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EFFECT OF TENSOR MESON EXCHANGE ON N-N SCATTERIHG

ЛАБОРАТОРИЯ ВЫЧИСЛИТЕЛЬНОЙ ТЕХНИКИ
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In a number of papers the simple one-boson-exchange models applying the explicit unitarization of Born partial-wave amplitudes have been used to describe elastic nucleon-nucleon scattering[x]. It was shown that nucleon-nucleon scattering phase shifts in the states with $\ell \geq 1$ in the energy region below 350 MeV can be satisfactorily reproduced if along with the one-pion-exchange the exchange of a scalar σ ($I^G = 0^+$, $J^P = 0^+$) and two vector ω ($I^G = 0^-$, $J^P = 1^-$) and ρ ($I^G = 1^+$, $J^P = 1^-$) mesons is taken into account. In the present investigation an attempt was made to consider the exchange of the tensor f-meson ($I^G = 0^+$, $J^P = 2^+$) as well as σ , π , ω and ρ particles exchange for the calculation of the elastic $N-N$ scattering amplitude. The expressions for Born partial-wave amplitudes corresponding to tensor meson exchange were obtained earlier in ref.[3].

The values of the masses and coupling constants of exchanged particles were determined by the least squares method. The $N-N$ scattering phase shifts in the states with $\ell \geq 1$ at energies of 25 MeV[4] and 50, 95, 142, 210 and 330 MeV[5] were taken as experimental information. The $^3D_2$ phase shift at 142 MeV was excluded from the analysis since its experimental value differed more than by 5 errors from the calculated one in all versions of the calculation. Thus, on the whole 101 values of the experimental phase shifts and mixing parameters were used in the analysis. The interaction Lagrangian densities between the meson fields and nucleon are given in ref.[3]

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[x] See for example refs.[1,2] and refs. in them.

In the case of tensor meson exchange it was taken into account only vector gradient coupling of the meson field with nucleon (tensor gradient coupling is partly taken into account by exchange of scalar particle). The method of K -matrix was used for the unitarization of the Born amplitudes. The results of different versions of the analysis are given in the table.

Table The pole parameters obtained from the N -- N phase shifts in the energy range of 25-330 MeV. The mass values are given in MeV. The fixed values of parameters are bracketed.

Solution	1	2	3	4
χ^2	300.4	170.2	125.9	115.6
$m(\sigma)$	498±14	543±9	383±12	453±20
$g^2(\sigma)$	5.14±0.67	11.17 ±1.10	3.40±0.36	6.26±1.07
$m(\pi)$	(135)	(135)	(135)	(135)
$g^2(\pi)$	12.34±0.18	12.57±0.18	12.93±0.19	12.92+0.19
$m(\omega)$	(783)	(783)	428±19	586±39
$g(\omega)$	2.87±0.14	5.10±0.19	1.59±0.10	2.98+0.40
$f(\omega)$	0.72±0.27	-0.54±0.18	0.82±0.15	0.16±0.22
$m(\rho)$	(770)	(770)	545±50	493+40
$g(\rho)$	-0.47±0.05	-0.54±0.04	-0.04±0.05	-0.05±0.05
$f(\rho)$	3.68±0.16	3.70±0.11	2.96±0.16	2.84±0.15
$m(f)$	-	(1254)	-	(1254)
$g^2(f)$	-	24.4±2.1	-	11.0±3.1
$\chi^2/\bar{\chi}^2$	3.20	1.83	1.37	1.27

From comparison of χ^2 values for the solutions 1 and 2 it is seen that the account of the tensor meson improves appreciably the

agreement of the model with experiment. In this case the addition of the tensor meson changes the coupling constans for σ and ω mesons without changing those for π and ρ mesons. Relatively small variation of χ^2 value for solution 4, in comparison with solution 3, shows that the effect of tensor f-meson seems to be partly compensated by variation of the ω and ρ masses.

The comparison of different state contributions into the total χ^2 sum has shown that the account of the f-meson exchange improves especially the description of $^3P_{0,1,2}$ and $^3D_1$ phase shifts and does not noticeably affect other phase shifts. The energy dependences of the phase shifts of the triplet P and D waves for solutions 1 (dashed line) and 2 (solid line) are shown in Figs. 1 and 2. It should be noted that the addition of other resonances (η and ϕ) does not lead to the appreciable improvement of the description of experimental phase shifts as it takes place in the case of f-meson exchange.

References

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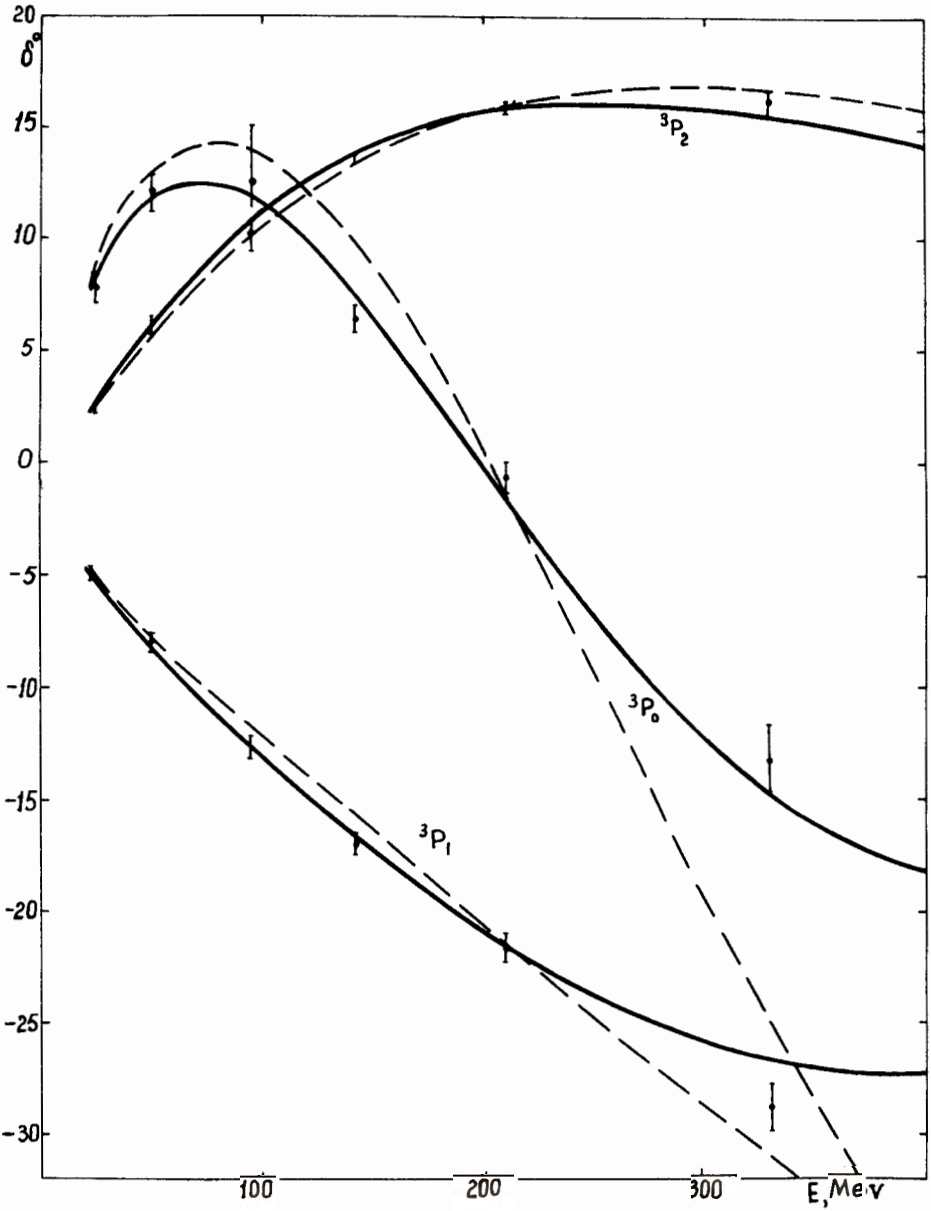

Fig. 1. The energy dependences of the phase shifts of $^3P_0$, $^3P_1$ and $^3P_2$ states for the solutions 1 (dashed line) and 2 (solid line) of the Table. The experimental N-N scattering phase shifts values/ 4,5/ are shown.

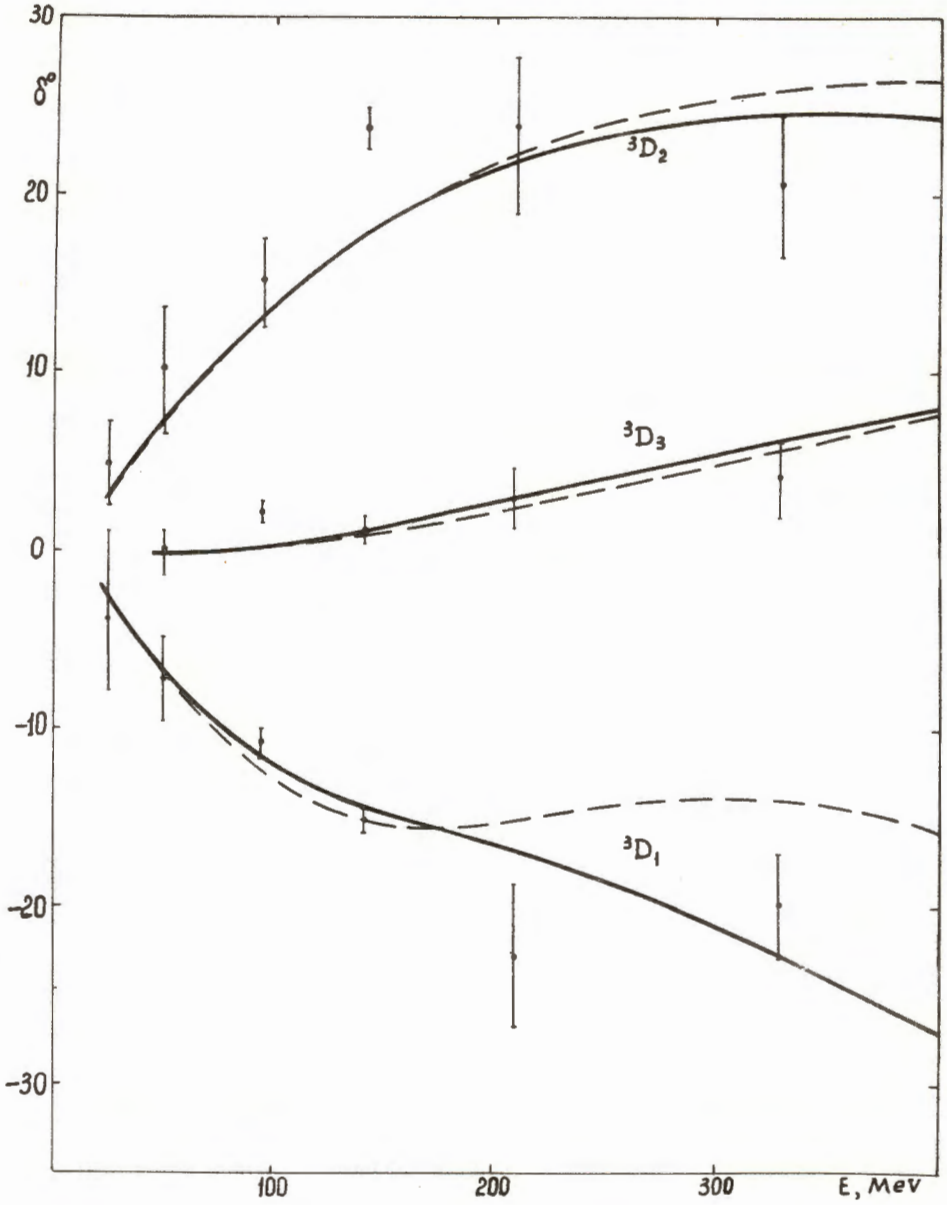

Fig. 2. The energy dependences of the phase shifts of $^3D_1$, $^3D_2$ and $^3D_3$ states for the solutions 1 (dashed line) and 2 (solid line) of the Table.