FLUCTUATION OF THE DECAY PRODUCTS FROM UNTABLE SYSTEM

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bstract: *A fluctuation of decay products of radioactive isotopes was studied theoretically ıd experimentally on the example of ^{52}V. It was recommended to use for interpretation : data processing especially in the low-level counting.*

Introduction

It is very difficult to make general statement on the accuracy of available data as ıcertainties vary depending on a number of factors, especially the historical importance data. Nevertheless, the question is sufficiently relevant to justify some comment, but it ust be emphasized that the uncertainties quoted are mainly guidelines and the situation r particular nuclide interactions may be different.

The nuclear data in the evaluated files can be divided in two broad categories:

(a) One for which experimental measurements exist, and

(b) One for which measured data are scare, or not available.

In case (a), the uncertainties in the data are related to uncertainties in the measure-ents and each case has to be considered individually. In (b), theoretical models must be ;ed to provide the required values and in this case it is possible to make some general ımments on achievable accuracies.

The follow level radiation measurements usually relate to decay products of the ɔtopes with very long half-lives and the measured data are really scare.

The present work is aimed at consideration of possible fluctuation of the decay prod-:ts related to non-exponential components and distribution of which probably influences ı accuracy of measured data.

The vanadium-52 was taken for example for the study.

Decay of an unstable system

The behavior of a system consisting of a large number of particles is governed by .e statistical laws, which differ from the laws obeyed by each of the particles making up .e macroscopic system. The behaviors of a single particle turn out to be in significant a statistical description. Hence the study of the properties of a system is reduced to

a determination of average values of the physical quantities that characterize the stat the system as a whole.

The state of an unstable system can be attained with a non-undergoing decay pr bility that the unstable system is in non-undergoing decay state coincides with probab that the quantity of non-undergoing decay nuclei at moment will take value $N(t)$. If r the total number of non-undergoing decay nuclei at moment $t = 0$, then probability will defined as /1-4/

$$L = e^{\frac{t}{\tau}} \left[1 + \alpha \sin \frac{\beta t}{\tau}\right],$$

where τ is lifetime of the decaying system, α and β are the amplitude and freque respectively, of the non-exponential contribution to the decay process.

3. Kinetic function of the non-undergoing decay probability

In the simple form, the kinetic function of the non-undergoing decay probabilit given as

$$S(ti, l) = \frac{\int_{ti}^{ti+l} L(t)dt}{\int_{ti+l}^{ti+2l} L(t)dt},$$

where t_i is the given moment of the observation and l is the magnitude of the time bi be searched.

In the case of pure exponential decay is was shown that

$$S(ti, l) = S(t, l) = Se(l) = e^{\frac{l}{\tau}},$$

where $Se(l)$ is the kinetic function of pure exponential decay.

The deviation from decay with maximum probability could be found by follow expression

$$\Delta S = \frac{S - S_{\max}}{S},$$

where ΔS is fluctuation of kinetic function.

Essential of the kinetic function is a comparison of the decay products in a gi time bin l with that in the same time bin next to it. In other works, the kinetic func is the ratio of non-decay probability at contiguous time bins. In principle, the kin function $S(ti, l)$ is the ratio of the decay probabilities also.

It is clear that the decay with maximal probability must be consider as a pro which determined by the smallest fluctuation ΔS. So that the state of undergoing de system is characterized by a certain variable S, the probability of small fluctuations a result of which variable S may vary in the range from S to $S + dS$, is expressed b kinetic function distribution.

Let consider a distribution of the decay probability in the form of kinetic functions example of ^{52}V.

Distribution of the decay probabilities of ^{52}V

The isotope ^{52}V was produced by reaction $^{52}Cr(n,p)^{52}V$ with 14MeV neutrons. nediately after irradiation the samples were transfered to $Ge(Hp)$ detector to record ıma rays of 1.434 MeV in multiscaling mode by multichanel analyzer. Timing data were en is different duration time bins. The acquired data were processed with computer by kinetic function method (5). Fig(1) shows the fluctuation of decay products of ^{52}V. he form of kinetic functions.

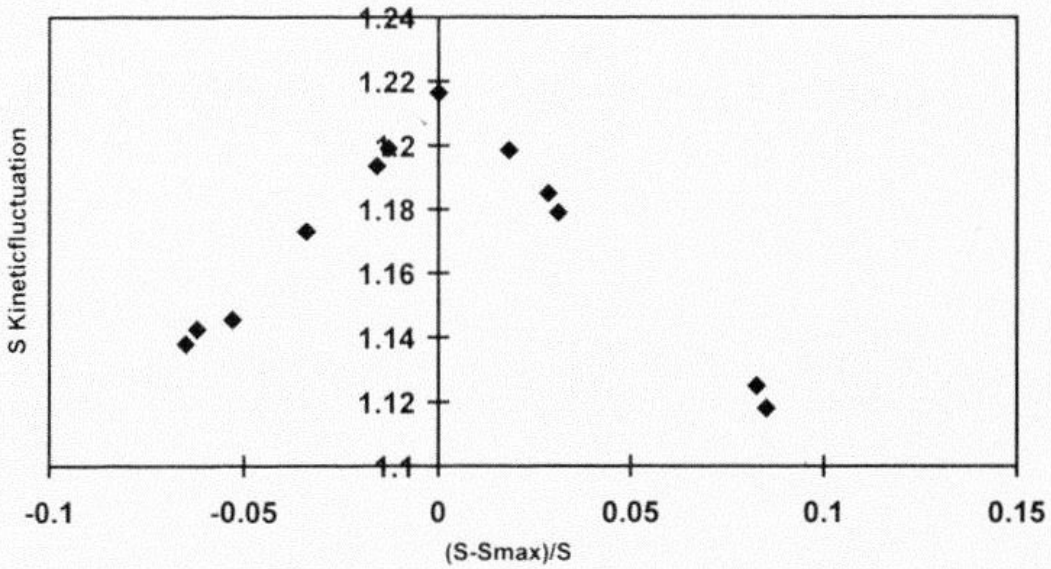

Fig 1. Typical time distribution of the decay products of ^{52}V.

Because the kinetic function is continuously changing, it is necessary to deal, not h long time in compare with the moment of creation of the given isotope. In other side elates also to decay product of the other isotopes in the surrounding medium, which e a very long half-lives. The variation of these products is introduced in Table 1, where exponential feature is not clear. In the table, the experiment date of decay products ^{2}V. at very long time after irradiation (number channel 151 is equivalent to 1890s) is ally considered as background.

Conclusion

The fluctuation of the experimental data have a statistical behavior of a system on basis of molecular - kinetic concepts and the method of mathematical statistics. On modern concepts of nuclear physics it probably concerns with non-exponential effects ch ere characterized by radioactive decays and must be corrected fairly.

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Table 1: Gamma rays of 1.434 MeV in decay of ^{56}V

Number Channel	Counts per channel time bin l=10s				
(1)	(2)	(3)	(4)	(5)	(6)
151	12	15	6	11	11
156	10	7	10	5	12
161	8	12	7	3	6
166	5	8	14	3	3
171	4	7	10	6	3
176	5	11	5	4	3
181	11	5	8	5	6
186	5	1	5	1	5
191	2	2	1	4	2
196	1	4	4	2	4
201	5	2	4	2	2
206	2	2	2	2	3
211	0	0	2	0	1
216	2	2	1	0	2
221	3	1	3	1	0
226	1	2	2	2	1
231	3	1	3	2	0
236	1	0	1	1	0
241	0	1	0	3	2
246	1	0	1	1	3
251	0	0	1	0	1
256	2	0	1	0	1
261	1	0	0	0	1
266	1	2	0	0	0
271	1	0	0	0	2
276	1	0	0	0	0
281	0	1	0	0	2
286	0	1	0	0	1
291	0	0	0	1	1
296	0	1	0	0	0
301	0	0	0	0	0
306	1	0	2	0	0
311	0	0	0	0	0
316	1	0	1	0	1
321	2	1	0	1	0
326	0	1	0	0	1
331	0	0	0	0	0
336	0	0	0	1	1
341	0	0	0	0	0
346	1	1	0	0	0
351	0	0	0	0	0
356	0	1	0	0	0
361	0	0	1	0	0
366	0	1	0	0	0
371	0	0	0	0	0
376	0	0	1	0	0
381	0	0	0	0	0
386	0	0	0	0	0
391	0	0	0	0	0
396	0	1	1	0	0
401	0	0	0	0	0
406	0	0	1	0	0
411	0	0	0	0	1
416	1	0	0	0	0
421	0	1	0	0	0

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THĂNG GIÁNG CÁC SẢN PHẨM PHÂN RÃ CỦA MỘT HỆ KHÔNG BỀN

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