§8. Radiation Education for High School Students by Measurement Sharing Method Using Potassium Chloride Radiation Sources

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In the National Institute for Fusion Science various exercises are practiced for high school students who visited to the facilities. One of the exercises is an environmental radiation measurement. In the recent exercise we began to use natural radiation sources fabricated from potassium chloride chemicals with method of formation and compression. Thus fabricated natural radiation sources emit beta particles with a maximum energy of 1.33 MeV and gamma radiation at 1.46 MeV because naturally occurring potassium contains radioisotope potassium-40. In the exercises beta particles were counted for 1 minute with GM survey meters (1-min integration counts).

The present exercise contains main three radiation measurements, dependence on time, dependence on distance, and dependence on shielding effects. The measurements of dependencies enabled students to better comprehend the principles underlying protection against external exposure to radiation based on time, distance, and shielding.

At the beginning of the exercise of the environmental radiation measurement, students were separated into several pairs. The number of pair depended on the number of students visited and radiation measurements were performed in pair. The pair number was from 4 to 8 so far.

In this study a measurement sharing method was first applied to the measurements. When applying the measurement sharing method, the paired students share a series of measurement. In the case of the measurement of dependence on distance, the 1-min integration counts of radiation were measured for several distances, 8 distances (0, 1, 2, 3, 7, 10, 20, 30 cm) for four pairs, being zero when the source was placed directly on the surface of the GM probe. The first pair measured the 1-min integration counts at distances of 0 and 7 cm, the second pair, 2 and 10 cm and so forth. As each pair had charge of two measurements, 4 pairs obtained 8 measurement data.

In recent years students from 9 high schools visited to our facility and 45 pairs took the exercise of environmental radiation measurement. All 1-minute integrated counts measured by 45 pairs on dependence on distance are shown in Fig. 1. As each pair measured twice, 90 data are plotted using open circles at eight distances in the range from 0 to 30 cm. The data vary depending on individual pairs.

A curve represented by function $Y = A/(a+X)^2 + BKG$ is also plotted in Fig. 1 for reference, X and Y corresponding to the distance and the 1-min integrated counts, and A, a and BKG being constants with values of 3500 (cpm·cm^2), 2.7(cm) and 46.9 (cpm), respectively. The plotted data lie along the curve. The initial steep decrease in the 1-min integrated counts was drastic as the distance from the source ranged closer. This steep decrease was followed by a slow decrease as the distance increased. These changes in distance could be explained according to the inverse-square law, which is an important principle of protection against radiation.

The small figure in Fig.1 indicates data obtained by a school students containing 4 pairs. There are 4 different symbols meaning different pairs and two same symbols mean data obtained by same pairs. The small figure can

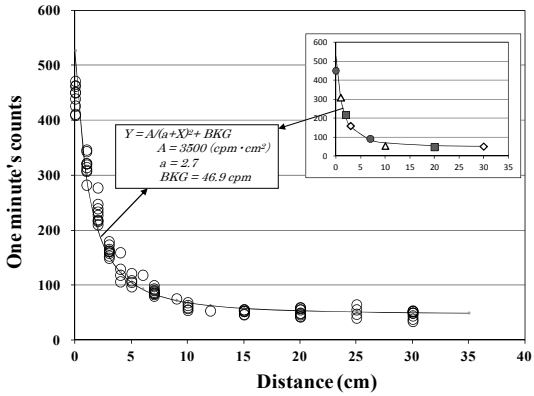

Fig.1 Dependence of one minute's counts on distance.

demonstrate the relationship between the 1-min integrated counts and the distances are the same as the large figure, although measurements of 1-min integrated counts at 8 different distances were shared among four pairs (each responsible for two of eight measurements).

The measurement sharing method was also applied to the dependence on shielding effects, and obtained results is shown in Fig.2, which can explain the exponential relationship between the effectiveness of shielding and its thickness based on the main and small figures in Fig.2.

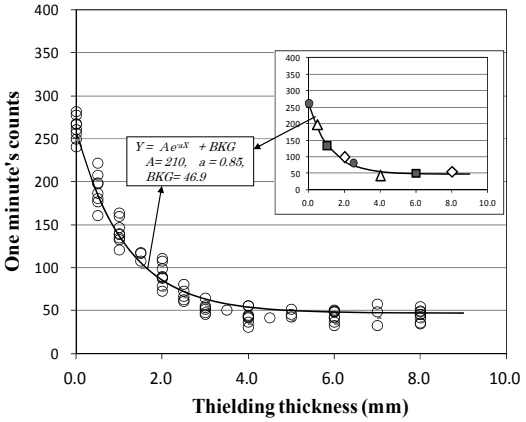

Fig.2 Dependence of one minute's counts on shielding thickness.

Through the exercise, students understood the existence of natural radiation and radioisotopes around us, and learned the three principles of radiation protection. According to the questionnaire survey conducted after the exercise, it was found that the environmental radiation measurement by the measurement sharing method using potassium chloride radiation sources was favorably received by many high school students.