Measurement and Analysis of Background Activity @NPRL, DU

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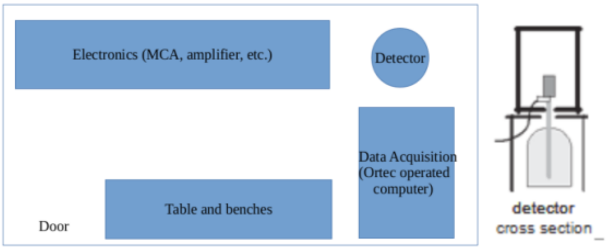
Introduction

The advancement in ground and space based observatories have opened a new avenue to explore the cosmos. The sophisticated experimental techniques and computational methods have steer to understand the microstructure of the universe. Observation and analysis of galaxies, stars, explosive events like novae, supernovae, and X-ray bursts span from radio to X-ray and/or gamma-ray energies indicate the elemental and isotopic abundances of stellar photospheres as well as the interstellar and intergalactic medium. Some of the processes are slow and their products may be emitted into space by any one of the explosions i.e. (i) Supernova (ii) Nova explosion and some of the processes are fast and their products may be ejected only in supernova explosions. In general, there are two neutron capture processes i.e. Slow-neutron capture and fast-neutron capture. The elements populated via the addition of low flux and slow neutrons builds up slowly, takes millions of years and lie near the line of stability. Hence, most of the elements are stable nuclei and their reaction rate typically may be measured directly. Further, the s-processes modelled with some precision, but the measured values of the cross-sections for (i) stable and (ii) radioactive nuclei at stellar energy regime are still lacking in the literature. Further, the study neutron capture reactions in neutron–rich light isotopes are topic of current interest. These reactions play a vital role in astrophysical scenarios because of the simulations of the evolution of the stars [1] and the synthesis of the heavy elements required to capture cross-sections as an input. Several studies [2-6] have been done to probe the chemical evaluation and nucleosynthesis processes in the Galaxies& Supernovae. Such measurements are also in need for wide nuclear applications viz., nuclear energy sources and emerging nuclear medicines for cancer treatments etc.

In order to carry the measurements using Ra-Be neutron source for neutron capture reactions a plan of the measurement of the background radiation has been undertaken. As the measurement and analysis of background radiation is an essential part of any experiment involving radionuclide. Since, spectroscopy of any radioactive sample includes the effects from residual contamination in the laboratory from its surrounding and other factors such as cosmic rays, life forms and/or the building material (emitting ^{40}K and traces of ^{14}C), environment (air). The geographical location, structure of building, in-house sources (like ^{137}Cs, ^{22}Na, ^{57,60}Co) & their type (weak/strong) are the factors that contribute to the background radiation incident on a laboratory. In June 1987, by Dr. Peter Bossew[7] in University of Austria, Vienna was conducted background measurements over a span of 16 years, summing up to 10^8 s and determined intensities of gamma-rays of background very accurately, which were added to the accuracy of the results of the experiments[7]. In general, analysis of the observed data for background radiation study reveals that intensities of the ^{226}Ra progeny lines (^{214}Pb, ^{214}Bi) are variable due to its dependence on environmental factors while ^{40}K-, ^{238}U-, ^{235}U- and ^{232}Th-series lines are comparatively constant.

Experimental details

In the present work, the measurement of the background radiation in the Nuclear Physics Research Laboratory(NPRL), Department of Physics and Astrophysics, University of Delhi (DU), Delhi have been carried out. The γ-rays are emitted in the laboratory via various sources i.e. cosmic rays, building material and/or life forms (emitting ^{40}K and traces of ^{14}C), environment etc. The geographical location also contributes to the background radiation of a laboratory. To detect the γ-rays a High Purity Germanium (HPGe) detector of 129cc active volume supplied by ORTEC was used. The arrangement of the detector in the laboratory is shown in FIG 1. The detector was calibrated for energy by using standard gamma –ray radioactive source ^{154}Eu, ^{137}Cs, ^{133}Ba, ^{60}Co,^{57}Co and ^{22}Na. These sources were also used to determine the efficiency of the detector. The resolution of the HPGe detector was 0.2% at γ-ray energy 661.7 keV of ^{137}Cs. The spectrums were recorded for the duration of 300*m* using HPGe coupled to a personal-computer-based multichannel analyzer setup employing the MAESTRO software shown in FIG 2. and the analysis of the spectra was performed using the software CANDLE[8] and the recorded gamma rays were identified using data



available in the literature [9,10].

Fig. 1 Layout of HPGe Detector inside the laboratory, NPRL, University of Delhi

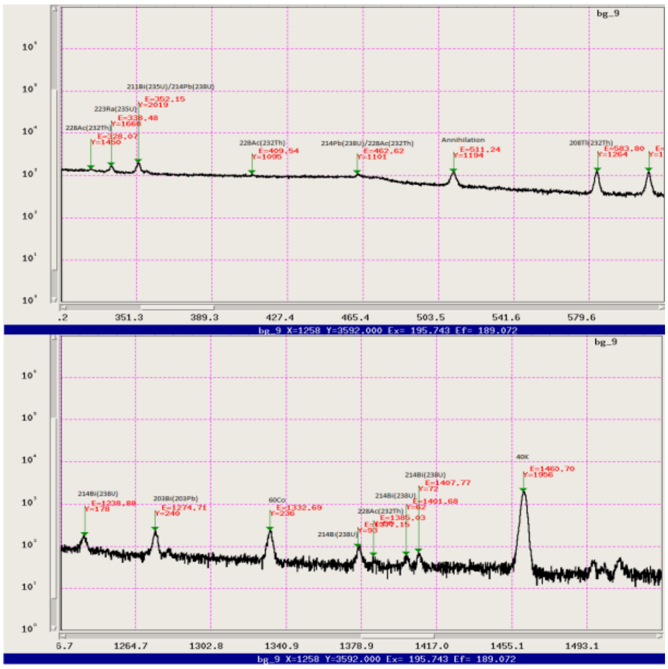


Fig. 2 Screen shots [Energy (keV) vs channel no] of background spectrum opened in CANDLE, observed peaks are marked

Results and discussion

In the present measurements of radiation in the laboratory background of NPRL, DU, a major contribution is observed from ^{238}U-, ^{235}U- and ^{232}Th-series, as shown in FIG. 3, where each of these nuclei decay via α-decay followed by two β-decay and so on till a stable Lead nuclide (^{206,207,208}Pb) is attained. Another contribution comes from the ^{226}Ra progeny lines (^{214}Pb, ^{214}Bi) along with sources present in the laboratory like ^{137}Cs, ^{22}Na, ^{57,60}Co. The ^{40}K is found due to the surroundings and presence of organic life and /or building material of laboratory around the experimental setup while Radon & its progenies are present in the environment around the setup. The Uranium & Thorium chain nuclides are found with significant count rate. Traces of ^{203}Bi were also detected which sources from ^{203}Pb. The complete recorded spectrum and a list of the identified gamma rays in the background along with the residues and their source will present during the symposium. In the future, the objective is to measure the background data for a longer term around 2-3 months, keep in mind the measurement will be performed for astrophysical reactions in NPRL, University of Delhi and to measure radionuclide that would take longer to acquire

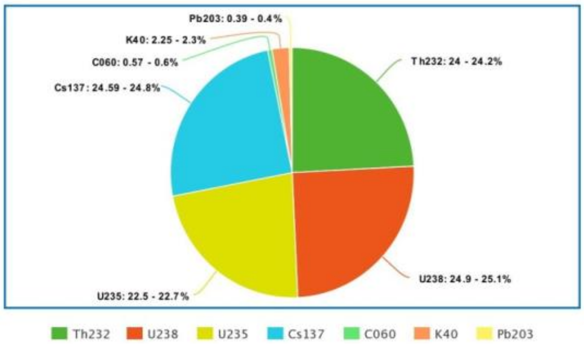


Fig. 3 Pie Chart distributions of radionuclide observed in the and their relative intensities are also mentioned.

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