Evidence for the Formation of $_4Be^8$ in the Disintegration of Lithium by Deuterons

From the determination of the range of the alpha-particles produced by the reaction

$$_1H^2+{}_3Li^7\rightarrow 2{}_2He^4+{}_0n^1.$$

Oliphant, Kempton and Rutherford[1] found the energy released in the disintegration to be 14.6 ± 0.25 MEV. By measuring the ranges of the recoil protons which had sufficient energy to penetrate a mica sheet (stopping power 114 cm) which was placed in the center of a high pressure cloud chamber, we have investigated the energy distribution of the neutrons in this reaction which were emitted with energies over 11 MEV. The chamber was operated at expanded pressures of 11.9 and 14.7 atmospheres. Otherwise, the experimental procedure was identical to that described in our article which appears in this issue. We have taken over 9000 pictures in which 86 tracks penetrated the mica and satisfied our requirement of being projected in the forward direction.[2]

Fig. 1 shows the energy distribution of these measured tracks. The points on the lower curve represent the actual number of tracks observed in an energy interval of 0.4 MEV, while the points on the upper curve have been corrected according to the varying probability, due to the geometry of the apparatus, of observing tracks of different lengths. Both curves show a pronounced maximum near 13 MEV. We believe that this increase is due to neutrons from the reaction

$$_1H^2+{}_3Li^7\rightarrow {}_4Be^8+{}_0n^1.$$

Evidence that $_4Be^8$ is formed in other nuclear reactions has been presented by Kirchner and Neuert,[3] and by Crane, Delsasso, Fowler and Lauritsen.[4] A preliminary investigation of the number of neutrons emitted with energies lower than 10 MEV shows that there is a much larger number with energies in the neighborhood of 2 or 3 MEV.

The maximum energy of the neutrons emitted at 90° appears to be 13.4 MEV. The calculated value of the energy of disintegration is 14.3 ± 0.5 MEV. From the value 14.6 ± 0.25 MEV obtained by Oliphant, Kempton and Rutherford, we have calculated that the mass of $_4Be^8$ is 0.3 ± 0.75 MEV greater than that of two alpha-particles. A recalculation of Kirchner's mass of $_4Be^8$ with Bethe's[5] new values gives a mass just equal to that of two alpha-particles; Crane and Lauritsen's mass of $_4Be^8$ is 1.5 ± 0.5 MEV greater that that of two alpha-particles. These agree with our results within the rather large limits of error.

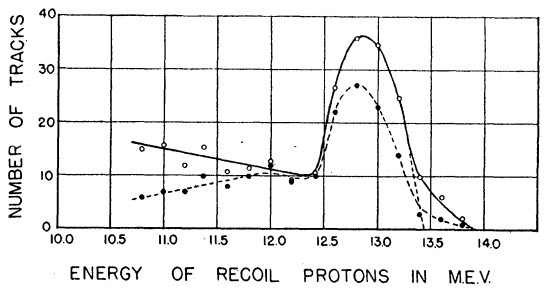

FIG. 1. Energy distribution curve of recoil-protons projected in forward direction.

Such a mass of $_4Be^8$ gives evidence for a resonance level in the interaction of two alpha-particles. This may be an important factor in the anomalous scattering, as pointed out by Beck and Horsley.[6]

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[2] See article by Bonner and Brubaker in this same issue.
[3] Kirchner and Neuert, Physik. Zeits. **35,** 293 (1934).
[4] Crane and Lauritsen, Phys. Rev. **47,** 420 (1935); Crane, Delsasso, Fowler and Lauritsen, Phys. Rev. **47,** 887 (1935).
[5] H. Bethe, Phys. Rev. **47,** 633 (1935).
[6] G. Beck and L. H. Horsley, Nature **135,** 430 (1935).
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The Correlation of Wave Functions with the States of Physical Systems

In their recent article, *Can Quantum-Mechanical Description of Physical Reality be Considered Complete?*[1] Einstein, Podolsky and Rosen arrive at the conclusion that the question put by the title of their paper must be answered in the negative. In the writer's opinion their argument is not sound.

The essential feature of their reasoning is the purported demonstration by means of an example that "*it is possible to assign two different wave functions . . . to the same reality.*" If this were true, it would mean that quantum-mechanical description is erroneous as well as incomplete, for each different wave function involves a different prediction regarding the future behavior of the system described and the authors of the above paper clearly intend the phrase "the same reality" to refer to the same system in the same physical state. Actually, however, the demonstration cited is incorrect.

The special problem discussed by Einstein, Podolsky and Rosen is that of a compound system whose two component systems α and β are assumed to interact during a limited time interval $0<t<T$. (We may suppose that the interaction is a collision between an atom and a free electron which takes place during this time interval.) After the interaction it is possible to measure any physical property of the system α without disturbing β. According to the usual quantum-mechanical procedure the wave function to be assigned to the system β after the observation of α depends on the type of observation made and on