## Disintegration-Experiments on Elements of Medium Atomic Number

In view of the drastic revision in the theoretical treatment of the penetration of nuclei by charged particles which is necessary if nuclei of medium and high atomic number are disintegrated by protons having energies of only a few hundred kilovolts, we have endeavored to verify the observations reported last year by Cockcroft and Walton.[1] Using a mixed beam of protons and hydrogen molecule-ions with currents exceeding $10\mu A$ to the target at voltages between 550 and 620 kilovolts (obtained with a one-meter electrostatic generator of the type devised by Van de Graaff) we have measured by means of a linear pulse-amplifier the number of alpha-particles (and protons) of range exceeding 16 mm which are emitted by targets of Al, Ni and Ag. The geometrical arrangement and dimensions of target and windows are nearly identical with those described by Cockcroft and Walton. A shutter ahead of the target and window eliminates possible spurious effects due to electrical disturbances affecting the amplifier or to radioactive contamination, all records being made in the sequence target-shutter-target-shutter with no changes in voltage, current, or other variables when the shutter is closed for the residual count. We selected Al, Ni and Ag, as representative of the heavier elements for which disintegration-counts were reported by Cockcroft and Walton (we had previously checked their later observations on Li and B).[2] Where they report (as "order of magnitude only") 135, 35 and 50 scintillation-counts per microampere per minute at 300 kilovolts we observe 0.2, 0.8 and less than 0.1 alpha-particle per microampere per minute through the window at 600 kilovolts for Al, Ni and Ag, respectively. The range of these particles was found within experimental error to be the same as that of the short-range (about 27 mm) particles observed from a boron target in the same apparatus, which gave a yield of 6600 alpha-particles per microampere per minute. The observed yields from Al, Ni and Ag can thus be explained by boron impurities of amounts 1/33,000, 1/9000 and 1/100,000 in these targets. Contamination to this extent by boron is certainly to be expected unless severe precautions are taken. The counts on Al and Ag are near the limit of detection with proton-currents of 10 to 20 microamperes. It should also be stated that a small number of very fast protons could perhaps have escaped notice, since the amplifier was set for convenient recording of alpha-particles and heavier fragments. We have no suspicion of such disintegration-protons, however. For these observations a minimum stopping-power of 16 mm was adopted, since the 600-kilovolt primary protons have a range of 12–13 mm. (It should be emphasized that roughly $10^8$ protons per second are scattered 90° through the 10 mm diameter window.) The absolute yield for boron in these observations is only 1/9 of the absolute yield (one alpha-particle per $4\times10^6$ protons and $H_2$ ions) observed by us in January 1933 with the use of a stopping-power of 12 mm. The reason for this discrepancy, which in no way invalidates the comparisons for Al, Ni and Ag, is obscure, but it may be in part due to the difference in minimum stopping-power and in part to a possible overestimate of the yield in our January results, which assumed a uniform distribution of the beam over the target-area. There is thus no evidence in our observations that disintegration-protons or alpha-particles of range exceeding 16 mm are produced when Al, Ni and Ag targets are bombarded by 600-kilovolt protons. These results were reported at the meeting of the Physical Society last week, and in preliminary form were presented March 25 before the Philosophical Society of Washington.

The above data were unexpectedly obtained with targets of quite ordinary purity, although the first aluminum target used gave a somewhat higher number of counts. The observations will be extended, particularly with view to observing possible shorter-range particles (necessarily at lower voltages). Housing is under construction for our 2-meter generator, which should also enable us shortly to carry these observations up to 1400 kilovolts or higher.

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May 5, 1933.

[1] J. D. Cockcroft and E. T. S. Walton, Proc. Roy. Soc. (London) **A137**, 229–242 (1932).

[2] J. A. Fleming, Science **77**, 298–300 (1933).

## Occurrence of $CuAl_2$ in Duralumin

The producer of airplane propeller blade forgings as well as the manufacturer and user of propellers is vitally interested in their performance. The superiority of the aluminum alloy propeller over the wood propeller it replaced is uncontested. Failures have been relatively few, but as long as any occur, every effort must be expended to reduce their number. In the majority of instances, failure has been found to be definitely the ultimate result of progressive damage accidentally initiated some time prior to the failure. The few cases where initial mechanical damage was not evident emphasize the desirability of being able to recognize and follow such progressive damage by some nondestructive test. This desideratum prompted a hopeful and careful consideration of the observations reported by Clark and Smith.[1] Drs. Clark and Smith reported the presence of diffraction lines attributable to $CuAl_2$ in x-ray patterns from a duralumin-type aluminum alloy aircraft propeller blade. The blade had been in service for an unusually long period of time. They postulated that the presence of $CuAl_2$ lines indicated

[1] Clark and Smith, Phys. Rev. **43**, 305 (1933).