



## Detection of Beta and Gamma Radiation as it pertains to Paranormal Research

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### Section 1: Preamble

While ionizing and deionising radiation is rare in people's homes in many parts of the world (*except of course locations where a radiological disaster has occurred*) is relatively rare, in the field of paranormal research it is imperative to attempt to detect any possible cause, no matter how unlikely it may be. Doing so, any anomalies you gather during an investigation and interview can be more closely analyzed, taking into account as much information about the environment as possible.

### Section 1.1: What is Alpha, Beta and Gamma radiation?

#### ALPHA PARTICLES

The alpha particle is the heaviest. It is produced when the heaviest elements decay. Alpha and beta rays are not waves. They are high-energy particles that are expelled from unstable nuclei. In the case of alpha radiation, the energy the particles leave the nucleus. The alpha particle is a helium atom and contains two neutrons and two protons. It leaves the nucleus of an unstable atom at a speed of 16,000 kilometres per second, around a tenth the speed of light. The alpha particles are relatively large and heavy. As a result, alpha rays are not very penetrating and are easily absorbed. A sheet of paper or a 3-cm layer of air is sufficient to stop them. Its energy is transferred within a short distance to the surrounding media. However, its short flight knocks about 450,000 electrons out of the surrounding atoms. The alpha particle emitter will not penetrate the outer layer of our skin, but is dangerous if inhaled or swallowed. The delicate internal workings of the living cell forming the lining of the lungs or internal organs, most certainly will be changed (mutated) or killed outright by the energetic alpha particle. The number of lung cancer cases among uranium miners from inhaled and ingested alpha sources is much higher than those of the public at large. Radon, the gas produced by the decay of radium-226, also emits alpha particles, which poses a hazard to lungs and airways when inhaled. Homes built in areas with high ground radioactivity should be tested for radon build-up in enclosed basement spaces.

## **BETA PARTICLES**

Beta rays are much lighter energy particles. The beta particle is an energetic electron given off by the nucleus of unstable isotopes to restore an energy balance. They leave the nucleus at a speed of 270,000 kilometres per second. They can be stopped, for instance, by an aluminium sheet a few millimetres thick or by 3 metres of air. The RS-500 can detect most energetic beta particles through the case. Weaker beta particles can be detected through the tube window. Although the beta particle is around 8000 times smaller than the alpha particle, it is capable of penetrating much deeper into living matter. Each encounter with a living cell, and there may be many before the beta energy is dissipated, is likely to damage some of the chemical links between the living molecules of the cell or cause some permanent genetic change in the cell nucleus. If the damage occurs within the generative cells of the ovaries or testes, the damage may be passed to new generations. The normal background radiation level must contribute to the mutation of the gene pool. Most mutations are undesirable with a very few leading to "improvements". Any increase in the background level of radiation should be considered harmful.

## **GAMMA RAYS**

The next "particle" is the very high energy "X-ray" called the gamma ray. It is an energetic photon or light wave in the same electromagnetic family as light and x-rays, but is much more energetic and harmful. It is capable of damaging living cells as it slows down by transferring its energy to surrounding cell components.

### **Section 2: Effect of Radiation on the Human Body**

To understand the nature of the damage caused by radiation, it is necessary to look at the microscopic structure of the human body. The human body is composed of a large number of individual cells. These cells can be split broadly into two categories, namely:

1. Somatic cells
2. Germ cells.

The germ cells are those that are responsible for reproduction of offspring, and constitute the sperm in males, and the ova in females. All other cells fall under the classification of somatic cells.

The genetic information that characterizes any individual is contained within the chromosomes. Somatic cells contain 46 chromosomes (23 chromosomes, occurring in pairs), and germ cells contain 23 chromosomes (23 chromosomes occurring once), so that when a sperm and an ovum come together, they produce a composite with the full 46 chromosomes. All cells in the body contain exactly the same genetic information; when cells divide, the chromosomes are reproduced exactly, so that the new cells resulting from cellular division contain exactly the same genetic information as in the original cell.

The chromosomes, in turn, are composed of linear sequences of genes. Genes are the basic units of heredity, and mammalian cells contain between 60000 and 70000 genes. The chromosomes are composed principally from deoxyribonucleic acid, which is usually shortened to 'DNA'. A molecule of DNA contains around 10 million atoms, and it consists of two chains that are entwined around each other (the famous 'double helix'). The diagram below shows the basic structure of DNA. The two chains are held together by various cross-connections (termed 'hydrogen bonds' by chemists) between the two chains. The genetic information held in the DNA molecule is defined by the sequence in which various groups of atoms occur on the molecule. Evidently, this is an extremely complex subject, and is beyond the scope of this article.



**The structure of DNA. It consists of two chains of atoms entwined around each other, with various bonds between atoms on the two chains. Each DNA molecule contains around 10 million atoms (mostly carbon, hydrogen, oxygen and nitrogen)**

Now, let us suppose that a collection of cells in the human body is subject to the types of radiation described above. We know that the main effect of this radiation is to cause ionization of the atoms in the absorbing medium. Thus, when cells are irradiated, it is likely that ionization of one or more of the atoms on some of the DNA molecules will occur. This can lead to a number of consequences for the affected molecule. These effects include :

1. Breakage of the chains of molecules comprising the DNA, and
2. Breakage of the links between chains.

In many cases, the cell is able to repair the damage, but not always. When the damage cannot be repaired, the affected cell is left with altered or damaged genetic information, compared with the unaffected cells. All descendants of that cell will contain altered or damaged information as well, because cellular division results in exact replication of the genetic information in the original cell. The direct attack of radiation on the structure of DNA is not the only means by which radiation can affect cells. The majority of the human body (about 60%) is made up of water, and the ionizing effects of radiation on water can lead to an indirect attack on DNA. The effect of radiation on water (via a series of chemical reactions) is to produce a liquid, similar to water in composition, called hydrogen peroxide. Hydrogen peroxide is, in contrast to water, a chemically active compound, and it is capable of reacting with DNA to damage cells and the genetic information contained therein. Cells can therefore be subject to an indirect attack due to the action of radiation on body water, as well as from the direct effects of ionization at the site of the DNA.

Therefore, if germ cells (sperm and ova) suffer damage to the genetic information and they are subsequently involved in germination with other germ cells (i.e. affected sperm cells uniting with an ovum); the offspring may well carry cells containing the damaged information. Similarly, somatic cells will divide to increase the number of cells in the body with damaged information. The proliferation of damaged cells that cannot perform their normal function is the root cause of cancer.

## *Stochastic Effects*

Stochastic effects are usually associated with exposures to low levels of radiation exposure over a long period of time (e.g. years). The term stochastic literally means 'random', the implication being that low levels of radiation exposure are not certain to produce an effect. The induction of cancer and genetic defects are two of the most familiar consequences attributed to stochastic effects. The description of stochastic effects is subject to a degree of controversy (owing to the difficulties in separating the effects of low-level radiation exposure from the effects of other carcinogens, e.g. tobacco smoke, non-radioactive species, etc), but the currently accepted theories lead to the following conclusions about stochastic effects:

There is no threshold level of radiation exposure below which we can say with certainty that cancer or genetic effects will NOT occur. Doubling the radiation dose doubles the probability that a cancer or genetic effect will occur.

Taken together, radiation experts refer to these two conclusions as the 'linear-no-threshold' hypothesis. This hypothesis is questioned from time to time; however, it provides a pragmatic means of estimating radiation risks, and is consistent with the (limited) data that are available.

### Deterministic Effects

Deterministic effects are associated with much higher levels of radiation exposure, usually incurred over a much shorter period of time (fractions of a second to tens of days) than is the case for stochastic effects. As for stochastic effects, deterministic effects have two characteristic features:

There is a threshold radiation dose, below which the deterministic effects are not observed; The severity of the deterministic effect increases with the magnitude of the radiation dose

There are a variety of deterministic effects that can be observed after an acute exposure to radiation. These include (in order of increasing severity):

**Hemopoietic syndrome** – an effect related to the effects of radiation on blood-forming tissues, normally indicated by changes in blood cell counts

**Gastrointestinal syndrome** – an effect signaling the destruction of the gastrointestinal epithelium (the lining of the gastrointestinal tract)

**Central nervous system syndrome** – an effect seen at very high radiation doses in which the central nervous system undergoes irreparable damage.

The usual symptoms following an acute radiation dose include nausea, vomiting and general fatigue. In the case of the hemopoietic syndrome, medical intervention may be capable of saving the victim. With the gastrointestinal syndrome, the most likely outcome is death within several weeks. Anyone suffering the central nervous syndrome will die within a few hours to a few days of exposure.

### Section 3: Natural Radiation

The level of radiation exposure from natural sources occurs at the level of stochastic effects, discussed in the previous section, and the principal sources are as follows:

1. Cosmic rays;
2. Naturally occurring radionuclides in soils and rock;
3. Naturally occurring radionuclides in our bodies;
4. Radon gas in our homes

#### Section 3.1: Cosmic Rays

Cosmic rays are a source of radiation that originates from outer space. In fact there are two sources; the first is the sun, with the remainder originating from outside the solar system. Primary cosmic rays (those that are incident on the atmosphere of the earth) consist mainly of protons (hydrogen nuclei), and alpha particles (helium nuclei). Also present are electrons and a small number of heavier nuclei.

The energy of the primary cosmic rays can be very high, and when these cosmic rays interact with the atoms and molecules in the atmosphere, a number of additional secondary particles are produced, including protons, electrons, neutrons, positrons and a variety of more 'exotic' particles that will not be discussed here. Many of these secondary cosmic rays are sufficiently energetic to reach the surface of the earth.

At sea level, it has been found that the number of ions produced by cosmic rays is about 2 ions per cubic centimeter per second. Using this information, it can be calculated that the absorbed dose rate due to these cosmic rays is about 32 nGy/hr (0.00000032 Gy/hr). The world average annual dose rate due to cosmic rays is about 0.4 mSv/yr (0.0004 Sv/yr).

#### Section 3.2: Radionuclides in Soils and Rock

A number of radioactive materials occur naturally in the earth itself. These radioactive materials all have very long half lives, and have been present in the earth since its creation. At the creation of the earth during the Big Bang, perhaps about 15 billion years ago, virtually all possible atoms were created. Most of the radioactive atoms will have decayed away, but there are three important radionuclides that have such long half lives that even after 15 billion years, they are still present in the earth. These radionuclides are:

Uranium-238	half life = 4.46 billion years;
Thorium-232	half life = 14 billion years
Potassium-40	half life = 1.3 billion years

Other primordial radionuclides include rubidium-87 and uranium-235, but these are not so important in considering radiation doses to man. Uranium-235 is an important source of fuel for many types of nuclear reactor, and the extraction of concentrated amounts of uranium-235 from natural uranium in the ground is a major technological challenge.

Uranium-238 and thorium-232 have the important property that their radioactive decay products are also radioactive. Both of these nuclides are at the beginning of long sequences of radionuclides (containing about 10 or 15 members) in which each member is radioactive, and decays to the next member in the series. Only the final member of the series consists of stable atoms. Uranium-235 is also at the head of a long sequence of radionuclides.

### Section 3.3 Radionuclides in the Body

An important radionuclide that can be found in the human body is potassium-40 (it is also found in soils and rocks, and contributes to the doses considered in the previous section). The human body of a 70 kg man contains about 140 g of potassium, most of which is located in muscle. Of this potassium, about 0.018% is radioactive potassium-40. This corresponds to a mass of potassium-40 of about 0.03 g. It can be shown by calculation that the decay of this potassium-40 produces about 6000 radioactive decays every second, and therefore body tissues will acquire a radiation dose. The dose arising from potassium-40 in the body (and a contribution due to naturally occurring potassium-40 in rocks and soils) is about 0.1 mSv/yr.

### Section 3.4: Radon in Homes

One of the most important sources of natural radiation arises from an element called radon. The two most important isotopes of radon are radon-220 and radon-222. The former is often called thoron and the latter is usually given the name of the element, i.e. radon. To avoid confusion, we will reserve the term radon for the name of the element, and we will refer to each isotope explicitly. Radon has two important qualities from the perspective of radiation protection:

1. Radon is a gas;
2. Both isotopes of radon are radioactive and are derived either from the decay of uranium-238 (radon-222) or thorium-232 (radon-220).

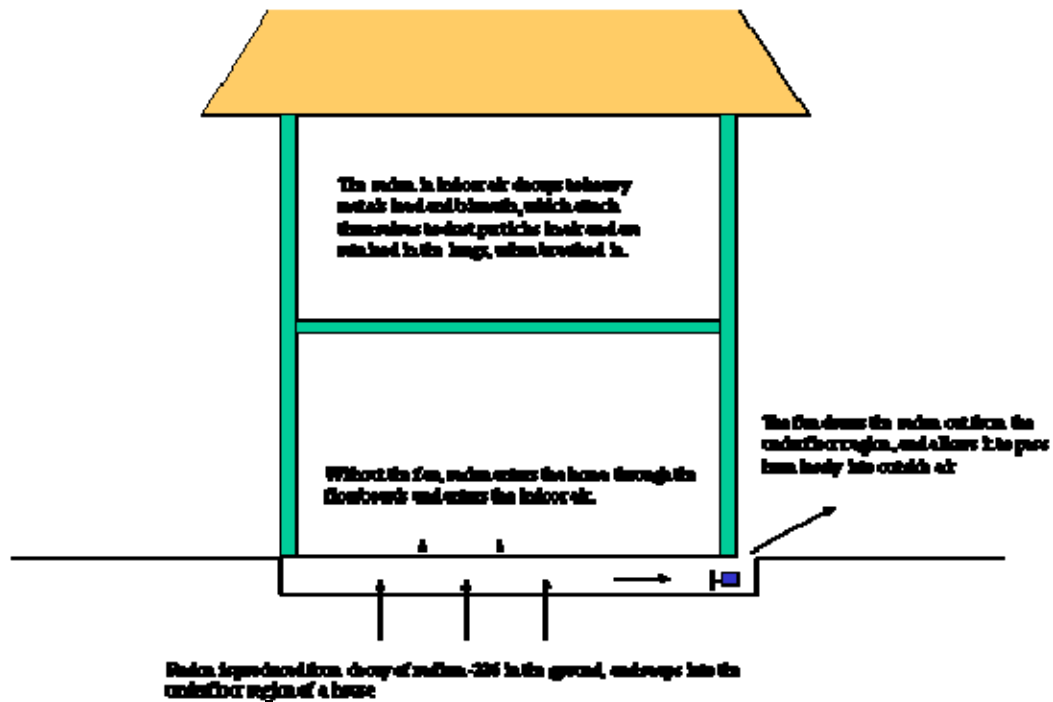
Thus, because uranium-238 and thorium-232 occur to some extent in all soils and rocks, it follows that radon gas is constantly emanating from the ground. In areas that are particularly rich in uranium and/or thorium ores, the rate of emanation can be quite high. However, the radiological hazard from radon-220 (thoron) is usually smaller than that from radon-222, because radon-220 has a half-life of only 55 seconds, and so decays away before radiological problems can arise. Radon is colourless and odourless, so we cannot perceive the presence of radon in the atmosphere. However, in most circumstances, only radon-222 is problematic.

Of particular importance is the fact radon can accumulate in enclosed structures such as homes and offices. The radon either seeps into buildings through the foundations, or in parts of the world where building materials are derived from local sources, the radon may enter the building as a result of emanation from the foundation and building materials themselves. If the degree of ventilation of the building is negligible, radon can accumulate to substantial levels. The radiological hazard is exacerbated by the fact that buildings such as homes tend to be occupied for substantial periods of time.

Strictly speaking, radon-222 itself is not particularly dangerous, as radon is an inert gas, and so radon breathed in tends to be breathed straight back out again. However, the decay products of radon-222 are isotopes of bismuth and polonium, which are 'heavy' metals that attach themselves to dust particles, and tend to accumulate in the lung. These isotopes then undergo further radioactive decay, and bombard the lungs with alpha particles, resulting in radiological damage to the cells of the lung. Thus, lung cancer is a possible outcome from exposure to radon. It should be noted that cigarette smoking tends to increase the likelihood of lung cancer in regions where radon levels are high.

The hazard of radon is taken so seriously that action levels are defined in most countries. These action levels specify the maximum concentration of radon and its decay products that is allowed

before intervention is required to lower concentrations. The most common type of intervention is the use of fans under the floor of an affected building to 'suck' radon out of the underfloor region, before it can enter the main volume of the building.



#### Section 4: Conclusion

As this article suggests, we have a number of sources of both natural and manufactured radiation around us today. In addition to article on EMF Radiation (*PRAB-CI-772\_EMF*), Beta and Gamma radiation have a detrimental health effect on our bodies and in sufficient doses can lead to the interpretations of events as having a paranormal source, instead of a natural one.