What is important for the B^{12}-N^{12} ratio is the charge distribution in C^{12} and the average of the B^{12} and N^{12} charge distributions. The latter is just the charge distribution of the excited state of C^{12} at 15.11 Mev. For simplicity we assume that to be the same as the charge distribution of the ground state.

In each case we calculate the terms of order $Z\alpha RE$ in the spectrum ratio, dropping higher orders in RE. The result in case I is a contribution to δA equal to

$$\delta A_{\mathrm{I}}^{(2)} = -4\alpha\{\int\vec{\sigma}\}^{-1}\sum_i\{\tfrac{2}{3}\int\vec{\sigma}|\vec{r}-\vec{r}_i| + \tfrac{1}{3}\int\vec{\sigma}\,\vec{r}\cdot(\vec{r}-\vec{r}_i)|\vec{r}-\vec{r}_i|^{-1} - \tfrac{1}{3}\int\vec{\sigma}\cdot\vec{r}(\vec{r}-\vec{r}_i)|\vec{r}-\vec{r}_i|^{-1}\}, \quad (8)$$

where the sum is extended over all protons except the decaying nucleon. In case II the result is

$$\delta A_{\mathrm{II}}^{(2)} = -4\alpha\{\int\vec{\sigma}\}^{-1}\int\rho(\vec{r}\,')d^3r'\{\tfrac{2}{3}\int\vec{\sigma}|\vec{r}-\vec{r}\,'| + \tfrac{1}{3}\int\vec{\sigma}\,\vec{r}\cdot(\vec{r}-\vec{r}\,')|\vec{r}-\vec{r}\,'|^{-1} - \tfrac{1}{3}\int\vec{\sigma}\cdot\vec{r}(\vec{r}-\vec{r}\,')|\vec{r}-\vec{r}\,'|^{-1}\}, \quad (9)$$

where ρ is the charge density in C^{12} in units of e.

(f) The Coulomb effect on weak magnetism itself. Since the weak magnetic effect on the spectra comes from V-A interference, it is of opposite sign in B^{12} and N^{12}. The first order Coulomb correction to it thus has the same sign in B^{12} and N^{12} and practically cancels.

(g) The Coulomb effect on the relativistic axial vector matrix element $\int\gamma_5$. Like the uncorrected $\int\gamma_5$, this has a negligible effect on the spectrum.

We have estimated $\delta A^{(1)}$, $\delta A_{\mathrm{I}}^{(2)}$, and $\delta A_{\mathrm{II}}^{(2)}$ using the shell model with harmonic oscillator wave functions adjusted in radius to give the charge distribution of Hofstadter.[9] The results are that $\delta A^{(1)} = -0.036\,\%$ per Mev, $\delta A_{\mathrm{I}}^{(2)} = -0.21\,\%$ per Mev, and $\delta A_{\mathrm{II}}^{(2)} = -0.23\,\%$ per Mev. Since case II is so close to case I and since case I is much closer to the truth, we take $\delta A = \delta A^{(1)} + \delta A_{\mathrm{I}}^{(2)} = -0.25\,\%$ per Mev.

The largest error in our result probably comes from the use of the shell model. We can estimate how bad the shell model is by using it to calculate the allowed matrix element $\int\vec{\sigma}$ for the β decay of B^{12}. The experimental matrix element is smaller by a factor of 0.4 (in absolute value—presumably the sign is right). The ratios in Eqs. (7)-(9) are probably calculated slightly better than the absolute value and we have therefore assigned an error of about 0.15% per Mev to δA.

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PREDICTION OF DEUTERON POLARIZATION FROM d-α SCATTERING

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There is current interest in possible means of producing and analyzing deuteron polarization. d-α scattering on the 1.07-Mev resonance[1-3] and the T(d, n)He[4] reaction[4] have been studied. The present note shows that d-α scattering can be a useful producer (and analyzer) of deuteron polarization at energies between resonances, where the weak energy dependence may be an advantage.

We have used the phase shifts of Galonsky and McEllistrem,[5] deduced from differential cross sections with the help of dispersion theory, to calculate polarization parameters in the interval between the resonances at 1.07 and 4.6 Mev (deuteron lab energy).

In the region of 2 Mev there is considerable vector polarization, increasing smoothly with

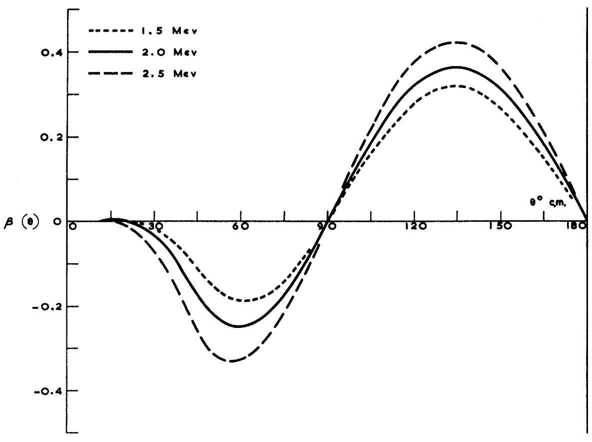

FIG. 1. d-α vector polarization near 2 Mev.

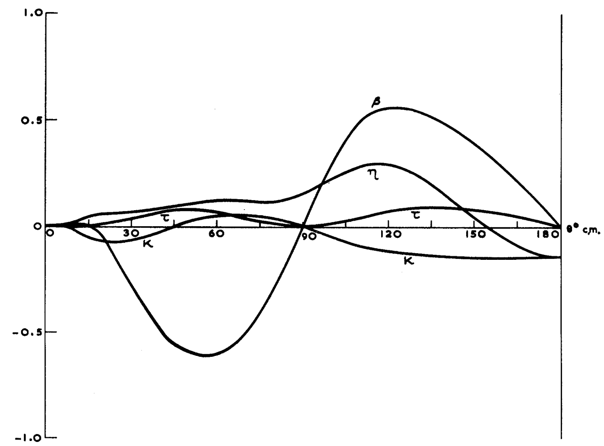

FIG. 2. d-α polarization at 3.5 Mev.

energy (Fig. 1); the tensor polarization parameters (see below) are everywhere less than 3 % and are not shown. These effects come mainly from the "tail" of the $^3D_3$ resonance (1.07 Mev) interfering with potential and Coulomb scattering.

At higher energies, however, $^3D_2$ and $^3D_1$ scattering (resonances at 4.6 and ~5.9 Mev) become more important. At 3.5 Mev the vector polarization has approximately doubled, while tensor polarization is no longer negligible (Fig. 2). Above this point the scattering becomes more strongly energy-dependent and is dominated by the 4.6-Mev resonance.

Our notation follows that of Stapp.[6] If $\vec{k}$ and $\vec{k}'$ are initial and final relative deuteron momenta, we define unit vectors $\vec{N}$, $\vec{K}$, and $\vec{Q}$ in the directions $\vec{k}\times\vec{k}'$, $\vec{k}'-\vec{k}$, and $\vec{k}'+\vec{k}$, respectively. Then if S_i ($i=1,2,3$) are the components of the spin-1 operator, the vector polarization $P_i \equiv \langle S_i \rangle$ and tensor polarization $T_{ij} \equiv \langle \frac{1}{2}(S_iS_j+S_jS_i) - \frac{2}{3}\delta_{ij} \rangle$ set up in the scattering of initially unpolarized deuterons have the forms

$$P_i = \beta N_i, \qquad (1)$$

$$T_{ij} = \eta(N_iN_j - \tfrac{1}{3}\delta_{ij}) + \kappa(Q_iQ_j - K_iK_j) + \tau(Q_iK_j + K_iQ_j). \qquad (2)$$

The analyzing power of the scattering is described by vector and tensor "analyzabilities" $\hat{P}_i$ and $\hat{T}_{ij}$,

$$\hat{P}_i = P_i, \qquad (3)$$

$$\hat{T}_{ij} = T_{ij} - 2\tau(Q_iK_j + K_iQ_j), \qquad (4)$$

such that the cross section σ for scattering polarized deuterons is

$$\sigma = \sigma_0(1 + \tfrac{3}{2}P_i\hat{P}_i + 3T_{ij}\hat{T}_{ij}). \qquad (5)$$

Here P_i and T_{ij} describe the incident polarization and σ_0 is the unpolarized cross section. For pure vector polarization, this is like the familiar scattering of spin-$\frac{1}{2}$ particles, except for the factor $\frac{3}{2}$ in Eq. (5).

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