for small $C = \omega e^{-1/\rho}$, $|K|/C$, $E_2/C$ ($\rho = g^2 \times (dn/dE)_{E=E_F}$). The secular equation becomes in that case of the form

$$(E_2^2 - s^2|K|^2/3) + \rho(s|K|/C)^2 f(E_2/s|K|) = 0. \quad (4)$$

In zeroth approximation

$$E_2 = s|K|/\sqrt{3}; \quad s = k_F/M, \quad (5)$$

which agrees with the result of Bogolyubov[2] and Galitskiĭ.[5] It is necessary to note that these authors found the energy $E_2$ by studying a model but not the true Hamiltonian. Such a procedure leads as a matter of principle to difficulties when one tries to determine corrections to $E_2$. Among other things, the approximate method stated in the foregoing enables us in principle to increase the accuracy of determining $E_2$ by improving the approximation in the wave function (and apart from this, of course, by calculating terms of higher order in $g^2$). In the framework of this method one can completely analogously study also more complicated than two-body excitations of Fermi-systems.

In conclusion I express my gratitude to Academician N. N. Bogolyubov for suggesting this work and to D. V. Shirkov for useful discussions.

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## *ON THE INFLUENCE OF THE PAULI PRINCIPLE AND OF SHORT-RANGE NUCLEAR FORCES ON THE ABSORPTION OF PHOTONS BY NUCLEI IN THE OSCILLATOR MODEL*

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As has been shown by Brink,[1] the collective[2] and the independent-particle[3] descriptions are identical in the case of the oscillator potential. This is due to the circumstance that the Schrödinger equation is separable in this case both in the single-particle and the Jacobi coordinates. In particular one can take for one of the Jacobi coordinates the difference of the coordinates of one proton and one neutron. Thus in this case the two-nucleon (quasi-deuteron) mechanism[4] will also be identical with the previous two.

This equivalence is violated on going over to a real nucleus, mainly because of the short range of the nuclear forces and because of the Pauli principle.

The influence of the short-range forces can be estimated taking for the zeroth approximation the oscillator Hamiltonian $H_{osc}$ and considering $H - H_{osc}$ as a perturbation. In the zeroth order the nuclear wave function is a product wave function. In first order this multiplicative character will be violated. The separability of a particular coordinate (i.e., the degree of applicability of the corresponding mechanism) can reasonably be indicated by the integral $N_{\sigma_0\tau_0}$ of the square of the modulus of the nonfactorizable part of the wave function:

$$N_{\sigma_0\tau_0} = \sum_{\sigma,\tau}{}' \left\{ \frac{\langle f_\sigma \varphi_\tau | H - H_{osc} | f_{\sigma_0}\varphi_{\tau_0}\rangle}{E_{\sigma\tau} - E_{\sigma_0\tau_0}} \right\}^2. \quad (1)$$

Here $f_\sigma$ and $\varphi_\tau$ are the zeroth-approximation oscillator functions corresponding to the factorized coordinate and the remaining variables respectively; the indices zero indicate the ground state. The function $N_{\sigma_0\tau_0}$ equals zero for a function factorizable in the coordinate singled out and equals unity for a function containing no factorizable part. The evaluation of (1) requires the application of the Talmi transformation[5] and is in general very involved.

The quantity $N_{\sigma_0\tau_0}$ was calculated for the ground state of $He^4$ with a two-body potential which has oscillator character at short distances and equals zero at distances larger than $1.7 \times 10^{-12}$ cm. Taking as a first approximation only the lowest states in the sum (1), we find that $N_{\sigma_0\tau_0}$ equals 0.015 for the collective, 0.014 for the single-particle, and 0.011 for the two-particle coordinates respectively. Thus we find that for the $\alpha$ particle either of these mechanisms can be applied with sufficient accuracy.

However, one can expect that for heavier nuclei the collective model will yield rather larger values for $N_{\sigma_0\tau_0}$ than the other models. Because of the short range of the nuclear forces, collective oscillations of many nucleons will be more difficult to establish than oscillations of individual nucleons. Even a rough estimate of the magnitude of $N_{\sigma_0\tau_0}$ as a function of the atomic number would be of interest.

The influence of the Pauli principle reduces to the circumstance that, for example in the excitation of the collective oscillation, the more tightly bound nucleons cannot be excited since those states are already occupied by other nucleons. This will also result in excitation of other degrees of freedom simultaneously with the excitation of the collective coordinate. One can take for a measure of the forbiddenness of collective transitions the quantity $Q = 1 - w_1/w_2$ where $w_1$ and $w_2$ are the probabilities of the collective dipole transition calculated with and without the Pauli principle respectively. In the oscillator model we have $Q = 9/25$ for $O^{16}$ and $Q = 5/9$ for $Ca^{40}$.

As can be seen the Pauli principle will also lead to quenching of the collective degrees of freedom.

Thus the collective model of the electric dipole excitation can be applied only for the lightest nuclei. For heavier nuclei the single and the two-particle mechanisms will play the more important role.

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## *MEASUREMENT OF THE DEGREE OF LONGITUDINAL POLARIZATION OF BETA PARTICLES*

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MEASUREMENTS of the degree of longitudinal polarization of $\beta$ electrons have been made by many authors (cf. for example the survey of Smorodinskiĭ[1]).

In the present work the longitudinal polarization was converted to transverse by passing the electrons through crossed magnetic and electric fields. After emerging from the field region, the electrons passed through a system of diaphragms and impinged on a thin gold scatterer. Electrons scattered through an angle of 120° were recorded by Geiger counters. In the experiment we measured the magnitude of the left-right scattering asymmetry, which is a measure of the polarization of the electrons.

The length of the field region, $l$, was 300 mm, and the gap between the plates to which the high voltage was applied was 14 mm. The size of the magnetic field H and electric field E needed to rotate the spin of electrons with momentum p through angle $\varphi$ was found from the relation

$$\varphi = eHl\sqrt{1-\beta^2}/pc; \quad E = \beta H.$$

The absolute values of the applied fields were found to an accuracy of about 1% from conversion lines of known energy. The measurements were carried out for an electron energy of 340 kev and an angle $\varphi$ equal to 90°.

The end points of the spectra of the isotopes studied differed very much, which could result in