PRODUCTION OF NEW NEUTRON-RICH NUCLEI BY USING HIGH FLUX FAST NEUTRON FROM AN AVF CYCLOTRON

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Abstract

This paper reports results of experiments for the production of new neutron-rich nuclei by using high flux fast neutron beam generated by an AVF cyclotron at RCNP, Osaka University. Obtained fast neutron flux was more than 10^{10}n/cm^2·sec·μA, and then this neutron beam was used for the production of a quite new nuclide ^{168}Dy by the reaction ^{170}Er(n,2pn)^{168}Dy.

1. Introduction

Nuclear spectroscopic information concerning neutron-rich nuclei in the rare earth region are less than that of proton-rich nuclei. The production method of the neutron-rich nuclei in this region is limited to the fast neutron irradiation and the cross sections of (n,2p), (n,2pn) and so on are small. Therefore, a high flux high energy neutron source is necessary for the study of the neutron-rich nuclei in the rare earth region. This paper reports results of experiments for fast neutron production by an AVF cyclotron and the production of a new neutron-rich nuclide ^{168}Dy.

2. Apparatus

The AVF cyclotron at Osaka University was used for the fast neutron production.

A Be target was irradiated by proton (E_p : 65 MeV) or deutron (E_d : 55 MeV) beam. The beam currents were about 1 μA.

The neutron flux was measured by the activation method.

A Ge(Li) detector with a 4096 channel P.H.A. was used for the measurements of gamma-rays of activities.

3. Flux Measurement of Fast Neutron

The flux and the angular distribution of the fast neutron were measured by the activation method.

The angular distribution was measured by using the reaction ^{27}Al(n,α)^{24}Na.

Twenty small aluminum foil samples were set at 20 positions in front of the Be target and irradiated simultaneously by the fast neutron. The gamma-ray intensities from the produced ^{24}Na were measured by the Ge(Li) detector. It was found that the produced fast neutron flux was intense in the forward direction and the so-called FWHM was about 20°.

The neutron flux in the forward directiction was also measured by the reaction ^{12}C(n,2n)^{11}C, and the obtained neutron flux was 10^{10}n/cm^2·sec·μA.

4. Production of a New Nucleid ^{168}Dy

The fast neutron flux produced by the Be-p(65 meV) reaction was used for the production of ^{168}Dy through the reaction ^{170}Er(n,2pn)^{168}Dy. The isotope ^{168}Dy is a new isotope and its properties are unknown.

Therefore, confirmation was made by observation of gamma-ray of daughter nucleus ^{168}Ho. The intrinsic life time of ^{168}Ho is 2.98 min[1]. However, if the ^{168}Ho is produced by the decay of ^{168}Dy, the decay pattern depends on the life time of ^{168}Dy. A decay curve of a strong gamma-ray (E_γ : 741 keV) in spectra taken by the Ge(Li) detector shows a long life component (Life time : 30 ~ 40 min).

This value is close to an estimated life[2] for ^{168}Dy from the gross theory, and suggests the production of ^{168}Dy.

Production of a new isomer of ^{152}Pm was also confirmed by observation of decay of gamma-rays of 121.8 keV and 244.7 keV, and a life of the new isomer was determined to be 15.0 ± 0.2 min.

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Reference

1) K. Kawade et al. : J. Phys. Soc. Japan 34(1973)857

2) K. Takahashi et al. : Atomic Data and Nuclear Data Tables 12(1973)101