sibility remains that a group of range up to 20 cm is produced by alpha-particles of low energy (near the end of their range in the thick layer). To test this the alpha-particles were retarded by gold foil of 2 cm stopping power and an absorption curve plotted. This is given in Fig. 1.

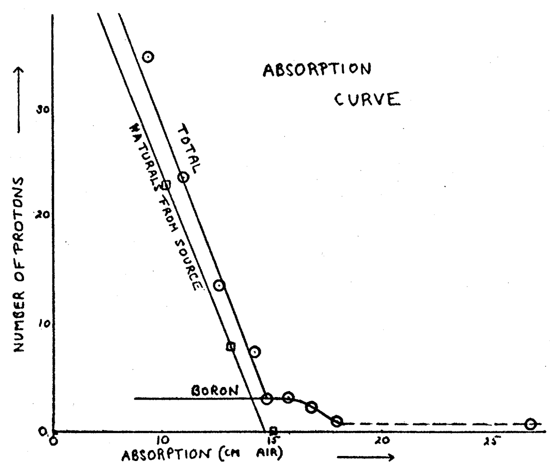

FIG. 1.

The presence of a group of 18.5 cm range can be seen. If the natural protons produced by the source be subtracted, the presence of a single homogeneous group of range 18.5 cm is evident. To trace the origin of these protons the space between the source and the gold foil was evacuated and refilled with oxygen to give any desired range to the impinging alpha-particles. In Fig. 2, the yield is plotted

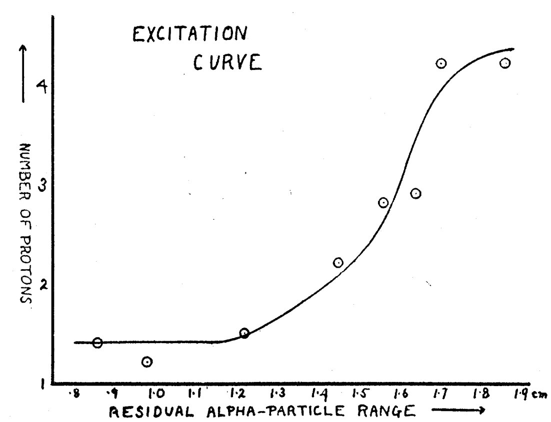

FIG. 2.

against initial alpha-particle range. It will be seen that no protons are emitted until the alpha-particle energy corresponds to a range of 1.20 cm. Beyond this the numbers rise smoothly, flattening off at 1.70 cm. This shows the group to be due to resonance entry of the alpha-particles, and, since there is a rising yield between 1.20 and 1.70 cm, the entry is through a rather wide band, in agreement with the fact that a high probability of penetration through the potential barrier already exists for such energies. The two limits of the band may be set at 3.91×10^{-6} and 5.03×10^{-6} erg, giving a mean of 4.57×10^{-6}. According to Fowler and Wilson the half width of the resonance band divided by the energy ($\Delta E/E$) is of the order of the penetration probability. Thus the results agree with a penetration probability of about 1/7, which is reasonable.

Curves showing evidence of resonance have been given by Curie-Joliot[3] and by Chadwick[4] for excitation of neutrons in boron. These are probably due to excitation of the B^{11} isotope, while the present work applies to B^{10}. Exact agreement would not therefore be expected, yet the curves of Curie-Joliot fit in with resonance between 1.1 cm and 1.45 cm, while Chadwick gives higher values, commencing at 1.4 cm. For a first approximation, this is satisfactory.

The nuclear energy change calculated from the process is $0.21\times10^{-6}\pm0.47\times10^{-6}$ erg or $0.13\pm0.28\times10^{-6}$ electron-volt. [The error is not so great as is apparent since the zero is the important figure.] Chadwick gives the value 0.35×10^{6} electron-volt, calculated from the group of 37.5 cm range due to excitation over the top of the barrier by the unretarded polonium α-particles. The agreement is within the error of the experiment and shows that the new group does not demand any *ad hoc* levels of energy inside the nucleus itself.

The presence of a small yield at larger absorption (beyond 18.5 cm) may mean that the long-range group (82 cm) can also be excited by entry through this resonance level. Assuming the value 4.96×10^{-6} erg for the nuclear energy change as given by Chadwick,[5] this process gives a group of 58 cm range protons numbering about one-third the main group.

The fact that the short range group found by Bothe is complex invalidates any deductions about its behavior. The sharp rise at 14 cm found by Heidenreich may be due to a second excited state which should have associated with it the emission of one or more quanta.

It is a pleasure to acknowledge the help given by Professor A. F. Kovarik in advice and discussion.

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[3] I. Curie and F. Joliot, C. R. **196**, 398 (1933).
[4] J. Chadwick, Proc. Roy. Soc. **A142**, 1 (1933).
[5] See Duncanson, Proc. Camb. Phil. Soc. **30**, 112 (1934).
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A Method of Attaching a Fluorite Window to Glass Apparatus

A fluorite window may be attached to a glass tube in such a manner that the apparatus can be evacuated and baked out in the usual way without leakage and without breaking the window upon cooling. The technique is as follows: (1) a glass channel is sealed around the orifice to be covered by the window (Fig. 1). The diameter of the

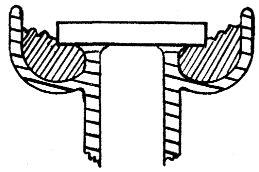

FIG. 1.

orifice should be 3–4 mm less than that of the window so that the latter, when in position, will project over the edge of the orifice to the center of the channel. (2) Before the window is placed in position the channel is filled with crumbs of silver chloride. (3) The apparatus is placed in the furnace and the temperature is raised to 470°C and held there for a minute thus melting the silver chloride. (4) When cool more silver chloride is added and the process is repeated until the outer level of the cold chloride is slightly above the level of the orifice. (5) While the apparatus is cold the fluorite window is laid over the orifice but is supported now at its outer edge by the chloride. (6) The temperature is raised to 450°C and then slowly up while the window is carefully watched. (7) As the chloride melts a thin layer runs in suddenly between the window and the ground surface of the orifice. (8) The heating should be stopped immediately. When cold the joint is vacuum tight and the apparatus may safely be baked out at 430°C.

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An Attempt to Find Neutron-Like Particles Accompanying β-Ray Emission

At the suggestion of Professor E. D. Eastman, an attempt was made to determine whether or not particles of the nature of neutrons were emitted simultaneously with β-rays. The apparatus used consisted of an ionization chamber collecting from about 1 cc volume, a linear amplifier and an automatic counter. The zero of the instrument was about 0.5 per minute.

Having placed a sq. cm of paraffin paper over the opening of the ionization chamber, it was exposed to about 100 mc of Ra D and Ra E contained in old Rn tubes. The source was separated from the counter by a lead screen 3 mm thick. If as do Be neutrons, such neutron-like particles from β active bodies produced approximately one proton per 4000 neutrons incident on paraffine, there should have been some 10^5 protons counted per minute. No effect was noticed, the zero count remaining at 0.5 per minute. Negative results were also found for a 300 gram KCl sample and for a 50 gram RbCl sample.

If then, some neutron-like particle is emitted simultaneously with a β-ray, such a particle must have insufficient energy, or have a mass too small to produce recoil protons observable with such apparatus as used here.

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