ally unstable if the magnetic field is parallel to the plane of explosion. They left open the problem of thermodynamic instability of rarefaction shock waves.

It turns out, however, that Zemplen's theorem is correct also in magnetohydrodynamics for an arbitrary explosion intensity and for an arbitrary magnetic-field direction, provided condition (1) is augmented by the condition

$$(\partial p / \partial T)_\rho > 0. \tag{2}$$

The increase in shock-wave pressure leads to an increase in density.

To explain how the tangential magnetic field $H_\perp$ changes upon passage of a shock wave, it is enough to use the formula

$$H_\perp = H_{0\perp}\rho(v_{0x}^2 - V_{0x}^2)/(\rho_0 v_{0x}^2 - \rho V_{0x}^2), \tag{3}$$

which follows from the conditions on the surface of the explosion (the subscript 0 refers to the region ahead of the shock wave, and V_x is the normal projection of the Alfven velocity). Small magnetic fields $[H_X^2 < 2\pi v_{0X}^2(\rho_0/\rho)(\rho+\rho_0)]$ become reinforced by passage of a shock wave, while large magnetic fields $[H_X^2 > 2\pi v_{0X}^2(\rho_0/\rho)(\rho+\rho_0)]$ are attenuated. This indicates that shock waves play a certain equalizing role.

The reinforcement of weak magnetic field by passage of shock waves was noted by Helfer.[4] In his opinion this is one of the mechanisms of formation of strong interstellar magnetic fields.

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ON THE PROBLEM OF TWO-NUCLEON INTERACTION IN THE TAMM-DANCOFF METHOD

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IN the field theory of nucleon interactions, the effective potential is usually calculated with the help of the so-called "adiabatic" approximation (i.e., neglecting the motion of the nucleons during the meson exchange).[1-8] Here the potential obtained in the adiabatic approximation is attractive already in the second order term in the coupling constant (g^2), and contains a singularity of type r^{-3}. In higher approximations with respect to the coupling constant, the singularity of the potential increases.

In the investigation of a system of two nucleons with the help of such mesonic potentials one usually introduces into the theory a second arbitrary constant,[6,7] the cut-off constant for the interaction r_c. This is a great deficiency of the theory. However, the author has shown[9] that this arbitrariness of the theory can be excluded in the non-adiabatic treatment of the nucleons, and that a theory can be constructed with a single arbitrary constant, the coupling constant. In the paper[9] it was shown that the Tamm-Dancoff method[1-2] for the two-nucleon system may be applied in its two-meson approximation only. It appeared that the terms of order g^4 in the nucleon interaction are significant only in the non-relativistic energy region of the interacting particles, while the interaction in the relativistic energy region is completely determined by the terms of order g^2. This result permits one to replace the exact equations for the state amplitude of the two-nucleon system by approximate equations in which the terms of order g^4 are treated only adiabatically (with $p, p' \le P < M$), while the terms of order g^2 are treated exactly. This greatly simplifies the solution of the equations.

Recently these equations were integrated numerically on the "Strela" electronic computer of the U.S.S.R. Academy of Sciences. For the state ${}^3S_1 + {}^3D_1$ of the two-nucleon system, we found the lowest eigenvalue of the coupling constant for which the system is in the bound state with binding energy $\mathscr{E} = 2.227$ Mev. The scattering problem was solved for the ${}^1S_0$ state with a given value for g^2.

TABLE I

	$P=0$, $g^2/4\pi=7.60$	$P=3$, $g^2/4\pi=7.40$	$P=5$, $g^2/4\pi=7.55$	Experiment
P_d	10%	8%	10%	$2\% \leqslant P_d \leqslant 6\%$
$^3r_1$	$1.8\cdot10^{-13}$ cm	$1.7\cdot10^{-13}$cm	$1.9\cdot10^{-13}$ cm	$(1.704\pm0.03)\cdot10^{-13}$ cm
Q	$4.0\cdot10^{-27}$ cm^2	$3.8\cdot10^{-27}$ cm^2	$4.0\cdot10^{-27}$ cm^2	$(2.738\pm0.016)\cdot10^{-27}$ cm^2
$\frac{u}{r}\Big\vert_{r=0}$	0.7	0.6	0.65	—

TABLE II

T, Mev	$P=0$ $g^2/4\pi=10;\ 12;\ 15$	$P=3$ $g^2/4\pi=10;\ 12;\ 15$	$P=5$ $g^2/4\pi=10;\ 12;\ 15$	Potentials G. T.[8] and S. M.[11]
0.7	8°, 11°, 16°	12°, 17°, 27°	12°, 17°, 27°	28°, 28°
5	12°, 17°, 26°	22°, 31°, 45°	22°, 30°, 44°	54°, 55°
15	0°, 0°, 7.5°	10°, 18°, 37°	11°, 18°, 37°	51°, 52°
50	—6°, —6°, —6.5°	—4°, —3° —2°	—4°, —3°, —3°	35°, 39°

From the solutions for the amplitudes u(p) and w(p) of the two-nucleon system in the $^3S_1$ and $^3D_1$ states, obtained by numerical integration, we can find the wave functions for the $^3S_1$ and $^3D_1$ states of the deuteron in coordinate space:

$$u(r) = \frac{2}{(2\pi)^2}\int_0^\infty pdp\sqrt{\frac{2M}{M+E_p}}\,u(p)\sin pr,$$

$$w(r) = \frac{2}{(2\pi)^2}\int_0^\infty pdp\sqrt{\frac{2M}{M+E_p}}\,w(p) \qquad (1)$$

$$\times\left\{\sin pr + \frac{3\cos pr}{pr} - \frac{3\sin pr}{(pr)^2}\right\},$$

where M is the mass of the nucleon, and $E_p = \sqrt{p^2+M^2}$ is the energy of the nucleon with momentum p. With the help of known formulas[6] we can use the functions u(r) and w(r) to determine the interaction parameters of the nucleons in the state $^3S_1 + {}^3D_1$ for low energies, viz.: $^3r_1$, P_d, and Q.

From the numerical results of the scattering problem for two nucleons in the $^1S_0$ state, we can determine the scattering phase for this state. In agreement with Dalitz and Dyson[10] we have

$$\tan\delta(^1S_0) = -\pi u_0(p_0), \qquad (2)$$

where p_0 is the relative momentum of the nucleons in the center-of-mass system; it is connected with the kinetic energy T of the incident nucleon in the laboratory system by the relation $p_0 = \sqrt{MT/2}$.

Table I shows the results of the numerical calculations for the deuteron and gives a comparison of theoretical and experimental values. In Table II the results of the calculation of the phase $\delta(^1S_0)$ are compared with the results obtained with the use of various phenomenological potentials,[8,11] which agree well with experiment up to energies of 50 Mev. It is seen that the contribution of the terms of order g^4 to the interaction in the bound state problem of the deuteron is small. But in the scattering problem of nucleons in the $^1S_0$ state the terms of order g^4 give a significant contribution. The comparison of experimental and theoretical values shows that the theory is qualitatively right in the description of the interaction of the nucleons at low energies ($T < 20$ Mev). For $T = 50$ Mev the calculated phase $\delta(^1S_0)$ is significantly smaller than the experimental phase, which indicates the breakdown of the two-meson approximation used here for relatively high energies.

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