LETTERS TO THE EDITORS

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Deuteron Reactions with Separated Magnesium Isotopes

Different investigators have studied the proton groups emitted during bombardment of magnesium[1]. Using separated isotopes and a counting method, Allan, Wilkinson, Burcham and Curling[2] have found three different groups from the reaction $^{24}Mg(d,p)\,^{25}Mg$ and one group from $^{26}Mg(d,p)^{27}Mg$. By bombarding magnesium-25, they found again three groups, the ranges and relative intensities of which, however, were nearly the same as those found in magnesium-24. They concluded, therefore, that the former groups were due to contamination with magnesium-24 and supposed that magnesium-25 under bombardment with deuterons (of 0·9 MeV.) does not emit protons at 90°. On the other hand, Pollard and Humphreys[3] earlier had reported the emission of three proton groups, although they did not state the actual energy release.

We therefore decided to study these (d,p)-reactions by means of photographic emulsions. Isotopic samples of magnesium of 15–90 μgm./sq. cm. were bombarded with deuterons of 1·9 MeV. The protons emitted at an angle of 90° were detected in a photographic emulsion (Ilford C 2, 100 μ) in an arrangement described earlier[4].

The following results, which are summarized in the table, were obtained:

Process	Range (μ)	Energy* (MeV.)	Q-value (MeV.)	Level (MeV.)	Relative intensity (approx.)
$^{24}Mg(d,p)^{25}Mg$	140	6·48	4·99±0·10	ground	20
	104	5·92	4·41±0·10	0·58	20
	81	5·58	4·05±0·10	0·94	15
	41	4·92	3·37±0·2	1·62	10
$^{25}Mg(d,p)^{26}Mg$	446	10·22	8·86±0·10	ground	1
	291	8·45	7·02±0·10	1·84	4
	203	7·34	5·86±0·10	3·00	7
	134	6·37	4·86±0·10	4·00	10
	108	5·98	4·45±0·10	4·41	15
	76	5·50	3·95±0·10	4·91	10
$^{26}Mg(d,p)^{27}Mg$	89	5·71	4·16±0·10	ground	35
	31	4·76	3·18±0·2	0·98	15

* Corrected for stopping in a mica foil.

$^{24}Mg(d,p)^{25}Mg$. Four proton groups were found. The first three groups give a Q-value and two levels in good agreement with other investigations[2,5]; the fourth group, however, has not been reported before. All four groups indicate the same excited states of magnesium-25 as found recently[6] in the process $^{27}Al(d,\alpha)^{25}Mg$.

$^{25}Mg(d,p)^{26}Mg$. Six proton groups were found. The three groups of longest range determine the ground-state and two excited states in magnesium-26 at 1·84 and 3·00 MeV., in close agreement with the levels given by Pollard and Humphreys (*loc. cit.*). It may be mentioned that these authors assumed that the process $^{23}Na(\alpha,p)$ gave quite different levels in magnesium-26. Recently, however, Motz[7] finds for the latter process levels at 1·91 and 2·85 MeV., and it seems reasonable to believe that these are the same states as occur in the (d,p)-reaction. (Motz also reports a level at 0·44 MeV.; in our work the corresponding proton group would coincide with a group due to nitrogen impurity in the targets, and we can therefore only conclude that, if such a group exists, it has a lower intensity than the group of longest range.)

The three shorter groups are those seen by Allan *et al.* A comparison with our groups from magnesium-24 shows that the ranges in the two cases differ by far more than the experimental error of the range measurements. For other reasons also we can exclude the possibility of contamination with magnesium-24, and we conclude that the groups in question are genuine, giving three more levels in magnesium-26.

$^{26}Mg(d,p)^{27}Mg$. Besides the strong group already reported by Allan *et al.*, we find indications of a weak group at 0·98-MeV. excitation.

A more detailed report of this work will be published in *Kgl. Dan. Vid. Selsk. mat.-fys. Medd.* I wish to thank Prof. N. Bohr for his continued interest, and Dr. S. Thulin, Nobel Institute, Stockholm, for preparing the isotopic samples. Mr. P. Oelgaard and Dr. S. Y. Tiwari have given me valuable assistance, especially in reading the plates.

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Use of Nuclear Plates for the Determination of the Uranium and Thorium Contents of Radioactive Ores

Mr. D. H. Pierson[1] has recently described a very ingenious method of determining the thorium–uranium ratio in radioactive ores. The main objection to his method is that it requires rather elaborate electronic equipment, and certainly could not be used in the field. In this respect the nuclear plate method presents great attractions, since the only essentials are some form of dark room and a fairly good microscope provided with a good micrometer eyepiece. A thick layer of the ore can be used, so that the ore need only be moderately finely powdered in a mortar and screened through a suitable mesh before the plate is placed in contact with it. We have found that an exposure time of eight minutes is suitable for thorium oxide, when in radioactive equilibrium. This exposure gives about twenty tracks in the field of a microscope using a 4-mm. dry objective and a × 10 eyepiece. Thus, even for comparatively poor ores, the exposure required would not be unduly long.

The results obtained by measuring the alpha-ray emission rate of the ore will, of course, be approximate, as Pierson points out. The stopping power of the ore for alpha-rays can be calculated from