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A SEARCH FOR B^{13}

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August 21, 1953

Berkeley, California

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ABSTRACT

When various elements were bombarded with 340 Mev protons and 190 Mev deuterons, no neutron activity was found which would correspond to the decay of B^{13} as a delayed neutron emitter with a half-life in the range from 0.5 millisecond to 0.5 hour.

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INTRODUCTION

Isotopes which decay by negatron emission followed promptly by a neutron are known as delayed neutron emitters. Several such isotopes have been observed as fission products and two more have been produced in cyclotron reactions. The best identified of the fission activities,[1, 2] Br^{87} and I^{137}, and the cyclotron activities,[3, 4] Li^{9} and N^{17}, all have in common the property that the end product of the decay contains a closed neutron shell. In addition, it has been suggested[5] that B^{13} should be a delayed neutron emitter going finally to C^{12}. Sheline[6], using a 50 Mev betatron, has not observed B^{13} in a search for new low Z beta activities of half-life greater than 0.1 sec.

Barkas[7] predicts B^{13} to be particle stable with a mass of 13.0207. This gives a beta plus neutron excitation of 7.45 Mev. Assuming an allowed transition with ft = 5×10^3, as is the case of N^{17}, one gets a minimum expected half-life of 0.2 sec. With outside limits on the mass and the ft value, one finds a minimum possible half-life of 0.002 sec.

EXPERIMENTAL PROCEDURE

Three holes were bored in a large block of paraffin, one for the targets and one on either side for a BF_3 counter. In order to reduce the background from neutrons reverberating inside the shielding, the target assembly was surrounded with 1/16 inch of cadmium and three more inches of paraffin. Various low and middle Z targets were exposed to the deflected 340 Mev proton and 190 Mev deuteron beams of the 184-inch cyclotron.

For examination of half-lives greater than 0.1 sec. the cyclotron was turned off after a short bombardment and the counting rate was monitored with a Brush Recorder. For half-lives shorter than 0.1 sec., the counter outputs were combined into ten scalers which were gated on and off in succession between beam pulses. The width of the gates could be varied from 80 μ sec. to 100 m sec. In addition, the first gate could be delayed in arbitrary time from the beam pulse. The deflector was pulsed only once a second so that build up of the Li^9 activity would not obscure any other decay of shorter half-life. It was found that all targets, except those producing a high yield of Li^9 or N^{17}, exhibit neutron decay which varies with the target but whose half-life in no case exceeds 240 μ sec. This is interpreted as the limit imposed by the diffusion of neutrons produced by nuclear transmutations in the target.

CONCLUSION

If B^{13} is particle stable, it should have been produced by spallation reactions; therefore, it is concluded that B^{13} is not a delayed neutron emitter with a half-life in the range from 0.5 m sec. to 0.5 hr.

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