 ± 15	—	—	emulsion	8	light emulsion nuclei
18.5 ± 3.5	—	—	emulsion	8	heavy emulsion nuclei
51 ± 14	—	—	bubble chamber	9	for carbor and fluorine in propane (C_3H_8) and freon CF_3Br
9 ± 5	—	—	bubble chamber	9, 12	for bromine in freon
19 ± 1.6	—	—	bubble chamber	13	fluorine in freon
19 ± 2	—	—	bubble chamber	14	average for all freon nuclei
19.6 ± 1.8	—	—	bubble chamber	15	average for all freon nuclei
11 ± 5	—	—	bubble chamber	16	average for all freon nuclei
52 ± 14	—	—	bubble chamber + emulsion	16	combined results for light nuclei
9.5 ± 3.0	—	—	bubble chamber + emulsion	16	combined results for heavy nuclei
			bubble chamber	11	for neon

or differ considerably from each other. The initial interaction of K^-mesons is assumed to occur randomly, first in the (0—10)% density region of nuclear matter (RI), then in the (0—25)% density region of nuclear matter (RII), and finally in the nuclear volume (RIII).

For computational convenience, the procedure is divided into three parts: (*a*) the initial interaction where the identity and momentum of the particles produced from the absorption interaction of K^- mesons are determined and their location within the nucleus is found: (*b*) the nuclear cascade where the particles produced in the initial interaction are followed (as they interact within the nucleus and initiate a nuclear cascade) until they are emitted or absorbed within the nucleous: all particles involved in the nuclear cascade are followed similarly: the trapping of a Λ° hyperon is assumed to produce a HF which is designated as a CF if its range is found to be less than one micron: and (*c*) the nuclear evaporation during which the excited nucleus de-excites itself by further emission of particles: it is assumed that once a Λ° hyperon is trapped, it remains so during the nuclear evaporation also.

III. RESULTS AND DISCUSSION

The results are broadly similar for the conjugate and nonconjugate heavy nuclei for which simulation is done in this work. This indicates that the calculated results are rather insensitive to the different numbers of protons and neutrons of such nuclei (having a fixed atomic number) and are not much influenced by a small change in the branching ratios of K^- capture interactions. Therefore, we present the results for the heavy emulsion nuclei only. Further, it is assumed that the results for all the light emusion nuclei (CNO) are broadly similar and, therefore, the results for carbon are taken as representing the whole (CNO) group.

III. 1. Trapping of Λ^0 hyperons

III. 1. 1. Λ°hyperons produced from single nucleon capture of K^-mesons

The calculated rates of the trapping of Λ° hyperons produced directly from a K^- capture or indirectly from a Σ conversion are presented in the third and fourth columns of Table 2. It is worth noting that for all nuclei, the trapping rate of indirectly produced Λ° hyperons (Λ_i) is very much larger than that of the directly produced Λ° hyperons (Λ_d) for RI and RII. For the light nucleus the same trend continues with a reduced difference in the two rates for RIII also: for the heavy nuclei no consistent resulst are obtained for **R**III, though the probability of trapping both Λ_d and Λ_i appears to be nearly the same in this case. These results can be explained as follows:

For **R**I and **R**II, the Λ_d are produced near the nuclear periphery but the Λ_i are produced deeper inside the nucleus, a region into which the Σ hyperons may be scattered as a result of an interaction with nucleons. It is obvious that a Λ° hyperon, deeper inside the nucleus, is more likely to be trapped than one near the nuclear periphery. For **R**III, Λ_d as well as Λ_i are produced deeper inside the nuclear volume and their trapping rates become similar, as both the categories of Λ° hyperons are likely to undergo many interactions inside the nucleus, more so in the large volume of a heavy nucleus before being absorbed or emitted. The consequence is that any differences in the energy distributions of the location of production of Λ_d and Λ_i, are eliminated and their trapping becomes equally probable.

III. 1. 2. Λ° hyperons produced from a two nucleon capture of K^-mesons

The rates of trapping of Λ° hyperons produced from two nucleon captures of K^- mesons are given in the last two columns of Table 2. Again, it is observed

Table 2

Calculated rates of Λ° trapping from single and two nucleon captures of K⁻ mesons

Nucleus	Location of initial K⁻ interaction	Rate of Λ° trapping (%) from single nucleon captures		Rate of Λ° trapping (%) from two nucleon captures	
		Directly produced Λ° hyperons (Λ_d)	Indirectly produced Λ° hyperons (Λ_i)	Directly produced Λ° hyperons (Λ_d)	Indirectly produced Λ° hyperons (Λ_i)
Carbon	(0–10)% density region	25	68	23	61
	(0–25)% density region	31	73	27	64
	nuclear volume	52	79	28	73
Bromine	(0–10)% density region	37	75	26	66
	(0–25)% density region	48	77	29	70
	nuclear volume	92	86	38	80
Silver	(0–10)% density region	38	73	25	68
	(0–25)% density region	48	74	30	74
	nuclear volume	96	86	45	84

that the trapping probability of Λ_i is much larger han that of Λ_d. In this case the Λ_d are much more energetic than the Λ_d produced from single nucleon K⁻ captures, for in the latter case the Λ_d are produced not only with a smaller Q-value but also get a small part of it, as most of it is taken away by the light particles (pions) produced along with the Λ_d hyperons. As a result, the trapping probability of Λ_d produced from a two nucleon K⁻ capture is always smaller (much more so for **R**III) than that of Λ_d produced from single nucleon capture. The trapping rates of Λ_d are the smallest for **R**I, the differences in those for **R**II are small, even the differences in those for **R**III are not large and certainly not as appreciable as is the case between the trapping rates for **R**I and **R**III when Λ_d produced from single nucleon K⁻ captures are considered. It seems that the trapping probability of the more energetic Λ° hyperons is less dependent on the location of their creation than that of the relatively slow Λ° hyperons. The larger kinetic energy of Λ_d (as well as their being produced near the nuclear periphery for **R**I and **R**II) produced from two nucleon captures makes their trapping less probable as compared to the trapping of Λ_i (produced from the same source).

In the case of the light nuclei the rates of the trapping of Λ_d produced from two nucleon K⁻ captures seem to be nearly the same for **R**I, **R**II as well as **R**III, while in the case of heavy nuclei the corresponding rates for **R**I and **R**II are smaller then those for **R**III. The energetic Λ_d seem to be more capable of escaping from a light nucleus than from the heavy nuclei, without losing much energy even if they are produced deeper inside the nucleous. This is logical, as in the case of heavy nuclei even the energetic Λ_d produced deep inside the nuclear volume are likely to lose relatively more energy due to their having to traverse a large nuclear matter and consequently to undergo more interactions than would be the case in a light nucleus.

The trapping of Λ_i produced from two as well as single nucleon K⁻ captures shows the same trend for all nuclei, i.e., the rates for **R**I, **R**II and **R**III slowly increase but the differences are small. The $\Lambda_i$produced in both cases are expected to have similar energy distributions and are always likely to be produced deeper inside the nucleus and consequently behave in a similar manner.

III. 1. 6. Combined results from single and two nucleon K⁻ captures

The experimental estimates are that the multi-nucleon captures of K⁻ mesons in complex nuclei occur in 20 % cases (these estimates actually vary from 10 % to 50 %, [19]. Therefore, we comnibe the single and two nucleon K⁻ capture results of the Λ° trapping probability in the ratios 90 : 10, 70 : 30, and 50 : 50, and present the results in Table 3.

It is observed that the rates of the trapping of Λ_i do not change appreciably

Table 3

Calculated rates of Λ° trapping — single and two nucleon results combined in different ratios.

Λ_d = directly produced Λ° hyperons
Λ_i = indirectly produced Λ° hyperons

Nuclues	Location of initial K⁻ interaction	Rate of Λ° trapping (%) — single and two nucleon K⁻-capture results combined in the ratio					
		90 : 10		70 : 30		50 : 50	
		Λ_d	Λ_i	Λ_d	Λ_i	Λ_d	Λ_i
Carbon	(0—10)% density region	25	67	24	66	24	65
	(0—25)% density region	31	72	30	70	29	69
	nuclear volume	50	78	46	77	40	76
Bromine	(0—10)% density region	36	74	34	72	32	70
	(0—25)% density region	46	76	42	75	39	74
	nuclear volume	87	85	76	84	65	83
Silver	(0—10)% density region	37	73	35	72	34	71
	(0—25)% density region	46	74	43	74	39	74
	nuclear volume	91	86	81	85	71	85

with the ratio in which the single and two nucleon K⁻ capture results are combined. This trend is obiously a reflection of the fact that their trapping probability is, as mentioned in Sect. III. 1. 2, nearly the same whether they are produced from single or two nucleon captures. In the case of Λ_d, there is an appreciable change in their rates of trapping for RIII but the change is less for RI and RII. This situation again brings out the fact that while for RIII the rates of the trapping of Λ_d produced from single and two nucleon K⁻ captures differ considerably, those for RI and RII do not. It is seen from Table 2 that the rates of the trapping of Λ_d produced from two nucleon K⁻ captures are, as already mentioned in Sect. III. 1. 2, less than those of Λ_d produced from single nucleon captures but the difference is not large enough to considerably alter the value of the trapping rate of these hyperons when the results from single and two nucleon K⁻ captures are combined in different ratios. Assuming that the volume absorption of K⁻ mesons is improbable (see Sest. III. 3) and consequently ignoring the results for RIII, we may infer that nearly the same percentage of Λ° hyperons produced from two nucleon K⁻ captures, directly or indirectly, is trapped as that of the Λ° hyperons produced from single nucleon K⁻ captures in a similar manner.

III. 1. 4. Overall Λ° trapping probability

In Table 4 are presented the overall rates of Λ° trapping with results for Λ_d and Λ_i combined as follows:

Table 4

Calculated overall rates of trapping of directly and indirectly produced Λ° hyperons

(Λ_d = directly produced Λ° hyperons; Λ_i = indirectly produced Λ° hyperons)

Nucleus	Location of initial K⁻ interaction	Rate of Λ° trapping (%)						
		from single nucleon capture			from two nucleon captures			combined results (80% single nucleon capture + 20% two nucleon capture)
		Λ_d	Λ_i	Total ($\Lambda_d + \Lambda_i$)	Λ_d	Λ_i	Total ($\Lambda_d + \Lambda_i$)	
Carbon	(0—10)% density region	24	76	33	39	61	22	31.0
	(0—25)% density region	29	71	39	40	60	24	36.0
	nuclear volume	32	68	60	44	56	36	55.0
Bromine	(0—10)% density region	28	72	40	43	57	22	36.0
	(0—25)% density region	29	71	50	47	53	30	46.0
	nuclear volume	30	70	83	48	52	48	76.0
Silver	(0—10)% density region	33	67	39	42	58	32	38.0
	(0—25)% density region	34	66	48	50	50	33	45.0
	nuclear volume	35	65	84	50	50	45	76.0

the percentages of all the Λ° hyperons (without making any distinction between Λ_d and Λ_i) trapped in the light and heavy nuclei are determined separately for single and two nucleon K⁻ captured. These are presented in columns 5 and 8 of Table 4. Then the fractions of Λ_d and Λ_i are found contributin to these percentages: i. e., for carbon the overall trapping rate of Λ° hyperons for **RI** is 33 % (see top line, column 5, Table 4). This means that 33 % of all Λ° hyperons $\Lambda_d + \Lambda_i$ are trapped, of which 24 % are Λ_d and 76 % Λ_i. The figures given in Tables 2 and 3 indicate the percentages of trapped Λ_d and Λ_i, which are, therefore, different from the figures given in Table 4. In the last column of this Table, the combined results of single and two nucleon K⁻ captures are given (columns 5 and 8), combined in the ratio of 80 : 20.

The overall calculated rates of the Λ° trapping are broadly similar for all nuclei for **RI** and **RII** (those for **RII** are somewhat higher but the difference is small): however, these increase sharply for **RIII** (see last column, Tab. 4). This feature can be used to examine the validity of the peripheral absorption hypothesis of K⁻mesons and will be further discussed in Sect. III. 3 A comparison between these rates and the experimentally estimted rates (see column 1, Table 1) of the Λ° trapping can be made:

(*a*) The calculated rates for **RIII** are much higher than the experimental rates: for further comparison, therefore, we consider the calculated rates for **RII** only.

(*b*) The calculated rates for light nuclei are lower than those for neavy nuclei but the difference is not as larga as ti the corresponding experimental rates.

(*c*) For light nuclei, the calculated rates are higher than the experimental rates while for heavy nuclei the calculated rates are in fair agreement with some experimental rates, t. g., with those given by Lemonne et al. [8], Knight et al. [9], [12] and Barth et al. [16].

Martin's calculations [20] indicate that the rate of the Λ° trapping following the K⁻ capture in silver is ~ 18 % while for a nucleus with $A = 100$, $Z = 40$, the trapping rate is (15—30)%. It may, however, be pointed out that Martin chose the Λ° potential well depth as 25 MeV (our choice is 32 MeV) and the ΛN scattering cross-section as 22.3 mb, while we use the cross-section estimated experimentally by Sechi-Zorn et atl. [21].

III. 2. Rates of the HF and CF formation

The rates of the HF and CF formation following single and two nucleon K⁻ captures, their combined results obtained for the nuclear emuslion as a whole are presented in Table 5.

Table 5

Calculated rates of HF and CF production folllwing K⁻ captures

Nucleus	Location of initial K⁻ interaction	Single nucleon captures		Two nucleon captures		Combined results (80% single nucleon + 20% two nucleon) captures		Combined (40% light + 60% hevy nuclei rerults)	
		HF	CF	HF	CF	HF	CF	HF	CF
Carbon	(0—10)% density region	33	—	22	—	31.0	—	12.0	—
	(0—25)% density region	39	—	24	—	36.0	—	14.0	—
	nuclear volume	60	—	36	—	55.0	—	22.0	—
Bromine	(0—10)% density region	13	27	18	4	14.0	22.0	8.0	13.0
	(0—25)% density region	13	37	24	6	15.0	31.0	9.0	19.0
	nuclear volume	41	42	37	11	41.0	35.0	25.0	21.0
Silver	(0—10)% density region	12	27	25	7	15.0	23.0	9.0	14.0
	(0—25)% density region	16	32	26	7	18.0	27.0	11.0	16.0
	nuclear volume	47	37	37	8	45.0	31.0	27.0	19.0

III. 2. 1 HFs and CFs produced from a single nucleon K⁻ capture

Single nucleon K⁻ captures in the light nuclei produce only HFs while such captures in the heavy nuclei result in the production of HFs as well as CFs, the rate of production of the latter being about twice that of the former for RI and RII and about the same for RIII (see columns 3 and 4, Tab. 5). It seems that the outgoing particles are often not able to impart a sufficient momentum to the heavy nuclei in which the Λ° hyperons are trapped in RI and RII and consequently, for these more CFs than HFs are produced. Due to the larger probability of absortpion of particles in RIII, the nuclear evaporation is likely to be more effective in reducing the mass of the heavy nuclei than it is in the case for RI and RII. The result is that in this case the rate of the HF formation increases and becomes about the same as that of the CF formation.

The rates of the HF production for RII are slightly higher than those for RI but the difference is small for all nuclei. The corresponding rates are much higher for RIII. Thus, the production rate of HF increases from 33 % for RI to 60 % for RIII in the case of the light nuclei and from 12 % to (35—40)% in that of the heavy nuclei. The corresponding increase in the production rate of CFs (which are produced from heavy nuclei only) is from 24 % to 40 %. The very high rates of the HF formation for RIII can be used as an indication that K⁻ mesons are not likely to be absorbed deeper inside the nucleus (see Sect. III. 3).

III. 2. 2. HFs and CFs produced from two nucleon K⁻ captures

The present calculations indicate that while in the case of single nucleon K⁻ captures, ~ 30 % HFs are produced from the trapping of Λ_d and the rest from that of Λ_i, in the case of two nucleon K⁻ captures, the trappings of Λ_d and Λ_i contribute almost equally to the formation of the HFs. As seen from columns 5 and 6 of Tab. 5, the rates of the GF production from a two nucleon capture of K⁻ mesons are similar for RI and RII but much larger for RIII. Such captures also produce only HFs from the light nuclei but HFs as well as CFs from the heavy nuclei. It is notworthy that while the single nucleon K⁻ captures in heavy nuclei produce a higher percentage of CFs as compared to that of HFs, the situation is reversed in the case of two nucleon K⁻ captures which produce a relatively much larger percentage of HFs as compared to that of CFs: this is, indeed, as it should be, since a larger Q-value of two nucleon captures results in the creation of relatively faster particles which eventually becomes directly (if amitted) or indirectly (if absorbed after sharing energy with other particles) the cause of imparting a larger momentum to the HFs.

III. 2. 3. Single and two nucleon K⁻ captures — combined results

The rates of the HF and CF production obtained from single and two nucleon K⁻ captures are now combined in a 80 : 20 ratio and presented in columns 7 and 8 of Table 5.

The HF production rates vary from ~ 31 % to ~ 36 % for the light and from ~ 14 % to ~ 19 % for the heavy nuclei for RI and RII: the corresponding rates for RIII are much higher. In this respect, the results for the CF production rates are different, and increase also from RI to RII and RIII but rates for RIII are not much higher than those for RI and RII.

While nearly the same percentage of single nucleon K⁻ captures results, as mentioned in Sect. III. 1. 3, in the trapping of Λ° hyperons as in that of the two nucleon K⁻ captures, a larger percentage of trapped Λ° hyperons produced from the latter source results in the production of HFs in the case of light nuclei: the situation is reversed when heavy nuclei are considered (see columns 3 and 5). For carbon (RI), the total HF production rate, 31.0 %, (column 7) comprises a contribution of ~ 86 % from the single nucleon, and ~ 14 % from the two nucleon K⁻ capture results (i.e., 80 % of single nucleon and 20 % of two nucleon HF production rates are 26.4 % and 4.4 %, which are, respectively, ~ 86 % and ~ 14 14 % of 31.0 %); in the case of heavy nuclei, the percentage of HFs produced from the two nucleon K⁻ captures is larger, e.g., for bromine, RI, the HF production rate, 14 %, gets a ~ 67 % contribution from the single nucleon and a ~ 33 % one from the two nucleon HF production rates. The CFs are overwhemingly produced from signle nucleon captures: thus, for bromine, RI, ~ 93 % CFs out of 22.0 % are produced from single nucleon captures. These results are different from the observation of Gorge et al. [3] according to whom the HF prodcution rates are similar from the single and two nucleon K⁻ captures.

III. 2. 4. Results for nuclear emulsion

The last two columns of Table 5 contain the rates of the HF and CF formation obtained for the nuclear emulsion as a whole on the assumption that results in nitrogen and oxygen are similar to those in carbon and also that 40 % of K⁻ captures occur in the light and 60 % in the heavy emulsion nuclei [22].

In view of the improbability of occurence of a K⁻ capture in nuclear volume (see Sect. III. 3), we consider here only the results for RI and RII. Thus, the rate of the HF formation is estimated to be (12—14) % for the light and ~ 10 % for the heavy nuclei. From the light nuclei only the HFs while from the heavy nuclei HFs as well as CFs are produced. The production of HFs from heavy nuclei was not detected in the early emusion studies [4], as the range of heavy HFs is very short, usually less than 3 μm. Our results agree with the observation of Knight et al. [9] that CFs are generally produced from K$^-$ captures in the heavy nuclei. The calculated results are also in agreement with those of Lemonne et al. [8], i.e., that the light and heavy nuclei contribute about equally to the production of the spallation HFs: our results show, as already mentioned, that ~ (12—14) % HFs are produced from the light and ~ 10 % from the heavy nuclei.

The experimentally estimated rates of the HF and CF production are given in columns 2 and 3 of Table 1. The experimental rates of the HF formation are lower than the calculated ones but the situation is different in the case of the rate of the CF formation. The rate estimated by the K$^-$ European Collaboration [2] and, Davis et al. [4] are higher than the calculated rates, while those of Cester et al. [6] and Filipkowski et al. [7] could be regarded as nearer to our results. As discussed in Sect. 1, this situation might be the consequence of the procedure followed in the nuclear emulsion to estimate the trapping of Λ° hyperons. It may also be pointed out that the criteria used to separate the K$^-$ captures on the light nuclei from those of the heavy ones in nuclear emulsion are not considered adequate [23]. It is, therefore, possible that the experimentally estimated rates of the HF and CF formation in the light and the heavy nuclei are, to some extent, mixed. Further, the experimental estimates refer either to the rate of the Λ° trapping or of the CF formation in the case of heavy nuclei, though HFs are also produced from such nuclei. An estimate of the rate of formation of heavy HFs(~ 10 %) is presented for the first time in this work.

III. 3. Peripheral absorption of K$^-$ mesons

The calculated rates of the Λ° trapping for RIII (last column, Table 4) are much higher than the experimental rates of the Λ° trapping for all nuclei. Similarly, the rates of the HF formation for RIII are much higher than the corresponding experimental rates. The calculated rates of the Λ° trapping as well as of the HF formation for RI and RII are closer to the experimental results. On the basis of these results, one might infer that the volume absorption of the K$^-$ mesons is very improbable. In view of the similarity of the results for RI and RII, the only possible inference is that the K$^-$ mesons are absorbed on the nuclear periphery, perhaps, with the (0—25) % density region.

IV. CONCLUSION

(*i*) The rates of the Λ° trapping in the light nuclei vary from ~ 31 % to 36 % and in the heavy nuclei from 35 % to 45 %, depending on whether the K$^-$ capture occurs in the (0—10) % or the (0—25) % density region of the nuclear matter.

(*ii*) The rates of production of HFs from the light and the heavy nuclei are about (12—14) % and 10 %, respectively.

(*iii*) Only HFs are produced from the light nuclei, while both HFs and CFs are produced from the heavy nuclei. The CF formation rates are ~ 13 % if the K$^-$ capture occurs in the (0—10) % density region of the nuclear matter and ~ 16 % if the capture occurs in the (0—25) % density region of the nuclear matter.

(*iv*) The K$^-$ mesons are absorbed in the (0—25) % density region of the nuclear matter.

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