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Discussions about whether radioactive half life can be changed by mechanic motion

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In this essay, some discussions and comments about the paper entitled "Can the decay rate of ^{32}P be changed by mechanic motion?" (Ding et al., Science in China Series B: Chemistry (Chinese version), 2008, 38(11):1035－1037) are given. It was strongly suggested that its experimental methods, data calculations and conclusion should be reconsidered. After the data were recalculated, the new results supported that the chiral mechanic motion could induce the changes of radioactive half life.

circular rotation, radioactive decay, half life, chirality

1 Introduction

It is interesting to see if the external factors can affect the radioactive decay. In general, there are no influences of physical and chemical factors on it. However, it was found that there were effects (< or = 1.5%) of external factors (e.g. pressure and chemical form) on the decay rate[1−3]. In our previous work, there was marked effect of chiral mechanic motion (force) on the radioactive decay rate[4].

Ding and his coworkers critically tested and verified our work[5,6]. Generally, to check whether one experimental result is right or not, it is necessary to use the same materials and follow the same methods. In fact, the experimental methods in ref. [4] were very different from those in refs. [5,6]. The experimental method, data and calculation in refs. [5,6] were questionable. Interestingly, after the data of refs. [5,6] were recalculated, the new results supported the conclusion of ref. [4].

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2 Comments on materials and methods of refs. [5,6]

(1) It is well known that to arrive at right conclusion, besides the factors to be studied, the experimental conditions should be the same as the control ones. In ref. [5,6], the half life of sample B was obtained from the decay curve consisting of 8 different B samples at different time, but the half life of control sample A was obtained from the decay curve consisting of one A sample at different time, resulting in that two decay curves were not comparable to each other. This is one of the biggest differences between the methods of refs. [5,6] and method of ref. [4].

Moreover, considering the statistic feature of radio-decay, 8 points in decay curve in refs. [5,6] may be too less to work out a believable half life, which may result in a larger error.

(2) The samples were solid in ref. [4] but liquid in refs. [5,6], and the scintillation fluid was required, which might make experimental error since there are more experimental processes. Liquid samples would also be af-

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fected by the errors of temperature, volume and stability of scintillation fluid, and so on. It was also noted that the scintillation fluid was added to sample A before running, and to sample B after running, which would result in the new experimental difference between samples A and B.

(3) Ref. [5] elaborates that the rotor of centrifuge was exposed in air so as to ensure the temperature and humidity of sample B are the same as those of sample A. As we know well, the regular centrifuge without temperature controllable function would change its body temperature after running for dozens of minutes, and it would be changed much after running for 47—647 h. Since there exist differences of temperature and humidity between samples A and B, the quenching effect of temperature on the scintillation fluid would cause the large radioactive counts error to result in that sample B was not comparable to sample A[7].

(4) In refs. [5,6], the sample purity was not shown and determined. In ref. [4], the sample nuclear purity was 99.9%. And it was not described how the error maybe caused by the sample tube position in the radioactive counter was eliminated or decreased in refs. [5,6].

(5) Ref. [4] illustrates that the effect of the circular mechanic rotation on radioactive half life can be explained by the chiral helical motion. When the chiral force was the natural Earth's orbital chirality force, its rhythms may be transferred to radioactive decay. It has been indicated that there were circadian rhythms in Co-60 decay, etc.[8−10]. This supported the existence of natural chiral force and the results in ref. [4]. The natural polar vector caused by Earth in Washington DC (USA) is different from that in Beijing (China). This would make the chiral effects different in Beijing and Washington when the axial vector is the same, respectively. This is one of the differences between refs. [5,6] and ref. [4].

In summary, there were obvious differences in experimental materials and methods between refs. [5,6] and ref. [4]. There were more experimental errors in refs. [5,6] than in ref. [4]. And, there were different experimental methods and conditions between sample B and control A, which would make the data incomparable and the conclusion unreliable.

3 Analyses and discussion of data of refs. [5,6]

It was noted that the same experiment was depicted in ref. [5] and presented on P36—37 of the Abstract of 8th Seminar on Nuclear Chemistry and Radiochemistry held on August 19—25, 2007, sponsored by Chapter of Nuclear Chemistry and Radiochemistry of the Chinese Nuclear Society, in Ürümqi, Xinjiang. Generally, the original experimental data should be the same for the same experiments, independent of publication media. Analyses and discussions of the data of refs. [5,6] are as follows:

(1) In ref. [5], A_2 was 49.93 mg in Section 1.1, ^{32}P samples, but 49.90 mg in Table 1. This was confusing.

(2) In Table 1 of ref. [6], A_3 was 100.27 mg, and the radioactive count was 1120495/min at 9:04 of 5/24/2007, its specific activity (Bq/mg) should be 186.25 other than 189.59. Thus, in Table 2 of ref. [6], sample B_1 after acting on by 47.18 h circular motion, its activity 189.17 Bq/mg was larger than 188.38 of A_1 and 186.25 of A_3, respectively. This indicated that sample B_1 in anticlockwise circular rotation had lower decay rate than control samples A_1 and A_3 in natural condition, respectively. After calculation, the half life of B_1 was larger than A_1 and A_3 at ~5%, close to that (4.34%) of ref. [4], i.e. the (chiral) mechanic motion can affect the radioactive decay.

However, in ref. [5], 100.27 mg of A_3 in ref. [6] was changed into 98.50 mg. Also in ref. [5], at 9:04 on 5/24/2007, A_3 was 1120495/min in Table 2, but 1112399/min in Table 4. It was so confusing that the mass and radioactive count of A_3 in ref. [5] were completely different from those in ref. [6] at 9:04 on 5/24/2007.

(3) Even taking the A_3 for 98.50 mg, according to Table 2 of ref. [6], the corresponding counts would be obtained. However, they were different from those in Table 4 of ref. [5] though they should be the same (Table 1). The maximum difference is at 0.95%, being larger than the uncertainty 0.6% in ref. [5]. Thus, it is interesting how the uncertainty 0.6% was obtained in ref. [5]. If taking the A_3 for 100.27 mg to calculate the corresponding counts, they did not match each other either in refs. [5] and [6] (data not shown here).

(4) Ding et al. in Section 2.3.2 of ref. [5] showed that $\ln A_0$ of specific activity of A_3 and A_1 was 5.3396 and 6.0187 at $T = 0$, respectively. In other words, the specific activity of A_3 and A_1 was 208.429 and 411.044 Bq/mg at $T = 0$, respectively. They were two control samples made from the same solution, there should be the same or

Table 1 Recalculations of the sample A_3 counts

Experimental time (h)	Activity in ref. [6] ($Bq \cdot mg^{-1}$)	If A_3=98.50 mg , counts in ref. [6] (min^{-1})	Counts in ref.[5] (min^{-1})	Counts difference (%)
47.18	189.59	1120477	1112399	0.73
143.32	155.59	919537	915395	0.45
244.45	126.47	747438	743803	0.49
311.03	110.69	654178	650460	0.57
407.85	90.87	537042	534818	0.42
479.03	78.55	464231	463673	0.12
575.15	64.55	381491	379401	0.55
647.10	55.90	330369	327270	0.95

Table 2 The normalization of specific activity (Bq/mg) of sample A_3 (98.50 mg)

Samples B ($Bq \cdot mg^{-1}$)	Normalization time	A_3 determination time	Time difference of normalization (h)	In ref.[5], A_3 counts (min^{-1})	In ref.[5], un-normalized A_3 specific activity	Renormalized A_3 specific activity	In ref.[5], normalized A_3 specific activity	Difference between both normalizations (%)
189.17	9:01 24/5/2007	9:04 24/5/2007	−0.050	1112399	188.22	188.24	189.61	0.72
155.57	9:09 28/5/2007	9:15 28/5/2007	−0.100	915395	154.89	154.92	155.62	0.45
126.41	14:17 1/6/2007	14:25 1/6/2007	−0.133	743803	125.85	125.89	126.51	0.49
110.53	8:52 4/6/2007	9:01 4/6/2007	−0.150	650460	110.06	110.09	110.73	0.57
90.59	9:41 8/6/2007	9:52 8/6/2007	−0.183	534818	90.49	90.53	90.90	0.41
78.22	8:52 11/6/2007	9:04 11/6/2007	−0.200	463673	78.46	78.49	78.58	0.12
64.59	8:59 15/6/2007	9:14 15/6/2007	−0.250	379401	64.20	64.23	64.58	0.54
55.57	8:56 18/6/2007	9:12 18/6/2007	−0.267	327270	55.38	55.41	55.93	0.94

close specific activity at the same time, but their difference was 97.2%, but why?

(5) The goal of refs. [5,6] was to see if there is half life difference between samples A and B. But, the activity of sample A was normalized with a literature half life (14.262 d), and this would affect the reality of experimental half life. In fact, it should be simpler and better if the activity was normalized with real time and counts.

Even if sample A_3 could be normalized like that in ref. [5], it was still surprising that there were data calculation errors (Table 2). The maximum was 0.94%, larger than 0.6% uncertainty of ref. [5]. According to Table 2, in fact, after recalculation, there usually was higher specific activity in samples B than corresponding control sample A. Interestingly, it supported the conclusion in ref. [4] other than the conclusions in refs. [5,6], i.e. the (chiral) mechanic motion can affect the radioactive decay.

Nuclear decay follows statistic rule, and the half life would be more reliable if there are more data points in decay curve. In refs. [5,6], there were only 8 data points in decay curve, and a small change in data or error might result in a bigger calculation error or even opposite conclusion. Thus, the accuracy of each datum is so important.

In summary, the changes and calculations of some original data in refs.[5,6] should be reconsidered.

4 Recalculations of data of refs. [5,6]

In refs. [5,6], the P-32 half life was obtained from decay curve consisting of 8 different sample B counts at different circular rotation time, being different from sample A. Relative to the starting time (T = 0), the half life of each sample B (total 8 B samples) was recalculated at different rotation time to get 8 half lives in order to make it comparable and more accurate.

According to the above discussion, control A_1 activity at T = 0 (2007.5.22, 9:50AM), 411.044 Bq/mg, was obviously unreasonable. Thus, the A_3 was used as the control in the following recalculations. According to ref. [5], the specific activity of solution I was 408.5 Bq/mg

Table 3 Recalculation of half life of sample B

B #	Running time (h)	Activity ($Bq\cdot mg^{-1}$)	Decay equation	$T_{1/2}$ (d)	Compared with control A_3 14.156 d (%)
B_0	0	207.63			
B_1	47.18	189.17	$y = 207.629800\exp(-0.001974x)$	14.631	3.35
B_2	143.32	155.57	$y = 207.629800\exp(-0.002014x)$	14.340	1.30
B_3	244.45	126.41	$y = 207.629800\exp(-0.002030x)$	14.227	0.50
B_4	311.03	110.53	$y = 207.629800\exp(-0.002027x)$	14.248	0.65
B_5	407.85	90.59	$y = 207.629800\exp(-0.002034x)$	14.199	0.31
B_6	479.03	78.22	$y = 207.629800\exp(-0.002038x)$	14.171	0.11
B_7	575.15	64.59	$y = 207.629800\exp(-0.002030x)$	14.227	0.50
B_8	647.10	55.57	$y = 207.629800\exp(-0.002037x)$	14.178	0.16
Average				14.278	0.86

(2007.5.8, 14:06), and A_3 half life was 14.156 d (decay constant for 0.00204), so at 9:50AM of 2007.5.22 (T = 331.733 h) when circular rotation began, sample B activity should be $\ln B = \ln(408.5) - 0.00204 \times 331.733$, B = 207.63 Bq/mg. In other words, all 8 B samples should have their specific activity at 207.63 Bq/mg at circular rotation starting time (9:50 on 5/22/2007). According to the B activity and decay equation after circular rotation for different time, 8 half lives were obtained from 8 B samples (Table 3).

Table 3 shows that anticlockwise circular rotation increased the half life of P-32 from 0.11% to 3.35% depending on rotation time. The average was 0.86% > 0.6% (uncertainty of ref. [5]). Compared with the control A_3, sample B_1 half life increased by 3.35%, being close to 4.34% of ref. [4] anticlockwise (4000 r/min).

Table 3 also shows that the half life tended to decrease when rotation time increased, strongly implying that there might be some systemic experimental errors (e.g. temperature effect) in ref. [5].

In summary, when the data of ref. [5] were recalculated, interestingly, the new result supported the conclusion of ref. [4].

5 Some discussion about Rutherford's and Freed's work[11,12]

E. Rutherford's work[11] and S. Freed's work[12] were mentioned in ref. [5]. In refs. [11,12], like in ref. [4], the centrifugal force produced by circular rotation is gravity, which was focused on whether there is some direct relationships between gravity and weak force in decay. However, refs. [11,12] focused on only the achiral centrifugal force, but ref. [4] explored the chiral centrifugal force produced by chiral mechanic rotation. There is obvious difference between the two ideas.

S. Freed et al. thought that there was no effect of circular rotation on radioactive decay at their experimental error (0.1%)[12]. However, it should be noted that the nuclear decay follows statistics. Besides other errors, there is an important error that should not be ignored, it is the $1/\sqrt{N}$ uncertainty error in radioactive count determination. In Table 1 of ref. [12], the initial counts were 60—1489/min, and the determination errors by $1/\sqrt{N}$ were 2.59%—12.9%. After circular rotation, the counts were 9—224/min, and the determination errors by $1/\sqrt{N}$ were 6.68%—33.3%. Because of the limitation in radioactive detection technique, there was lower count with larger radioactive determination error in the early 20th century. But, besides the other errors, the relative determination error $1/\sqrt{N}$ should not be ignored in total experimental errors.

In Table 1 of ref. [12], comparing the literature and observed half lives, there were several percent changes. For example, in Cl-38, its literature and observed half lives were 37.40 min and 39.1 min, respectively, and there was difference of 4.55%. However, within determination error 2.59%—33.3%, it was difficult to make a confirm conclusion.

6 Summary

According to the above analyses and recalculations, it was suggested that the materials and methods, as well as data calculation and conclusions in refs. [5,6] should be reconsidered. In fact, the new result from the recalculations of data of refs. [5,6] supported the conclusion of ref. [4], i.e. chiral mechanic motion could change the radioactive decay rate.

Of course, even if the conclusions of refs. [5,6] were wrong, it does not mean that ref. [4] was surely right. It is a new idea that the radioactive decay rate may be affected by chiral mechanic motion (force). Indeed, it should be strictly further tested in both theory and experiment.

To focus on whether the chiral gravity produced by chiral mechanic circular motion can affect the nuclear decay rate or not[4] would be helpful to exploring the basic scientific relationships between gravity and weak force[11].

7 Extra notes

Based on original experimental data and serious calculations, any critical comments and discussions about our work[4] are welcomed.

When this essay was almost finished, it was found that some data and information in ref. [5] (Chinese edition) were changed/corrected again in ref. [13] (English edition) for the same experiment, which supports our above corresponding comments on ref. [5].

(1) In Table 1 of ref. [13], the A_2 mass was changed/corrected from 49.90 to 49.93 mg.

(2) In ref. [13], A_1 decay equation was changed into $\ln A = (5.3393\pm0.0023)-(2.040\pm0.0056)\times10^{-3}\ t$, $T_{1/2} = (339.78 \pm 0.93)$ h$=(14.156 \pm 0.039)$ d.

However, according to A_1 data of ref. [13], the decay equation of A_1 should be $A = 207.753177 \times \exp(-0.002028\ t)$, $\ln A = 5.3364-0.002028\ t$, $T_{1/2}=14.241$ d, other than 14.156 d of ref. [13].

(3) In ref. [13], all 8 A_3 counts in Table 4 of ref. [5] were changed, the maximum change rate is 0.94% (Table 4).

Table 4 Changes of A_3 radioactive counts between ref. [13] and ref. [5]

Experimental time	Counts in ref. [13] (min^{-1})	Counts in ref. [5] (min^{-1})	Changes of counts (%)
9:04 24/5/2007	1120495	1112399	0.73
9:15 28/5/2007	919542	915395	0.45
14:25 1/6/2007	747444	743803	0.49
9:01 4/6/2007	654197	650460	0.57
9:52 8/6/2007	537023	534818	0.41
9:04 11/6/2007	464221	463673	0.12
9:14 15/6/2007	381468	379401	0.54
9:12 18/6/2007	330348	327270	0.94

However, according to the new A_3 data of ref. [13], the new decay equation of A_3 should be $A = 208.42827645 \times \exp(-0.00203536\ t)$, $\ln A = 5.3396 - 0.00203536\ t$, $T_{1/2} = 14.190$ d, other than 14.156 d of ref. [13].

Moreover, although all 8 A_3 counts in Table 4 of ref. [5] were changed into these in ref. [13] to match the A_3 activity in ref. [6], the ref. [13] has not clarified why the mass of A_3 was changed from 100.27 mg in ref.[6] to 98.50 mg in refs. [5,13]. As we know, the mass is so important for radioactive activity.

It is so confusing and surprising why some data were changed/corrected from ref. [6] to ref. [5], then to ref. [13], and the decay equations of samples A_1 and A_3 in ref. [13] were still questionable. Because of the data uncertainty of refs [5,6,13] for the same experiment, we don't think it is interesting to have further academic discussions about refs. [5,6,13].

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