the experimental error and probably indicates the presence of a statistical delay in the discharge of untreated NaCl and KBr specimens. If $t_{st} = 0$ for treated specimens, the difference in the discharge delay time will be the statistical delay time for untreated specimens, with values 5×10^{-10} sec for NaCl and 4.7×10^{-10} sec for KBr. If $t_{st} \neq 0$ for the treated specimens, the differences in the delay time are the differences in the statistical delay times of the discharge in untreated and x-ray treated specimens of NaCl and KBr.

The author takes this opportunity to thank Prof. A. A. Vorob'ev for guiding this research.

[1] A. F. Walther and L. D. Inge, Dokl. Akad. Nauk SSSR 2, 65 (1934).

[2] A. Walther and L. Inge, Arch. Elektrotechn. 28, 72 (1934).

[3] G. A. Vorob'ev, Dissertation, Tomsk Polytechn. Inst., 1956.

[4] K. K. Sonchik, Изв. Высшей школы СССР, Физика (News of the Higher Schools, Phys. Ser.) No. 4, 73 (1958).

[5] E. A. Konorova, J. Exptl. Theoret. Phys. (U.S.S.R.) 32, 603 (1957), Soviet Phys. JETP 5, 497 (1957).

[6] Kawamura, Ohkira, and Kichi, J. Phys. Soc. Japan 9, 541 (1954).

[7] G. A. Vorob'ev, Изв. Высшей школы СССР, Физика (News of the Higher Schools, Phys. Ser.) No. 4, 174 (1958).

[8] Voznesenskiĭ, Korotkikh, Chernetskiĭ, and Koporskiĭ, Usp. Fiz. Nauk 62, 4, 497 (1957).

Translated by J. G. Adashko
101

ON THE QUESTION OF COLLECTIVE EFFECTS IN LIGHT NUCLEI

V. V. BALASHOV and A. F. TULINOV

Institute of Nuclear Physics, Moscow State University

Submitted to JETP editor June 27, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) 36, 615-616 (February, 1959)

IN the region of light nuclei, the shell model gives good agreement with experiment for the magnetic moments and the probabilities of the magnetic dipole γ transitions. On the other hand, there is no such agreement for the probabilities of the E2 transitions and the electric quadrupole moments (cf. the table; the energy of the levels, E, is given in Mev).

The values for τ_{theor} for the transitions in C^{12} taken from the paper of Kurath,[5] corrected for the value $\langle r^2 \rangle = 5.7 \times 10^{-26}$ cm^2 obtained by Hofstadter.[6] It is seen from the table that in all three cases the measured transition probability is higher than the calculated one. The analysis of the relative intensities of the E2 and M1 transitions leads to the same result.[5,7]

If we further consider that the measured nuclear quadrupole moments lie well above those calculated with the shell model,[8] we are driven to the conclusion that the shell model always gives too low values for the corresponding matrix elements.

It is believed that this situation is connected with the collective motion of the nucleons in the nucleus. This effect was accounted for in the nucleus O^{17} by introducing an additional effective nucleon charge $e' = \alpha e$, which is connected with the excitation of collective quadrupole oscillations in the nucleus.[9] α was found to be ≈ 0.6. We note that better agreement with experiment is indeed obtained by using approximately this value for the effective charge in the calculation of the matrix elements for the transitions in the nuclei C^{12} and B^{10}. However, the concept of an effective charge is closely connected with the formalism of the unified nuclear model of Bohr and Mottelson,[10] whose applicability to light nuclei is doubtful. In this sense the use of an effective charge in the region of light nuclei corresponds to the formal introduction of additional parameters; the question of the role of collective effects in E2 transitions in light nuclei, therefore, remains open.

In view of this it is of interest to consider the collective effects in the nucleus in a general way, independently of the specific mechanism of the collective intensification of the electric quadrupole transitions and, hence, of the introduction of any additional parameters.

In the absence of the single-particle operator, the operator for the quadrupole transition connected with the collective motion contains, owing to the charge independence of nuclear forces, only the scalar component of the isotopic spin. (In the framework of the unified nuclear model this follows immediately from relation (7.12) of refer-

Nucleus	Transition $E(J, T) \to E(J', T')$	τ, experiment	τ, theory	
			$L-S$	$j-j$
C^{12}	$4.43\,(2.0) \to 0\,(0.0)$	$5.25 \cdot 10^{-14}$ sec [1]	$1.8 \cdot 10^{-13}$ sec	$4.2 \cdot 10^{-12}$ sec
B^{10}	$0.72\,(1.0) \to 0\,(3.0)$	$1.05 \cdot 10^{-9}$ sec [2]	∞	$4.5 \cdot 10^{-9}$ sec
Be^{10}	$3.37\,(2.1) \to 0\,(0.1)$	$< 8 \cdot 10^{-14}$ sec [3]	$1.4 \cdot 10^{-13}$ sec	∞ [4]

ence 10.) Collective effects are therefore absent in E2 transitions in which the isotopic spin changes, and one may assume that the shell model theory gives the correct values for the probabilities of these transitions. We note that the conclusion that the shell model theory cannot give the probabilities of quadrupole transitions is based on the analysis of transitions in which the isotopic spin does not change (see above).

The verification of the above assertion is of special interest in the region of light nuclei, where the isotopic spin may be considered a good quantum number and where, moreover, the shell model successfully explains the spectrum of energy levels. Within the p shell only a few pure E2 transitions with a change in the isotopic spin can be observed:

B^{10} 3.58 (2.0) → 1.74 (0.1), C^{12} 16.1 (2.1) → 0 (0.0),
B^{10} 4.77 (2.0) → 1.74 (0.1), N^{14} ? (2.0) → 2.31 (0.1).
B^{10} 6.02 (4.2) → 5.16 (2.1),

For the first three transitions experimental values are available only for the total Γ width of the level.[7,11] Γ, the width for the transition 16.1 → 0 in C^{12}, is equal to 0.72 ev (reference 12). In the limit of j-j coupling (the intermediate coupling parameter $\xi = \infty$) the ground state of C^{12} corresponds to the closed shell $p_{3/2}$, and the excited state at 16.1 Mev corresponds to the configuration $|p_{3/2}^{-1} p_{1/2}; 21\rangle$. Using the value $\langle r^2 \rangle = 5.7 \times 10^{-26}$ cm² (reference 6), we obtain, in this approximation, $\Gamma_{theor} = 0.87$ ev. Perturbation theoretical calculations show that Γ_{theor} decreases for deviations from strict j-j coupling, with $d\Gamma_{theor}/d(1/\xi) = 0.24$ ev in the limit of j-j coupling.

This example therefore confirms our previous contention that the increase in the probability of quadrupole transitions is connected with collective effects and that these effects vanish in transitions in which the isotopic spin changes. Unfortunately, experimental data are available only for the single case 16.1 (C^{12}).

In this connection the following experiments are of interest: (a) A measurement of τ for the transitions 3.58 → 1.74 Mev and 4.77 → 1.74 Mev in B^{10}. This can be done either by the Doppler method, e.g., in the reaction $C^{12}(d, \alpha)B^{10}$, or by measuring the relative transition probabilities from the states 3.58 and 4.77 Mev to the lower lying states. (b) A measurement of the relative probabilities in the mixed M1 + E2 transitions, in particular, in the transition 17.63 → 2.9 Mev in the nucleus Be^8, for which an experimental value for the total Γ width is available.[11]

[1] Swann, Metzger, and Rasmussen, Bull. Am. Phys. Soc., Ser. II **2**, 29 (1957).

[2] Bloom, Turner, and Wilkinson, Phys. Rev. **105**, 232 (1957).

[3] A. N. Boyarkina and A. F. Tulinov, J. Exptl. Theoret. Phys. (U.S.S.R.) **36**, 353 (1959); Soviet Phys. JETP **9**, 244 (1959) this issue.

[4] V. V. Balashov, Доклады на Всесоюзной конференции по ядерным реакциям при малых и средних энергиях (Proceedings of the All Union Conference on Nuclear Reactions at Low and Intermediate Energies) Moscow, 1957.

[5] D. Kurath, Phys. Rev. **106**, 975 (1957).

[6] R. Hofstadter, Revs. Modern Phys. **28**, 214 (1956).

[7] L. Meyer-Schuetzmeister and S. Hanna, Phys. Rev. **108**, 1506 (1957).

[8] M. Mayer and J. Jensen, Elementary Theory of Nuclear Shell Structure, N. Y. 1955.

[9] B. H. Flowers, Доклады на Всесоюзной конференции по ядерным реакциям при малых и средних энергиях (Proceedings of the All Union Conference on Nuclear Reactions at Low and Intermediate Energies) Moscow, 1957.

[10] A. Bohr and B. Mottelson, Kgl. Danske. Vid. Selskab, Mat.-fys. Medd. **27**, No. 16 (1953).

[11] F. Ajzenberg and T. Lauritsen, Revs. Modern Phys. **27**, 77 (1955).

[12] A. Lane and L. Radicati, Proc. Phys. Soc. **67**, 167 (1954).

Translated by R. Lipperheide
102

DIFFRACTION STRIPPING OF RELATIVISTIC PARTICLES

I. I. IVANCHIK

P. N. Lebedev Physics Institute, Academy of Sciences, U.S.S.R.

Submitted to JETP editor June 27, 1958

J. Exptl. Theoret. Phys. (U.S.S.R.) **36**, 617-618 (February, 1959)

In a number of papers[1-4] various authors have considered the diffraction dissociation of the deuteron on a "black" nucleus in the deuteron energy region $E_d \sim 100$ to 200 Mev. The nucleus is also black when $E_d \gtrsim 6$ Bev. We first show that the results obtained earlier[1-4] also apply for a relativistic deuteron.

First we consider diffraction scattering. If φ is the wave function for free motion the wave func-