ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ

Дубна

E- 2244

I. Rotter

ON THE OBSERVED ISOSPIN VIOLATION IN THE $B^{10}(Li^{6}, d)N^{14}$ REACTION

ЛАБОРАТОРИЯ ТЕОРЕТИЧЕСКОЙ ФИЗИКИ

1965

E-2244

I. Rotter

ON THE OBSERVED ISOSPIN VIOLATION IN THE $B^{10}(Li^{6}, d)N^{14}$ REACTION

Recently, Carlson and Throop[1] have shown the T = 1 level at 9.17 MeV to be populated in the $B^{10}(Li^6, d)N^{14}$ reaction. At first glance, this is a violation of the known isospin selection rule, which is found to hold strongly in other reactions on light nuclei. In the following it will be shown that in the $B^{10}(Li^6, d)N^{14}$ reaction as well there has been so far no necessity for isospin violation to occur. For this purpose, further examinations have to be done.

Since the Li^6 nucleus has a marked cluster structure the mechanism of Li^6 induced reactions with one of the clusters outgoing is expected to be a stripping one. In the reaction a deuteron or an α -particle will be exchanged

$$(\alpha + d) + A \rightarrow \begin{matrix} (A + \alpha) + d \\ \\ (A + d) + \alpha \end{matrix}$$

The experimental results seem to verify these assumptions, what was shown first by Morrison[2] and discussed in more detail in[3]. Therefore, here a stripping-like mechanism will be assumed in discussing two possible ways in which the T = 1 level at 9.17 MeV of the N^{14} nucleus can be populated in the $B^{10}(Li^6, d)N^{14}$ reaction.

Violation of the isospin selection rule can occur if by Coulomb forces the first T = 1 level of the B^{10} nucleus at 1.74 MeV is excited. (Here we we will not discuss the real possibility of such an excitation with 4 MeV Li^6 ions, but only the consequences). Therefore, we have to consider not only

$$Li^6 + B^{10}_{g.s.} \rightarrow N^{14*} + d ,$$

but also

$$Li^6 + B^{10*}_{(T=1)} \rightarrow N^{14*} + d .$$

If one assumes a stripping-like mechanism for the reaction one can estimate the population of the T=1 level at 9.17 MeV relative to the population of the first T=1 level at 2.31 MeV in the N^{14} nucleus. Using the shell model wave functions from ref./4/ one gets for $(2J+1)\theta^2$ which is proportional to the population ratio/3/

$$(2J+1)\theta^2 = \begin{array}{l} 2\times10^{-3} \text{ for the 2.31 MeV level} \\ 4\times10^{-3} \text{ for the 9.17 MeV level.} \end{array}$$

Here θ^2 is the reduced α-width, J is the spin. The population ratio estimated in this way contradicts experimental data in which the 2.31 MeV level could not be seen (or only very weakly). Therefore, another possibility for population of the 9.17 MeV level in the $B^{10}(Li^6, d)N^{14}$ reaction should be discussed.

For some time the existence of the so-called threshold states has been known. In the nucleus A a level is supposed with the structure (B+a) or some levels which lie in the neighbourhood of the threshold for the decay A → B+a.

Here, the nature of such levels will not be discussed, only their existence will be assumed. In either case, there will be a maximum in the population of levels near threshold in lithium induced reactions. Indeed, such a maximum is observed in some (Li^6, α) reactions near the deuteron threshold the nature of which is discussed in/6/. A maximum is observed also in the (Li^6, d), (Li^7, t), and (Be^9, He^5) reactions on B^{11} near the α-particle threshold of N^{15}/7/. The population of threshold levels is found to be some dozens the population of any other level in the lower excitation region.

If one assumes the existence of an α-threshold level (or some levels near α-threshold) in the N^{14} nucleus also, there will be a maximum in the deuteron spectrum of the reaction $B^{10}(Li^6, d)N^{14}$ near the α-particle threshold lying at 11.6 MeV. Carlson and Throop did not find this maximum because they observed deuterons in coincidence with following γ, only. But they found a population of the T=1 level at 9.17 MeV which is in the very neighbourhood of the expected threshold level, so that Coulomb mixing of these levels will be relatively strong. Though Carlson and Throop could not find the threshold level itself, they "found" this level (or these levels) in observing the T=1 level at 9.17 MeV, possibly. The nonobservation of the T=1 level at 2.31 MeV lying far away from the α-threshold is in agreement with this statement.

Naturally, for the examination of threshold levels further experiments are necessary. To this end lithium induced reactions seem to be very suitable and it will be very interesting to do such experiments.

I am grateful to B.N.Kalinkin for a stimulating discussion.

References

1. R.R.Carlson, M.Throop. Phys. Rev. 136 (1964) B630. R.R.Carlson, Congres International de Physique Nucleaire, Paris, 1964.
2. G.C.Morrison. Phys.Rev. Letters 5, 565 (1960).
3. I.Rotter, to be published.
4. А.Н.Бояркина. Изв. АН СССР 28, 337 (1964).
5. A.I.Baz, Advances in Physics 8, 349 (1959).
6. D.R.Inglis. Nucl. Phys. 30 (1962).1. В.В.Балашов, И.Роттер. Препринт ОИЯИ Р-2079 (1965).
7. G.C.Morrison, N.H.Gale, M.Hussain, G.Murray; G.Hortig, H.Werner, W.Gentner, Both in Proc. Third Conf. on Reactions Between Complex Nuclei, Asilomar, 1963.

Received by Publishing Department on 25 June, 1965.