the range cell. The range cell was 6.86 cm long with a mica foil on the end away from the target cell. The pressure in the range cell could be varied, allowing a change of about 6 cm in the air equivalent of the range cell. The ionization chamber and foil holder were fastened next to the exit window of the range cell. The entire assembly of target cell, range cell, foil holder and ionization chamber were screwed firmly together so that no relative motion of the parts could take place.

The pressure in the range cell could be read to about 1 mm Hg. The set of mica foils used in this experiment were all from one sheet and the stopping power in mg/cm²/cm of air was measured for two thin foils. The air equivalents of the thicker foils were obtained using the value 1.42_5 mg/cm²/cm air for 5-Mev alpha-particles. The value 1.07 Mev for the energy of the deuterons was computed from the physical constants of the cyclotron. A high bias was used on the counting Thyratron of the amplifier and a correction made for the bias and depth of the ionization chamber using the specific ionization curves for alpha-particles[1] and protons.[2]

Two proton groups have been measured by Cockcroft and Lewis[3] from the $N^{14}(dp)N^{15}$ reaction. These proton groups were measured in the present work and, in addition, a group of protons of 66.1-cm range was observed. This 66-cm group was observed both with the $N^{14}-N^{15}$ mixture and with ordinary tank nitrogen in the target cell, but was not observed with CO^2 as the target gas or with the target cell evacuated. Thus there is reason to assign the 66-cm proton group to the $N^{14}(dp)N^{15}$ reaction.

With the same $N^{14}-N^{15}$ mixture in the target cell three groups of alphas were observed. Two of these have been found previously[3, 4] and are from the $N^{14}(d\alpha)C^{12}$ reaction. The other group (5.09-cm range) can be attributed to the $N^{15}(d\alpha)C^{13}$ reaction since it appeared with no target gas except the one containing N^{15}. Further, the Q value, 7.40 Mev, checks sufficiently well with the Q value 7.55 calculated from the mass values.[5] In addition to the three homogeneous groups the intense continuous distribution of alphas arising from the reaction $N^{14}+H^2\rightarrow 4He^4$ was found below 3.9-cm range.

Because of the relatively large number of alpha-particles in the region below 6 cm it was not possible with the present equipment to detect the short range ($\sim$3.5 cm) proton group expected from the $N^{15}(dp)N^{16}$ reaction. It is hoped that with a target of much higher N^{15} concentration it will be possible to detect protons in this region below 6 cm.

TABLE I. *Experimental results of deuteron bombardment of* N^{14} *and* N^{15}.

REACTION	RANGE CM 15°, 760 MM	Q VALUE MEV	EXCITATION LEVEL MEV
$N^{14}(d\alpha)C^{12}$	11.59	13.21	C^{12} gr. st.
	6.37	8.86	4.35
$N^{14}(dp)N^{15}$	90.76	8.41	N^{15} gr. st.
	66.10	6.88	1.53
	20.99	3.10	5.31
$N^{15}(d\alpha)C^{13}$	5.09	7.40	C^{13} gr. st.

The results of the present experiment are shown in Table I. The Q values obtained from range measurements are all lower by about 0.15 Mev than those obtained from mass values.[5] Repeated checks on the method used in measuring the ranges indicate that a systematic error is not likely in this part of the experiment. It is possible that there is an error in the energy value 1.07 Mev of the incident deuterons, although this figure was checked by direct measurement of the deuteron ranges.

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A Radioactive Isomer of Sr^{87}

In connection with studies soon to be reported of the radioactive isotopes of Sr and Y we have given particular attention to a period of 2.7 ± 0.2 hours which appears to be associated with an excited state of stable Sr^{87}.

Stewart, Lawson and Cork[1] reported a 3-hour Sr period produced by $Sr+d$ and $Sr+n$ (slow). They assigned it to an isomeric state of Sr^{89}, rejecting other possible assignments because the activity was electron rather than positron emitting. Cloud-chamber observations showed an apparently continuous spectrum with an upper limit of 610 kev. Our cloud-chamber measurements are similar to theirs, but the beta-ray spectrograph shows that the spectrum consists only of a strong line at $H\rho 2340$ (360 kev). (The broadening of the spectrum in the cloud chamber is undoubtedly due to the scattering which is important at these low energies.) These electrons are evidently K and L conversion electrons accompanying a 370-kev gamma-ray emitted in a K-electron capture or an isomeric transition. This removes the necessity of assignment to Sr^{89}.

We further find that this same period with the same electron spectrum is produced strongly by $Rb+p$ at 6 Mev. Only a $p-n$ reaction could account for the yield, which restricts the assignment to either Sr^{85} or Sr^{87*}. There is also a strong period of $\sim$60 days produced in this reaction. In view of the argument below this may be assigned to Sr^{85}.

Finally an 85 ± 5-hour yttrium activity (produced either by $Sr+p$ or $Sr+d$) shows the same electron line. When Sr is extracted from an aged sample of this activity the Sr fraction decays with the 2.7-hour period while the Y fraction grows with this period. The only Y isotopes which could be produced by both $Sr(p, n)$ and $Sr(d, n)$ are Y^{87} and Y^{88}. The latter has already been assigned[1] a 2-hour (e^+) period, since it is produced also by Y+fast neutrons. Stewart *et al.*[1] reported a 60-hour Y period from $Sr+d$ which they identified with the 60–70-hour Y^{90}, produced by $Y+n$ and $Y+d$, postulating a $Sr^{88}(d, \gamma)Y^{90}$ reaction.

Since the Y decay curves are complicated by the growth of the 2.7-hour Sr and by a very long Y period we believe that they were also observing this 85-hour period. This activity does not show the high energy beta-rays of Y^{90}.

We conclude that both the 85-hour and 2.7-hour periods must be assigned to isobars of mass 87. Then Y^{87} decays by K-electron capture to the excited Sr^{87*} which goes to the ground state Sr^{87} with the 2.7-hour period and the emission of a partially converted 370-kev gamma-ray. Absorption measurements in Pb show the expected absorption coefficient for this gamma-ray and Al absorption curves indicate a conversion factor of about 15 percent. The 2.7-hour activity emits x-rays also which show high mass absorption coefficients in both Se and Br indicating they are Sr rather than Rb K x-rays. The same Sr^{87*} is also produced directly by $Rb^{87}(p, n)$ and $Sr^{86}(n, \gamma)$. In the $Sr+d$ and $Sr+p$ bombardments it is probably produced only by the decay of Y^{87}, which accounts for the low and variable yield.[1]

The question arises whether Sr^{87*} is formed by the decay of naturally radioactive Rb^{87}. We extracted Sr from 5 g of RbCl but found no activity as much as 0.1 percent of that expected if every Rb^{87} atom decayed to Sr^{87*}. Furthermore, Libby and Lee[2] have found the maximum energy of the electrons from Rb^{87} to be 132 kev. There is thus no evidence for the 360-kev electrons from Sr^{87*} and it seems probable that only the decay to the ground state of Sr^{87*} is energetically possible.

It is interesting that in three of the five known pairs of adjacent isobars there is now known an excited radioactive state in one of the pair (In^{113} and In^{115} being the other cases[3]). In each case the period of the excited state is in the neighborhood of 2–4 hours and the energy is in the range 330–390 kev above the ground state.

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