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To cite this article: Vladimir K Nevolin 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **839** 042002

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Background gamma radiation and plant photosynthesis

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Abstract. The idea of experiments is inspired by experimental data on the transmutation of isotopes in biological systems. Model particles, in our opinion, responsible for nuclear reactions can be hydrogen atoms in unusual states. Previously, we have experimentally shown that the formation of such hydrogen atoms is observed under hard ultraviolet radiation (they can be formed during photosynthesis in plants). In turn, these atoms, entering into nuclear reactions, can lead to gamma radiation. In this regard, it is possible to emit both ultraviolet and gamma radiation from plants. Two radiascan 701A dosimeters were used for experimental studies of gamma radiation from indoor plants in daylight and in the dark. The radiation from deciduous plants was observed in daylight and stopped in the dark. The relative value of the background gamma radiation of plants did not exceed 2% of the background level in the room. In the case of cactus, there is mainly absorption of background gamma radiation associated with a significant green mass of the plant and scattering and absorption of gamma quanta in the volume of the cactus. Cactus radiation can be observed if it exceeds the absorption of gamma quanta. The probability of such a situation depends on the extent to which the surface of the cactus is developed, intensive vegetation (flowering), and regular watering. For applied purposes, these radiations can be used for remote diagnosis of the state of plants.

1. Introduction

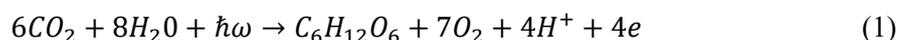
Taking into account the intrinsic energy of the quantum motion of an electron in a proton-electron system, according to De Broglie, it is possible to predict the existence of subatomic states of hydrogen atoms. These are unusual states of hydrogen with a more compact localization, which makes it possible for the nuclei of the atoms to approach each other at substantially closer distances. On average, the subatom is electrically neutral, however, due to its superhard electron cloud with a formation energy of ~500 KeV, generally, this results in a “heavy” electron. Such a particle moves significantly slower than a free electron and can come rather close to the nuclei of other elements due to Coulomb’s law of attraction of opposite charges. A repelling electric field generated by external nuclei that penetrates the electron cloud can in turn ultimately “squeeze” a proton out of a hydrogen subatom. Nevertheless the proton ends up at a significantly closer distance from the external nucleus than if it were just a free proton. Such a proton can, with some probability, overcome the nucleus’s Coulomb barrier and react with it¹.

Assuming then that hydrogen subatoms can account for cold nuclear transmutation, one can consistently explain a great deal of prior accumulated experimental data regarding isotope transmutation in biological systems. In this regard, a series of experiments have been carried out in the aim of proving the existence of hydrogen subatoms. During the formation of bonded states between hydrogen subatoms,



we should be able to observe ultraviolet radiation with a characteristic wavelength in the region of 206 nm. Such radiation has in fact been observed during photosynthesis in a number of indoor plants².

Let's formulate the photosynthesis reaction during which free protons and electrons are formed within the cell structures, mainly due to the dissociation of water and the reversion of negative oxygen ions to their normal molecular state³:



Under stationary conditions, electrons weakly bonded to the walls of cellular structures can "capture" hydrogen ions (protons), with some probability of forming hydrogen subatoms with bonding energy:

$$\Delta\varepsilon = \frac{2e^2}{9a} = 6.02eV \quad (2)$$

where e - electron charge, a – subatom diameter.

Therefore, we should observe weak ultraviolet radiation with a characteristic wavelength in the region of 206 nm during photosynthesis.

Let us hazard an assumption that in the plant world, photosynthesis must generate hydrogen subatoms, which, to our mind, are vitally indispensable to the self-preservation and development of plants – replicating crucial elements via cold transmutation of nuclei.

The presence of nuclear reactions can be established by observing gamma radiation and possibly beta radiation. The energy of electrons β^- depends on the extent to which the hydrogen subatom interacts with the nucleus. If the hydrogen subatom $^*H^1$ introduces only a single proton into the nucleus's capture zone, the electron will have minimal energy. Whereas, if the hydrogen subatom is captured in its entirety, the energy of the emitted electron will be significant. On the whole, these types of reactions can be represented as:



We have not been able to observe any amounts of detectable β^- - radiation with an energy of over 0.05 MeV and a current density of 5 part/(cm²/min). The presence of β^- - radiation in nature would mean the plants were immersed in electric fields. Let us give an example of an instance when an electron, as such, does not participate in a nuclear reaction. For the reproduction of calcium in plants, direct pairwise reactions in the leaves are possible when a potassium nucleus collides with a $^*H^1$ hydrogen subatom, delivering a proton to the potassium nucleus.



The energy of gamma quanta in this reaction is $\gamma \approx 6.35 \cdot 10^3 keV$. Reactions involving a potassium nucleus and a proton were experimentally observed and described earlier⁴. These are "hard" gamma quanta. Due to the Compton scattering of energy on the electrons of the atoms present in the medium, this energy can decrease significantly and become measurable with conventional dosimeters.

In this manner, hydrogen subatoms are formed during photosynthesis in plants, and "signal" their formation by radiating hard ultraviolet radiation. In turn, these hydrogen subatoms immediately enter into nuclear reactions with the surrounding nuclei, followed by possible additional radiations. As theoretical calculations indicate, hydrogen subatoms can also precipitate nuclear reactions in adjacent atoms without being directly involved in the reactions themselves. Therefore, at night, when photosynthesis ceases, background ultraviolet (as is experimentally proven earlier²) and gamma radiations should drop to infinitesimal values. It is useful to note, that this is not the only possible mechanism for nuclear transmutation and the emission of gamma radiation. Vysotskiy *et al.*⁵ collected and aggregated a significant amount of experimental materials in the study of microorganisms. The accumulated data led them to the conclusion that the mechanism for nuclear reactions at low temperatures is associated with the occurrence of coherent correlated states created in non-stationary nanoscale potential wells, formed and transformed in the growth zones of biological objects (regions

where we observe cell division, DNA replication, biological membrane surfaces). This kind of universal mechanism can continue functioning in the dark.

The aim of this present paper is to provide experimental proof of the background gamma radiation effect observed during plant photosynthesis.

2. Materials and methodology

The metabolism of microorganisms and, therefore, the amount of radiation they emit can be controlled by creating a comfortable ambient temperature and providing a sufficient amount of nutrients⁶. The plant world, on the other hand, has a higher order of organization and any kind of manipulation of their environment often leads plants to enter a state of stress, which violates the natural rhythm of their existence and of the processes occurring within them, in particular, photosynthesis. It is possible that this fact accounts for the absence of direct experimental observations of plant gamma radiation and of the occurrence of nuclear transmutations within them, even though this possibility seems only natural and is mentioned in monograph Vysotskiy *et al.*⁴.

In terms of the plants used in the experiment, we chose two varieties of indoor plants: the mandarin tree (*citrus unshiu*), which has a dense crown of leaves, and the jade plant or “money plant” (*crassula ovate*), which is characterized by thick succulent leaves.

To measure gamma radiation, we used two RadiaScan 701A dosimeters with the following parameters: dose indication range 0.001 - 1000 mSv, dose rate indication range 0.01 - 10000 μ Sv/h, photon radiation energy detection range 65 – 3000 keV. The dosimeters were placed in cast lead containers with 15 mm wall thickness and an input aperture 25 mm in diameter, which almost halved the natural background of gamma radiation. This step was taken in order to increase the intensity of the signal we were looking to observe in relation to the background radiation, which was $\sim 0.11 \mu$ Sv/h on average. The lead containers were also meant to reduce the “hardness” of high-energy gamma-quanta due to the Compton scattering effect on the electrons of the lead atoms, including “gliding” scattering on the walls of the lead containers’ input apertures. The levels of background radiation depended mostly on solar activity and the weather – the presence of clouds and rain.

The main problem, which was resolved over the course of many weeks, was how to stabilize the studied plants in a calm, stress-free state. The displacement of the plants, the shift in their orientation relative to the cardinal points, the change in illumination, and the introduction of artificial LED lighting all contributed to a state of stress and the absence of radiation. We ended up resorting to regular humidification via spraying, anti-stress mineral additives, which are available for many kinds of plants, and maintaining stable conditions in the plants’ environment over time. “Night time” for the plants was induced by putting two spacious dark polyethylene plastic bags one on top of the other over the pots with the plants.

The dosimeters were installed back to back on a rotating pole, which meant that they could be rotated 360 degrees and positioned at different heights.

In the process of the experiment, we compared the measurements of the two dosimeters, one of which was measuring the background gamma radiation – its input aperture was pointed away from the plants; the other was measuring possible plant emitted radiation and background radiation. As it turned out, the suitable dose accumulation time was 30 minutes. After each 30 minute period, the dosimeter data was recorded and reset. Since the dosimeters did not have matching characteristics, every 30 minutes they were rotated 180 degrees. The time it took to obtain the dosimeters data, record it, reset and rotate 180 degrees of dosimeters was less than a minute. Therefore, the relative error in the accuracy of the time intervals was less than 3%. The recorded measurement results were processed according to the following formula:

$$\sum \gamma = \left(D_1^1(\Delta t) - D_1^2(\Delta t) \right) + \left(D_2^1(\Delta t) - D_2^2(\Delta t) \right) \quad (5)$$

where D_i^k – the dosimeter data over the period of $\Delta t = 30$ minutes, D_i^1 corresponds data of the dosimeter directed towards the plants, D_i^2 corresponds data of the dosimeter directed away from the plants. Selected

experiments demonstrated that spatial anisotropy of the gamma-ray background wasn't observed in the room area. Formula (5) is used to give the hourly dose of radiation – or dose rate.

We conducted five-hour-long daytime measurement sessions, and the average dose rate was calculated using the formula:

$$\langle \gamma \rangle = \frac{2}{n} \sum_{i=1}^n \left(D_i^1(\Delta t) - D_i^2(\Delta t) \right) (-1)^{i-1} \quad (6)$$

In our case, $n=10$. It is possible to assess the effect according to each dosimeter data individually, having carried out the appropriate calculation. However, it should be assumed that the background radiation level during the measurements remains unchanged.

3. Results and discussion

Representative measurement results for the mandarin tree – the average daytime dose rate was:

$$\langle \gamma_D \rangle = (2 \pm 1) \cdot 10^{-3} \mu Sv/h$$

Here, the random measurement error of the dose coincides with the discrete single digit measurement unit of the dosimeter. The average dose rate of background radiation was:

$$\langle \gamma_f \rangle = (55 \pm 5) \cdot 10^{-3} \mu Sv/h$$

Thus, the relative value of the background gamma radiation emitting from the plant does not exceed 2% of the background level in the room. This background radiation of $\sim 0.11 \mu Sv/h$ surrounds the plants.

The average dose rate for the plant's night time radiation was insignificant:

$$\langle \gamma_N \rangle = (0 \pm 1) \cdot 10^{-3} \mu Sv/h$$

The measured values of the radiation doses emitted by plants depend on the time of year and the life cycle stage in which the plant finds itself. It may be in a state of suspended animation - anabiosis. Vital activity in this case will be minimal, as will gamma radiation. In our particular case, measurements of the mandarin plant's daytime radiation dose were carried out during the summer and autumn seasons. It was necessary, as indicated above, to artificially stimulate the plant's activity.

For the study of the gamma radiation emitted by the money plant, which was carried out during the autumn-winter seasons, the results were as follows:

$$\langle \gamma_D \rangle = (1 \pm 1) \cdot 10^{-3} \mu Sv/h, \langle \gamma_N \rangle = (0 \pm 1) \cdot 10^{-3} \mu Sv/h$$

The average daytime radiation dose rate of the money plant was half mandarin tree dose rate. Note that the radiating leaf surface area of the money plant's crown is less than half the size of the mandarin tree's crown. In both instances, the studies were conducted outside of the plant growing season, during which an increase in gamma radiation can be expected.

We want to pay particular attention to the results of observation of the interaction of cactus with background gamma radiation. In consideration of the representations described above, the possible cactus gamma radiation is proportional to the developed surface morphology, since ultraviolet radiation is reduced in the cactus body. However, the large volume of the cactus body leads to gamma quanta absorption. Thus, these are two rival processes. In our case, the cactus body volume was at least 1000 cm³ (equal to the pot volume ~ 1 liter) and the average absorption during the day was $\langle \gamma_D \rangle = -(3 \pm 1) \cdot 10^{-3} \mu Sv/h$.

To observe the background gamma radiation of the cactus, we have provided regular watering and have waited for its flowering, the average radiation in this case was $\langle \gamma_D \rangle = (4 \pm 1) \cdot 10^{-3} \mu Sv/h$. The radiation reduced to zero when we stopped watering, and the cactus begun absorption of the background gamma radiation again. The flowers dried up after eight weeks without watering, but the cactus appearance remained the same, and the background radiation absorption stabilized. We suggest that the cactus vital activity maintained through "hard" photosynthesis provided by gamma quanta absorption and the electron-ion conductivity of the medium in cellular structures.

4. Conclusion

Based on the experimental findings, the background gamma radiation of deciduous plants emitted by the studied plants within the sensitivity range of the dosimeters can be associated with daylight, when photosynthesis and background hard ultraviolet radiation occur². The predominant process of the vital activity of cactus is the absorption of background gamma radiation. The above-mentioned types of radiation can be used for applied purposes as remotely diagnosing the plant's condition.

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