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# How Element Changes Proceed with Nuclear Transmutation by Pairs of Electron and Proton in Hydrogen Atom of Water

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## Abstract

We have experienced reduced radioactivity in contaminated soils in Fukushima since 2011 using specially processed water. The results indicated a drastic decrease in radioactivity by changing the radioactive cesium to stable barium without applying substantial energy. We repeated our experiments using water decontamination on Fukushima farms. On the base decontamination evidences, our research presents new insights into applying high pressure (> 100 MPa) to seawater at various locations in the Pacific Ocean. We found element changes by chemical analyses of elements in the seawater to compare them before and after the high-pressure process. Water may form a presumed particle after the dissociation of hydrogen bonds by 147 MPa. Then, we discuss the theoretical viewpoints that element changes occur with the weak energy due to pair of electron and proton in hydrogen atom of water. This work involves the behavior of a proton and an electron pair, and we focus on their nuclear spins. We develop the conversion of sodium to magnesium, cesium, and barium with the presumed particles.

***Keywords:*** nuclear spin; proton and electron; element change; water hydrogen bonds; weak energy of water

## Introduction

We often experienced a reduction in radioactivity ($79.6 \times 10^4$ to $25\times 10^4$ Bq/kg for less than one year) in contaminated soils with specially processed water introduced later. Since then, studies in different areas have been repeated. We processed the reduction of radioactivity in water from soils contaminated by the Fukushima nuclear power plant disaster [1]. We analyzed non-radioactive stable elements such as barium, lanthanum, and cerium and compared them with the usual elements of the soils in 2011-2016. Typically, they focused on studies related to nuclear mutation reactions with high energy, such as keV [2, 3].

Furthermore, Cs and Pr were detected after treatment with $H_2O$ or $D_2O$ on a Pd film (CaO) [3], Ni coating [4], and alkali metal ions [5]. In other research, tritium generation and large excess heat evolution by electrolysis have been reported [6]. One fusion technology reported anomalous reactions between carbon rods in highly purified water [7]. Electrolytic tritium production using high-density hydrogen isotopes [8]. Several thousand technical papers have been published in this area from the 1990s through the early 2000s, known as cold fusion, low-energy nuclear transmutation, or chemically assisted nuclear reactions. An XeCl excimer laser was used [9]. In addition to these nuclear fusion issues, there has been a little different view research, namely, it was another field of superconductors, (Nd, Sr) $NiO_2$ with a pairing of electrons [10]. The other was the H-bond in the oxygen and zinc vacancies of ZnO films, which they did not discuss with spin [11]. Another study reported the spin-orbit interaction, but it was in a metal [12].

We have known many claims for cold fusion for an extended period since Fleischmann and Pons published the nuclear fusion of deuterium in 1989 [13], an unlikely explanation for the excess heat. As far as a nucleus is concerned, we must discuss another nuclear parameter, such as spin, magnetic moment, and radiation, besides the nucleons. We did not discuss each nucleon because it is limited to particle physics. In this section, we examine the radiation and spin of an element. We notice that every element possesses any radioactive isotope even if its half-life is short, which emits radiation with keV~ MeV energy. Therefore, we can elucidate that this radiation energy in our water system is related to nuclear change. They did not discuss the essential characteristics of water itself, and they did not report the reason why atomic nuclei generally change except for nuclear fission, although there was a precious discussion of β-decay [14, 15]. However, Sugihara developed techniques to reduce radiation, in which the soils contained mostly cesium 134, 137, strontium 90, and iodine 130, 131 at a distance of 23 km from the Fukushima nuclear power plant (2011). We employed the "weak" energy from water (less than an eV) to reduce radioactive cesium (Cs) and strontium (Sr). Subsequently, we discussed the precise mechanisms to change the nucleus, maintaining energy and mass conservation laws [16, 17].

Based on the findings of these previous studies, we developed the present treatment, which we called a unique process. We applied a pressure of 147 MPa to seawater (three different locations in the Pacific Ocean) to break the hydrogen bonds. Thus, we can create the physical states of water. A hypothetical particle $<H^+\sim e^->$ that is neither an ion nor an atom formed after the dissociation of the hydrogen bonds, as shown in Fig.1. These hypothetical particles, which we call extended particles, remain similar to the elementary particles, and oscillate between $H^+$ and $e^-$ at a distance of the picometer order. The symbolic particle name is "infoton" [18], which I call regardless of the nuclear reaction in the beginning. It may hypothetically transfer information such as momentum to other substances, and we call the water "SIGN water" (Spin Information Gauge-field Network). However, we have not yet directly discovered the existence of an infoton. The only method to indirectly estimate the size of water is to use hydrogen-based nuclear magnetic resonance (H-NMR) compared with tap water every time. Accordingly, this study aims to discuss the relevant mechanism of element changes with the infoton. It seems that the nuclear spin of another substance plays a role in the spins of the infoton by obtaining kinetic energy from radiation of the radioactive substance. The present study only focused on the changes in sodium (Na) to magnesium (Mg), including the conversion of Cs to barium (Ba). We referred to the nuclear data from "Evaluations published by mass number for A = 21 to 293" [19]. The overall characteristics of elements [20-25] which are good for knowing all element characteristics, although they overlap in the contents.

Furthermore, we propose a theoretical formula for nuclear changes involving gravity when the infoton accesses a nucleus. The results of this research will be useful for the desalination of seawater and reduction of radioisotopes such as $^{134}$Cs, $^{137}$Cs, $^{90}$Sr, and $^{3}$H from nuclear waste.

## Experimental Methods

We collected every two samples in pet bottles of surface sea water (100 cm$^3$) approximately 50 m from the sea shore at different locations in the Pacific Ocean (three places of the ocean with a difference of a few kilometers). They applied a high pressure of 147 MPa in a water tank of approx. 2mΦ x 3 m depth for 10 min, which has been used previously (Sugihara 2009~ 2018). We asked the Japan Agency for Marine-Earth Science and Technology (JAMSTEC, Yokosuka) for high-pressure. One of their studies attempted to simulate the deep sea, such as 6500 m, for the instrument devices used there. We also asked Echigo Seika Co., Ltd. (Niigata Prefecture) for a high-pressure process (200 MPa). In SIGN water, the presumed extended particles, infotons, may have a picometer ($10^{-12}$ m) size according to an indirect evaluation of hydrogen-NMR (R-90H, Hitachi). Herein, we investigated the water properties based on chemical analyses (ICP-AES, Shimadzu ICP-7510) to compare the amount of each element before and after the high-pressure- process. We measured the water properties in the region of terahertz with FT-IT spectroscopy (FT/IR-6000, JASCO) because water usually absorbs terahertz waves, whereas SIGN water can transmit somewhat (approximately 30% transmittance) in the region so that we can identify the water compared with control water like tap water or deionized water.

## Results and Discussion

Nuclear spin is regarded as one of the key parameters for changing the nucleus. We introduced RI cesium changing to stable barium because we have much experimental evidence in Fukushima [1, 16, 17]. We discuss the nuclear change in RI cesium in terms of spin change.

Following this, we discuss the elements in ocean water, and we focus on sodium, magnesium, and barium in this article.

### *General aspects of element changes*

### *Functions of infoton in SIGN water*

Before we discuss the nuclear change mechanism owing to the weak energy of the infoton, it is essential to note that when the nuclear spin ($N_I$) is not zero, it has an associated magnetic moment. However, a detailed description of the magnetic moment is not required. Spin may be the key to the nuclear changes induced by the reaction with water. Infotons can have spins equal to 1 (= ½ + ½), 0 (= ½ − ½), or (+½ and −½), corresponding to $<H^+\sim e^->$, $<H^+\sim\sim e^->$, and $<H^+\sim\sim\sim e^->$, respectively. Their distances assumingly determine ~30 pm, ~50 pm and ~70 pm, respectively due to the spin correlation of proton and electron. Therefore, the extended particles, the infotons could behave as bosons ($N_I = 1$) or fermions ($N_I$ = ½ or -½).

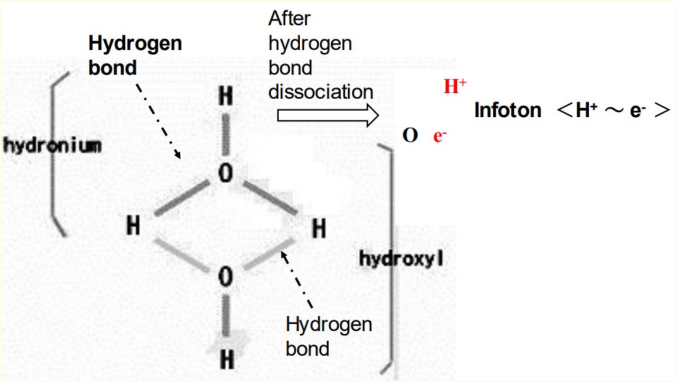

***Figure 1:*** Infoton formed by hydrogen bond-dissociation from two water molecules.

Furthermore, the extended particles are supposed to form a gauge field that can change the characteristics of matter and its physical properties, such as momentum, owing to spin and oscillation. The equation for nuclear magnetic moments can be expressed as follows:

$$I \propto \frac{e\hbar}{m_{Ep}\, c} N_I \qquad (1)$$

Where $m_{Ep}$ is the mass of infoton, NI is the nuclear spin, and c is the light speed (≃ $2.998\times10^8$ m/s).

We observed conversion from Cs to Ba in contaminated soils in Fukushima. We repeated the visits to Fukushima and tested it to reduce radioactivity [1, 16], and [17]. Many people reported the 2011 accident from the viewpoints of the distribution and spread of $^{134}$Cs, $^{137}$Cs, $^{29}$I, and $^{90}$Sr [26-31]. Regardless of the accidents, there was a unique study on the pressure dependence of 7Be [32]. They reported the analysis of the element without the mechanism, and measured the change in the decay constant only. Moreover, they did not find the essential mechanisms of element change except for nuclear fission, which has been covered in textbooks [33-35]. One study of the title is a low-energy nuclear reaction (LENR); they reported an intriguing approach to cold fusion using unitary quantum theory [36-37]. They reported that LENR resembles a catalytic mechanism using an equation describing the oscillating charge.

Another theoretical study focused on quantum tunnelling. Quantum tunneling is a quantum mechanical phenomenon in which a wavefunction can propagate through a potential barrier [38] and is related to superconducting properties [39-41]. Another interesting research is that the law of force between emitted α-particles and the rest of the nucleus is substantially the same in all the atoms, even where the decay rates are in the ratio of $10^{22}$ [42]. Moreover, it is unique article, quantum optics is discussed in terms of the observation of nuclear fusion driven by a pyroelectric crystal [43].

### *The roles of radioactive elements*

Table 1 lists the stable elements and abundances (%) of the earth, and primary nuclear spin (ref. 20 and 22), as is well known. The abundance number of 100% of $^{23}Na_{11}$ means only element is the stable one in sodium. On the other hand, they describe the three stable elements of magnesium in the Earth's crust with each percentage, as shown in Table 1. Incidentally, both elements are 23000 ppm in the Earth's crust (ref. 20).

| *Stable isotope* | *Abundances (%)* | *Nuclear spin (I) ** |
|---|---|---|
| $^{23}Na_{11}$ | 100.00 | 3/2 |
| $^{24}Mg_{12}$ | 78.99 | 0 |
| $^{25}Mg_{12}$ | 10.00 | 5/2 |
| $^{26}Mg_{12}$ | 11.01 | 0 |

*;Nuclear spin (I) is reported in units of $h/2\pi$, and is defined as the total nuclear magnetic moment.

***Table 1:*** Stable elements and primary nuclear spin (ref. 20 & 22).

Notably, almost all the elements possess radioactive isotopes, as shown in Table 2, although isotopes with a half-life of less than minute are abbreviated here.

Here is an example of the electron capture;

$$^{26}Al_{13} + e^{-} \rightarrow {}^{26}Mg_{12} + \nu_e \qquad (2)$$

where $\nu_e$ indicates an electron neutrino, which is one of the leptons in the standard elementary particle physics model. Although we do not discuss the formation of Al in this article, we note a few introductions for electron capture related to our discussion. We introduce a detailed discussion of Eq. (1) in the spin function section. $^{26}Al_{13}$ is a radioisotope (half-life is 7.2 $\times 10^5$ years, and decay mode is $\beta^+$ (4.0MeV) 82% EC and 18% γ-ray [19, 20, 21] listed in Table 2. The stable isotopes used were $^{24}Mg_{12}$, $^{25}Mg_{12}$, and $^{26}Mg_{12}$. The abundance of $^{24}Mg$ (spin 0) and $^{26}Mg$ (spin 0) is more than $^{25}Mg$ (5/2), although we do not refer to the reason why the spin is supposed to have the key here.

| *Radioisotope* | *Nuclear spin* | *Half-life** | *Decay, MeV *** |
|---|---|---|---|
| $^{22}Na_{11}$ | 3 | 2.6 years | $\beta^+$ (2.84) 90% EC & 10% γ |
| $^{24}Na_{11}$ | 4 | 15 hours | $\beta^-$ (5.51) γ |
| $^{27}Mg_{12}$ | 0 | 9.45 min. | $\beta^-$ (2.61) γ |
| $^{28}Mg_{12}$ | 1/2 | 21 hours | $\beta^-$ (1.83) γ |
| $^{26}Al_{13}$ | 5 | $7.3 \times 10^5$y | $\beta^+$ (4.0) 82% EC & 18% γ |
| $^{28}Al_{13}$ | 3 | 2.3 min. | $\beta^-$ (4.6);γ |
| $^{29}Al_{13}$ | 5/2 | 6.5 min. | $\beta^-$ (3.7);γ |

*; half-life of less than a second is abbreviated. **; EC: electron capture.

***Table 2:*** Radioisotopes and primary nuclear data (Ref. 20, 22 & 23).

**Citation:** Sunao Sugihara., et al. "How Element Changes Proceed with Nuclear Transmutation by Pairs of Electron and Proton in Hydrogen Atom of Water". Medicon Engineering Themes 5.2 (2023): 25-35.

Gian-Carlo Wick first discussed the theory of electron capture in 1934, and it was developed by Yukawa [15] and others. Alvarez first observed K-electron capture in vanadium (https://en.wikipedia.org/wiki/Luis Walter Alvarez), which was reported in 1937. He studied electron capture in gallium and other nuclides; $^{67}Ga_{31}$ (half-life of 3.26 days) decays by electron capture and γ emission to stable $^{67}Zn_{30}$. The electron captured is one of the atoms' own electrons and not a new incoming electron, as might be suggested by the above reactions [41].

As we have seen previously, they performed reactions such as deuteron and deuteron using high energy to observe neutrons as fusion evidence. It is reasonable that neutrons may be generated because of high-energy deuterons [42]. Research on solid molecular hydrogen has three phases under high pressures. They reported that the three phases exhibited a strong isotope effect, in which they focused on the quantum mechanical properties of hydrogen nuclei, and determined the atomic configuration by density-functional theory (DFT) [44]. However, they did not discuss electrons.

### *Nuclear changes from Na to Mg.*

Another new insight is that almost all elements have isotopes, and radioisotopes that emit some form of radiation ($\alpha^-$, $\beta^-$, $\beta^+$, and γ-rays). Water may obtain such radiation energy to increase the kinetic energy that reacts with the nucleus of the other atom. This is a key reason for nuclear changes at room temperature. We previously reported the radiation reduction with water [1, 16, 17], although we did not report the precise mechanisms involving the spin. The reports describe the amounts of elements on Earth or in the ocean and their characteristics with the atomic structure [19-25]. The radioactivity of the nuclear power plant accident has been reported in "Radioactivity has spread in Japan" [27-28].

Herein, we assume that the particle, infoton speed equal to 10% of the light speed.

Firstly, we discuss the elements with the actual data. Na has only one stable isotope, $^{23}Na_{11}$, and two radioactive isotopes (RIs), $^{22}Na_{11}$ and $^{24}Na_{11}$ (Table 2). The two Na RIs have half-lives of 2.6 years and 15h, respectively. Thus, the analysis shows that Na RIs readily undergo nuclear reactions and are converted to Mg, as discussed later. Three stable isotopes of Mg exist; $^{24}Mg$, $^{25}Mg$, and $^{26}Mg$ (Table 1). The half-lives of the RIs $^{27}Mg$ and $^{28}Mg$ are listed in Table 2.

Any plant may convert the RIs of Na to Mg when absorbing water through aquaporin protein against gravity through their roots (the calculated pressure is approx. 0.8MPa which is not enough to dissociate hydrogen bonds of water). That is the reason why plants possess aquaporin protein three times more than that of an animal. Subsequently, they developed chlorophyll. In sea-water, the Na content is 23,000 parts per million (ppm), whereas the Mg content is only 1,200 ppm. The generation of stable, $^{23}N_{a11}$ depicts the following reaction with infoton and the mark, 《 》 in the reaction indicates a stable atom:

$$^{22}Na_{11} + 2 <H^+ \sim e^-> \rightarrow 《^{24}Mg_{12}》 \quad (3).$$

Reaction (2) maintains the mass balance before and after it, and an electron of the infoton disappears due to the reaction with $\beta^+$emitted from $^{22}Na_{11}$.

We analyzed seawater elements under high pressure. The results indicate that the sodium content decreased by 4.2% in Table 3. In comparison, the magnesium content increased by 18% on the average for five samples after high-pressure treatment in three kinds of places of seawater. It is necessary to understand the mechanisms by which elements are converted into one another.

We considered the energy balance of the reaction. The momentum of a particle can exceed the nuclear force and enter the nucleus, where it resonates with the nuclear spin. We calculated the particle's kinetic energy by assuming 10% velocity (v) of the speed of light ($v = 3\times10^8$ m・$s^{-1}$), and its mass; $1.673^8 \times 10^{-27}$ kg. The calculation results for the particle kinetic energy of 4.71 MeV. The energy of 2.84 MeV from the radiation of $^{22}Na_{11}$ amounts to the total energy of 7.5 MeV, which is close to the nuclear binding energy of $^{22}Na_{11}$ (7.92 MeV) and β- decay energy (-4.78MeV) [31-32].

| *Element* | *before (ppm)* | *after (ppm)* | *change rate (%)* |
|---|---|---|---|
| Na | 14400 | 13800 | - 4.2 |
| Mg | 57000 | 75750 | +18.0 |
| Al | 56.8 | 48.4 | -14.8 |
| Si | 2.7 | 4.6 | +67.2 |
| P | 10.1 | 11.0 | + 9 |
| S | 65800 | 62440 | - 5.5 |

***Table 3:*** Chemical analyses of seawater changed before and after high pressure of 200 MPa (average values from June 2017 to December 2018).

### *Formation of Na*

We focus onpay attention to the nuclear spin and spin-balance (up or down) for the element changes.

When an infoton reacts with RI $^{22}Na_{11}$, the next equation holds;

$$^{22}Na_{11} + 1 <H^{+}\sim e^{-}> \rightarrow 《^{23}Na_{11}》$$

spin state; 3 × {1×1(=1/2+1/2)} → 3/2; *down*. (4).

An electron of the infoton disappears because of the reaction with $\beta^{+}$ keeping mass balance.

We elucidate the spin state in the reaction;

The first numeral, 3, depicts the spin of $^{22}Na_{11}$ and the parenthesis { } for infoton, the number, 1 shows an infoton, and two numbers, 1/2 indicate a half-spin of protons and electrons. The last numeral, 3/2, describes the spin of stable Na depicted with the symbol, 《 》, and *down* indicates the spin of change from 3 of $^{22}Na_{11}$ to 3/2 of $^{23}Na_{11}$ owing to the reaction with infoton.

The beta decay ($\beta^{+}$) energy of $^{22}Na_{11}$ is 4.78 MeV [22], which may close to the infoton's kinetic energy at 10% of light speed. We regard the spin-balance and spin-down as necessary between the left-hand and right-hand in the spin term.

### *Formation of Mg*

A different product is magnesium, which has three stable atoms: $^{24}Mg_{12}$ (78.99% abundance), $^{25}Mg_{12}$ (10%), and $^{26}Mg_{12}$ (11%). The following reactions may generate each of these:

$$^{22}Na_{11} + 2 <H^{+}\sim e^{-}> \rightarrow 《^{24}Mg_{12}》, \quad (5).$$

spin state; 3 × {2×0 (=1/2 -1/2)} → 0; *down*.

$$^{24}Na_{11} + 1 <H^{+}\sim e^{-}> \rightarrow 《^{25}Mg_{12}》,$$

spin state; 4 × {1×0 (=1/2 -1/2)} → 5/2; *up*. (6).

If three infotons react with 22Na11, the result is following;

$$^{22}Na_{11} + 3 <H^{+}\sim e^{-}> \rightarrow 《^{25}Mg_{12}》,$$

spin state; 4 × {1×1 (=1/2 +1/2) + 2 × 0 (=1/2 -1/2)} → 5/2; *down*. (7).

In the case of two infoton;

$^{24}\mathrm{Na}_{11}$ + 2 <$\mathrm{H}^+$~$\mathrm{e}^-$> → 《$_{26}\mathrm{Mg}_{12}$》 ,

spin state; 4 × {2×0 (=1/2 -1/2)} → 0; *down*.  (8).

The reaction of Eq. (6) is possible, but there may be fewer than in equations (5) and (8). Therefore, stable $^{25}\mathrm{Mg}_{12}$ amounted to 10%. Furthermore, an electron of the infoton reacts with a positron in the β-decay theory (p→ n + $\mathrm{e}^+$ + ν), and then vanishes in the reactions, as shown in Eq. (4).

The electrons of the three in Eq. (7) remains. In this meaning, Eq. (7), is difficult to obtain.

Let's check the electron capture in the relation to Mg;

$^{26}\mathrm{Al}_{13}$ + <$\mathrm{H}^+$~$\mathrm{e}^-$> → 《$^{26}\mathrm{Mg}_{12}$》 + 1/2 $\mathrm{H}_2$.

spin state; 5 × {1×0 (=1/2-1/2)} → 0; *down*. (9).

Generation of hydrogen plays a role to hold mass balance and spin state.

$^{26}\mathrm{Al}_{13}$ emits $\beta^+$ ray with energy of 4.0 MeV leading to disappearing of $\mathrm{e}^-$ of the infoton, and an electron of Al works for forming hydrogen.

Thus, we understand that Mg can have a source to generate from other atoms than Mg, resulting in a larger amount of $^{26}\mathrm{Mg}_{12}$ (11%) than $^{25}\mathrm{Mg}_{12}$ (10%) (Table 4).

### *Nuclear changes of RI cesium to stable elements*

We discuss radioactive cesium in stable bariums, and we previously researched radioactive reduction with water [1, 7]. Here, is a theory from the viewpoint of the spin. Before that, we introduced a cesium element with seven kinds of RI from $^{129}\mathrm{Cs}_{55}$ to $^{137}\mathrm{Cs}_{55}$ with a half-life of more than one day. The stable cesium is only $^{133}\mathrm{Cs}_{55}$, as shown in Table 4. Furthermore, the cesium radiating beta ray can provide energy to the infoton (s), resulting in nuclear changes as follow.

$^{134}\mathrm{Cs}_{55}$ + <$\mathrm{H}^+$~$\mathrm{e}^-$> → 《$^{134}\mathrm{Ba}_{56}$》 + 1/2 $\mathrm{H}_2$,

spin state; 4 × {1×1 (=1/2+1/2)} → 0 (+); *down*. (10).

The neutron disintegrates in the β decay of Cs as follows;

n → p + $\mathrm{e}^-$ + $\bar{\boldsymbol{\nu}}$, where the particles, p + $\mathrm{e}^-$ are an infoton itself.

$^{137}\mathrm{Cs}^{55}$ +1 <$\mathrm{H}^+$~$\mathrm{e}^-$> → 《$^{138}\mathrm{Ba}_{56}$》

spin state; 7/2 × {1×1 (=1/2+1/2)} → 0; *down*. (11).

The amounts of stable $^{136}\mathrm{Ba}_{56}$ and, $^{138}\mathrm{Ba}_{56}$ are reported at approx. 7.8 % and 71.7%, respectively [20-22], in Table 5. These differences are due to the shorter half-life of $^{134}\mathrm{Ba}_{55}$ than that of $^{137}\mathrm{Ba}_{55}$. Therefore, the amount of stable $^{138}\mathrm{Ba}_{56}$ increased.

In the case of the amount of 11.2% of $^{137}\mathrm{Ba}_{56}$ [20-21], generation of hydrogen is assumed to preserve the spin balance as follows;

$^{137}\mathrm{Cs}_{55}$ + <$\mathrm{H}^+$~$\mathrm{e}^-$> → $^{137}\mathrm{Ba}_{56}$ + 1/2 $\mathrm{H}_2$,

spin state; 7/2 × {2×1 (=1/2+1/2)} → 3/2 (+); *down*. (12).

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Then, the mass balance under the reaction seems to be maintained by generating hydrogen gases, as shown in Eq. (10). Moreover, the infoton preserves to remove an electron from $^{137}Cs_{55}$, and form hydrogen gases with the 1.18 MeV of radiation from it (Table 4).

We can estimate from Eq. (10) and (12), hydrogen gas is partially generated in the nuclear reactor.

| ***Radio isotope Cs*** | ***Nuclear spin*** | ***Half-life time*** | ***Decay energy MeV*** |
|---|---|---|---|
| $^{131}Cs_{55}$ | 5/2 | 9.7 days | β (-) 1.37 |
| $^{132}Cs_{55}$ | 7 | 6.5 days | β (+) 2.12 |
| $^{133}Cs_{55}$ | 7/2 | stable | -------- |
| $^{134}Cs_{55}$ | 4 | 2.1 years | β (-) 2.06 |
| $^{135}Cs_{55}$ | 7/2 | 2.3 days | β (-) 0.21 |
| $^{136}Cs_{55}$ | 5 | 13 days | β (-) 2.55 |
| $^{137}Cs_{55}$ | 7/2 | 30.1 years | β (-) 1.18 |

***Table 4:*** Isotope and radioisotope of Cs.

| ***Stable Ba & RI*** | ***Nuclear spin (abundance %)*** | ***Decay energy MeV*** | ***Half-life time*** |
|---|---|---|---|
| $^{128}Ba_{56}$ | 0 | EC 6.75 | 2.4 days |
| $^{130}Ba_{56}$ | 0 (0.11) | | |
| $^{131}Ba_{56}$ | 1/2 | β (+) 2.91 | 11.7 days |
| $^{132}Ba_{56}$ | 0 (0.1) | | |
| $^{133}Ba_{56}$ | 1/2 | EC 2.06 | 10.5 days |
| $^{134}Ba_{56}$ | 0 (2.41) | | |
| $^{135}Ba_{56}$ | 3/2 (6.59) | | |
| $^{136}Ba_{56}$ | 0 (7.85) | | |
| $^{137}Ba_{56}$ | 3/2 (11.23) | | |
| $^{138}Ba_{56}$ | 0 (71.7) | | |
| $^{140}Ba_{56}$ | 0 | β (-) 1.05 | 12.8 days |

***Table 5:*** Atomic characteristics of barium isotopes, stable and RI.

Any elements may change with the infoton, as previously shown. Tritium ($^3H$) solution is also an essential exhausted waste-water from a nuclear power plant (half-life of 12.32 ± 0.02 years). Therefore, we will apply SIGN water to reduce tritium ($^3H$) according to the same theory of nuclear change.

Finally, it is worthwhile to note the following discussion when RI accesses another nucleus. Namely, we propose the involvement of the Einstein gravity equation and Yukawa potential for nuclear change [16]. These are the following two equations;

$$\int dN/N = -\lambda \int dt + \int (8\pi G/c^4)\, T_{\mu\nu}\, dt \tag{13}$$

where $T_{\mu\nu}$ is the energy momentum tensor that describes the matter distribution in the Einstein gravity equation. Moreover, the first term rephrases to involve the Yukawa potential $\{-\lambda t + (Mv/d^2)\}\int dt$, then;

$$\int dN/N = \{-\lambda t + (Mv/d^2)\}\int dt + \int (8\pi G/c^4)\, T_{\mu\nu}\, dt \tag{14}$$

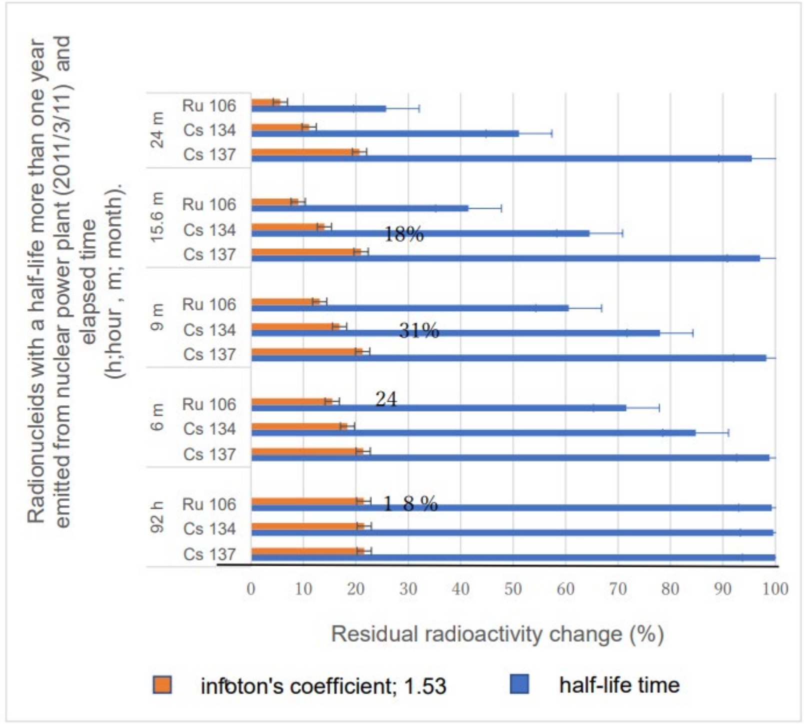

***Figure 2:*** Radioactivity changes calculated by the half-life time formula for each element of Ru 106, Cs 134 and Cs137, and estimated changes from Eq. (14).

where infoton's velocity, $v$ assumed to be 10% of velocity of light, and infoton's mass, M, $<H^+\sim e^->$, is $1.6738\times10^{-27}$ kg. The value of $d$ describes the distance between the nucleus and infoton approaching the nucleus, and the second term in Eq. (14), is constant. We define that $\lambda t + (Mv/d^2)$ is the infoton's coefficient. Figure 2 describes the results of calculation assumed as the infoton's coefficient, 1.53. We expect the radiation reduction of tritium by treatment with SIGN water applying the theory.

## Conclusion

The mechanisms of element changes such as Na to Mg and Cs to Ba with the weak energy of the water were discussed, based on the considerations of a few RIs of the elements as well as their nuclear spins. Furthermore, we theoretically proposed the Einstein gravity equation and the Yukawa potential related to nuclear change. We postulate that hydrogen bonds in water molecules dissociate to generate infotons, which may react with any nucleus obtaining the energy from RI without any higher energy. The necessity of spin 0 or down to make a stable product by nuclear reaction with an infoton is also important in addition to the preservation of mass and spin (including spin-down). We will propose a reduction in the radioactivity of tritium from nuclear waste and report the element change from silicon to chlorine in the future.

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### *Competing interest statement*

The authors declare that they have no competing financial interests.

### *Ethics statement*

The study was approved by the Ethics Committee of University.

### *Data availability*

The data supporting the findings of this study are openly available and aits supplementary information and from the corresponding authors upon request.

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