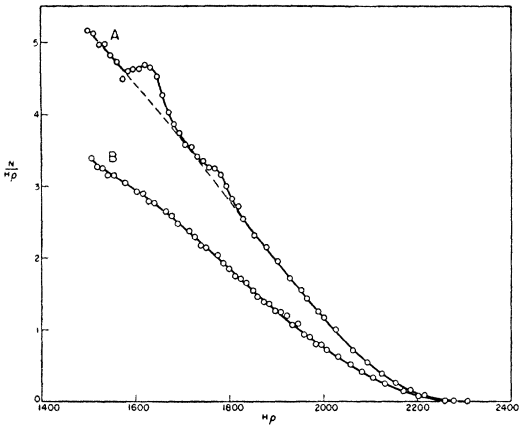

FIG. 1. Curve A. Beta-spectrum of Xe^{133} 11 days after bombardment. Curve B. Beta-spectrum of same source 20 days later with ordinate scale multiplied by 10.

later. It can be seen that the 196-kev conversion line has essentially disappeared in curve B. This shows that the 232-kev gamma-ray decayed with a shorter half-life than the 5.3-day beta-radiation.

The decay of the unconverted 232-kev gamma-ray, which was found in low intensity, was measured with a Tl activated NaI scintillation spectrometer. This gave a half-life of approximately 2 days in agreement with the observed decay of the 196-kev conversion electrons.

This 232-kev gamma-ray is undoubtedly the same as the 232-kev gamma-ray found by Bergström and Thulin and is therefore associated with the decay of an isomer of mass 133. Their suggestion that the 232-kev gamma-ray is emitted in an isomeric transition in Xe^{133} is probably correct. However, the half-life of 2-day is not the same as that of the 5.3-day beta-decay and therefore the two transitions cannot occur from a single metastable level in Xe^{133} as proposed in their decay scheme.

Bergström and Thulin have pointed out that the level assignments in the decay scheme they proposed were consistent with the nuclear shell model of Mayer.[3] This theory is also consistent with the experimental results reported here provided that the assignment of the 2-day metastable level is $h_{11/2}$ and the 5.3-day ground-state assignment is $d_{3/2}$.

It is hoped that work now in progress on parent-daughter relationships and internal conversion coefficients will help to establish decay schemes for I^{133} and Xe^{133}.

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Acceleration of Stripped C^{12} and C^{13} Nuclei in the Cyclotron*

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THE acceleration of stripped C^{12} and O^{16} nuclei in the cyclotron has been reported.[1-4] The significance of this feat was limited by the fact that the obtainable intensities were far too small to produce a sufficient number of nuclear reactions to permit the detection of radio-isotopes formed by the transmutation of target nuclei by these heavy ions. The discovery of the trans-uranic elements has given considerable impetus to attempts to achieve this. For the last four years, a program to increase the intensities of accelerated heavy ions has been under way at the Crocker Laboratory using the 60-in. cyclotron. This program has included attempts to accelerate B^{10}, B^{11}, C^{12}, C^{13}, N^{14}, O^{16}, O^{17}, O^{18}, and F^{19}.

TABLE I. Ranges and energies of accelerated nuclei of He^4, C^{12}, and C^{13}.

Particle	Measured range (mg/cm² Al)	Expected range	Measured energy (Mev)	Expected energy (Mev)
$_2He^4$	158±2	158	38.6±0.4	38.6
$_6C^{12}$	53.5±2	54	115±2.4	116
$_6C^{13}$	55.5±2	58	122±2.5	125

To date, detectable intensities of completely stripped C^{12} and C^{13} ions have been observed. A hooded capillary ion source gave the best results. The source gas for the production of carbon ions was CO_2. Range determinations using aluminum absorbers were made and the data is summarized in Table I, giving the measured and expected range-energy relationships.

The maximum intensity of the external deflected beam of C^{12} ions that has been obtained to date is of the order of 10^5 C^{12} nuclei per second, and 10^4 C^{13} nuclei. In the case of C^{13}, material enriched to 50 percent of this isotope was employed.

Aluminum and gold were selected as target elements as they can be obtained in a high degree of purity and possess a single stable isotope. The transmutation products sought were Cl^{34} and the light isotopes of astatine. These possess conveniently short half-lives and may be isolated by relatively simple chemical procedures. The At isotopes were particularly attractive in view of the fact that the lighter ones, notably At^{203}, At^{204}, and At^{205} could not be produced in the 60-in. cyclotron by the ever-present contamination of alpha-particles.

Internal targets of Al and Au were bombarded. The 33-min. positron emitting Cl^{34} and the[5] 24-min. At^{205}, were chemically isolated and identified by the character of their radiations and rates of radioactive decay. Further proof identification was made of At^{205} by the use of the alpha-particle pulse analyzer developed by Ghiorso who made these determinations for us. The yields were in the range of from 0.1 to 0.002 microcurie. Assuming the cross section for the production of Cl^{34} from Al to be in the range of 0.1 barn, the internal C^{12} beam was estimated to be of the order of 10^8 ions per second. The nuclear reactions for the production of these two radio-isotopes are presumably $Al^{27}(C^{12}, \alpha n)Cl^{34}$, $Au^{197}(C^{12}, 4n)At^{205}$.

Internal target bombardment of Al with stripped C^{13} nuclei gave inconclusive results. The bombardment of Au with C^{13} ions produced a small amount of alpha-particle activity. The presence of 11- and 25-min. components suggests the possibility that the 7-min. At^{203} and 24-min. At^{205} had been produced.

Control runs were made to rule out radioactive contamination. Al and Au were bombarded with alpha-particles and runs were made using an argon arc at the magnetic resonance value for C^{12}. In both instances, no Cl^{34} from Al and no alpha-activity in the gold was observed. Covering the targets with 0.3-mil Al foil demonstrated that sputtering of radioactive materials in the cyclotron could not account for the production of Cl^{34} or the alpha-particle activity in the C^{12} and C^{13} bombarded Au.

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