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A METHOD FOR RECORDING
NUCLEAR RESONANCE CAPTURE SPECTRA

Thomas R. Jeter
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Department of the Army Project No. 512-10-001
Ordnance Management Structure Code No. 5610.11.705
BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

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A METHOD FOR RECORDING NUCLEAR RESONANCE CAPTURE SPECTRA

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March 1961

A METHOD FOR RECORDING NUCLEAR RESONANCE CAPTURE SPECTRA

ABSTRACT

A method is described for continuously varying the Van de Graaff ion beam energy while the count rate from the decay of the compound nucleus is monitored and recorded. The method utilizes a synchronous motor system to synchronize the recorder and the magnetic field control of the Van de Graaff analyzing system.

Use of this method results in significant time saving in calibration of the Van de Graaff accelerator and the determination of target thicknesses.

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INTRODUCTION

For many nuclear reactions the cross section is appreciable only if the energy of the incident particle is near certain resonance values. These resonance energies correspond to excitation energies close to the allowed states of the compound nucleus. Thus a plot of the cross section for a given reaction against the energy of the incident particle gives the resonance spectrum for the reaction.

Resonance spectra are often obtained by measuring the intensity of gamma radiation resulting from decay of the compound nucleus formed in the nuclear reaction as a function of incident particle energy. The resonance spectrum for the reaction $\text{Al}^{27}(\text{p},\gamma)\text{Si}^{28}$, for example, is obtained by plotting the intensity of gamma radiation as a function of the incident proton energy (1,2,3). Such spectra are usually plotted by measuring the gamma radiation intensity for a number of fixed energy values of the proton beam. It is the purpose of this report to describe a system for continuously recording resonance spectra produced by bombardment of a target with the ion beam of a Van de Graaff accelerator.

EXPERIMENTAL

The system utilizes a continuous method of varying the Van de Graaff ion beam energy while the count rate from the decay of the compound nucleus is monitored and recorded. The energy of the ion beam of a High Voltage Engineering type KN Van de Graaff accelerator is easily controlled over small ranges by varying the strength of the analyzing magnetic field. This may be simply done using a synchronous motor to drive the field current control potentiometer of the analyzing system. Gamma radiation from the reaction being studied can be monitored with a count-rate meter, and the output of this meter recorded continuously. The recorder and the drive on the analyzing magnet are then synchronized with a selsyn system.

An arrangement of components used for recording the $\text{Al}^{27}(\text{p},\gamma)\text{Si}^{28}$ resonance spectrum is shown in Figure 1. Clearly a variety of components could be used, and those shown in Figure 1 are only representative.

RESULTS

Typical spectra recorded for the $\text{Al}^{27}(\text{p},\gamma)\text{Si}^{28}$ reaction in the proton energy range from about 1.350 to 1.385-Mev. are shown in Figure 2. Spectra are given for two sweep rates. The limiting feature of the system is the response time of the count-rate meter. For weak resonances, the sweep speed must be reduced. In the limit, for very weak resonances, the system offers, of course, little advantage over the point-by-point technique. The effect of sweep speed on the strong resonances at 1.372 and 1.379-Mev. can be seen by comparing the recordings in Figure 2.

CONCLUSIONS

The system described above offers significant saving in time for such routine operations as the calibration of the Van de Graaff accelerator ion beam and the determination of target thickness and purity. It is also useful in rapidly locating resonances that are to be studied in more detail by coincidence measurements and angular correlation techniques.

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FIGURE 1
RECORDING NUCLEAR RESONANCE SPECTROGRAPH

FIGURE 2

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