Monitoring of Ionizing Radiation Using Geiger Instrument during February to April 2015 in Sao Jose Dos Campos, SP, Brazil

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Abstract: Measures of ionizing radiation were observed in a tower which is 20 meters above the ground relative height. They show a distinct period of 24 hours oscillation during this February 11 to April 11, 2015. It is suggested that these oscillations originate from radon gas (^{222}Rn) vented from the ground floor. One Russian specific Geiger tube with associated electronics developed at ITA was used. Monitoring of ionizing radiation from 30 keV to 10 MeV shows that the X and gamma rays up to 3.0 MeV is prevalent in the region comes from the Radon gas ^{222}Rn that decay in ^{214}Bi and ^{214}Pb in the energies of the gamma rays 0.269, 0.609 and 1.05 MeV respectively. Then, with this simple, portable instrument was possible to monitoring the dynamics of radon gas in the region every interval minutes.

Key words: Atmosphere, radon gas, gamma radiation.

1. Introduction

The low energy radiation (α , β , X and gamma rays) in local environment depends on the presence of radionuclides and radon gas in the region. The local geological formation, the secondary cosmic radiation and human activities improve these radiations in same environment. These radiation with enough energy ($E > 12 \text{ eV}$) can ionize an atom. The ionizing radiation called “background” or background radiation in a particular region is the sum of these components. The geological origin radiation is largely the result of the decay of radioactive isotopes potassium (^{40}K), uranium (^{238}U) and thorium (^{232}Th) [1]. The radioactive decay, the cores can emit alpha radiation, beta, gamma or X-rays. Moreover, they are formed natural radioactive isotopes belonging to each decay series mentioned above. The ^{235}U has a half-life of

713 million years while the ^{238}U has a half-life of 4.5 billion years. With this, there is in nature a much smaller amount of ^{235}U comparing to ^{238}U [2-4].

The other major source of ionizing radiation in the soil-air interface is radon gas (^{222}Rn) which is also formed by the decay of uranium and thorium. In turn, the radioactive decay of radon produces ^{218}Po , ^{214}Pb and ^{214}Bi can be observed in the air near the ground by the presence of alpha particles, X and gamma. An important fact related to radon is that during rain, the concentration close to the ground may increase due to transportation of this gas by rain droplets [5, 6].

The radiation from the cosmic component (primary and secondary) produced in the lower atmosphere varies little over time. However, it varies greatly with latitude and height above the earth's surface [7]. This cosmic radiation produces “extensive showers” composed of particles and energy photons that reach the earth's surface. Artificial ionizing radiations are those produced by humans in a variety of activities such as medicine, dentistry and research in the

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industry. However, the sources of radiation are, in principle, confined and under control at a specific location [8, 9].

2. Materials

The basic part of the detector is a Geiger built in the laboratory of atmospheric and solar physics Moscow (Dolgaproudny), Russia. It was used tube 25 cm long by 3 cm in diameter with 5 atmospheres internal pressure and subjected to a voltage of 500 VDC Stozhkov YI (Fig. 1) [10]. Measurements were carried out in the tower of the Institute of Aeronautics and Space (IAE).

The data acquisition system was developed in the department of physics ITA using a data logger with Arduino platform. The same data logger collected parameters such as external temperature, relative humidity, atmospheric pressure and rainfall intensity on site every minute. The Fig. 2 shows the inside and outside of the data logger employed in the measurements made here. Viewing an SD card were measures saved each day in a txt file which identified with the year, the month and the day and always started at 0.01 minutes and ended at 23:59 minutes. The graph of the radiation measured by the Geiger was made every day, minute by minute and added over the entire monitoring period as shown in Fig. 3.

3. Experimental Results

The measurements were carried out between February 11 and March 11, 2015 with the Geiger placed in a temperature-controlled room of 20 °C and a height of 20 meters to the ground relative height. Fig. 3 shows the variation of data every minute (black) with a smooth of 1,440 minutes worth a full day between 00:01 to 23:59 hours. There is great deviation of counts from a minimum of 80-140 counts/minute with a daily average of 110 counts/minute (0.25 $\mu\text{Sv}/\text{hour}$).

The measures carried out in the period from February 11 to April 11, 2015 were few influenced by rains on site. This facilitates observing the regularity of intervals which can be seen in Fig. 3. With this frequency of 1 day, confirmed by FFT as shown in Fig. 4, it shows that the radiation observed by Geiger gamma rays are coming from radon gas in the period day and night because the temperature variation factor close to earth's surface next to the place of detector. The gamma radiation is coming from the ^{222}Rn decay in ^{218}Po , ^{214}Pb and ^{214}Bi emitting particles α in 5,490 MeV and photons γ in the energies of 0.609 MeV and 1.05 MeV. The α particles are not detected by Geiger due to their absorption in the metallic casing tube, then only the X and gamma radiation in sensitive

Fig. 1 View geiger counter with data logger on the upper room of observation tower.

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Fig. 2 External view of data logger and its used sensors.

Fig. 3 Intensity of integrated X and γ radiation in the period of February 11 to April 11 2015.

Fig. 4 Fast Fourier Transform (FFT) of Geiger counts per minutes (amplitude).

range is observed by Geiger [11-13].

4. Conclusions

The conclusions were made on the analysis of the measurements by using a Geiger data acquisition system ITA data logger. There is a clear periodicity of counts per minute of 24 hours. This periodicity confirms that the Geiger and associated electronics work properly since this phenomenon has been observed in the same location using a gamma scintillator "3 × 3" inches of NaI (TI) associated with photomultiplier. This indicates that the Geiger Russian detector system associated to ITA data logger is a simple and easy apparatus to use for observation ionizing radiation in various locations near the Earth's surface, this gets dispersed in a gradual way in the course of the day and breaks due to atmospheric warming.

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