ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ

Дубна

E - 2743

Z. Janout, Yu. M. Kazarinov, F. Lehar

PHASE-SHIFT ANALYSIS OF THE NUCLEON-NUCLEON SCATTERING AT 400 MEV

ЛАБОРАТОРИЯ ЯДЕРНЫХ ПРОБЛЕМ

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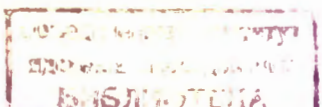
Submitted to JETP



Previously the phase-shift analysis at 400 MeV was performed in ref.[1]. Three sets of phase-shifts with equal probability of χ^2 criterion were obtained. The phase-shift analysis was carried out at $\ell_{max} = 4$, i.e. beginning from the orbital momenta $\ell = 5$, the scattering amplitude was taken in one pion exchange approximation. It was assumed, that the pion production exists only in initial P ,D and F - states with isotopical spin equal to unity and is characterised with the mean coefficient of absorbtion[2] for a given state[x].

Later, the data for the polarization and triple-scattering parameters used in ref.[1], were specified and published in[3]. This made it possible to perform the specified phase-shift analysis whose results are given below.

The use of more accurate data of the polarization and triple-scattering parameters resulted in the fact that two phase-shift sets became equal and the errors of phase-shifts slightly decreased.

Two remaining phase-shift sets are given in Table 1. Both sets have an imaginary part only at phase-shift $^1D_2$ -wave. The imaginary parts of ^3P and ^3F phase-shifts are very small and cannot improve the fit of experimental data.

The used experimental data are shown in Table 2.

The angular dependences of experimental quantities were calculated on the basis of two remaining phase-shift sets and are shown in Figs. 1-10.

It is seen from the figures, that it is necessary to perform at least one np -triple scattering experiment in order to exclude one of the two remaining sets at 400 MeV. The planning of such an experiment and the determination of the optimal angle for the measurement is given in[13]. It follows that under the existing conditions it is most effective to measure the triple-scattering parameters D_{pn} and A_{pn} at angles 60^o and 55^o (c.m.s.), respectively.

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x) The imaginary parts of phase-shifts P and F waves in this case are equal.

In conclusion the authors express their deep gratitude to E. Dudova, J. Fingerova, T.D. Timofeyeva and N.V. Volczkova for help in the work.

Table 1

The phase-shifts in degress (the Stapp representation /14/)

	1 - st set $\delta^0 \pm \Delta\delta^0$		2 - nd set $\delta^0 \pm \Delta\delta^0$	
	real parts of phase-shifts			
ϵ^2	0,078	0,009	0,09I	0,009
$^1S_0$	-I3,46	I,78	-I2,27	I,65
$^3S_1$	3,42	3,68	29,02	6,I7
$^3P_0$	-I3,50	I,9I	-I5,I3	I,99
$^1P_1$	-48.43	2.I5	-37,48	8.00
$^3P_1$	-33.80	0.8I	-33.30	0.83
$^3P_2$	I8.20	0.50	I8.30	0.53
ϵ_1	4.79	2.97	-20.I0	7.05
$^3D_1$	-29.66	2.74	20.97	3.54
$^1D_2$	I2.8I	0.52	I2.93	0,48
$^3D_2$	I2.44	2.96	I.66	4.I8
$^3D_3$	- I.79	I.59	7.02	2.I7
ϵ_2	- I.II	0,69	- I.28	0.68
$^3F_2$	I.77	0.57	I.78	0.55
$^1F_3$	- 3.59	I.30	- 3.60	I.30
$^3F_3$	- 2.55	0.43	- 2.37	0.45
$^3F_4$	3.68	0.27	3.70	0.28
ϵ_3	7.70	0.88	3.I6	I.59
$^3G_3$	- 0.66	I.77	- 4.38	2.52
$^1G_4$	2.2I	0.28	2.27	0.29
$^3G_4$	3.90	0.88	5.27	I.3I
$^3G_5$	- 2.8I	2.I8	- 3.32	2.I3
	imaginary part of phase-shifts			
$^1D_2$	3.69	0.94	3.I4	0,93
χ^2	79.20		82.I4	
$\frac{\chi^2}{\chi^2}$	0.90		0.93	

Table 2

The experimental data, used in phase-shift analysis

Measured quantity	Actual experimental energy	Number of points	Ref.
σ_{pp}	380, 437	34	/4/
P_{pp}	415, 430	14	/3,5/
D_{pp}	415, 430	8	/3,6/
R_{pp}	430	7	/3/
A_{pp}	430	7	/3/
A'_{pp}	430	7	/3/
C^{pp}_{nn}	380, 400	3	/7,8/
$C^{pp}_{m\ell}$	400	2	/8/
σ^{t}_{pp}	410	1	/9/
σ_{np}	400	19	/10/
P_{np}	350	9	/11/
σ^{t}_{np}	410	1	/12/

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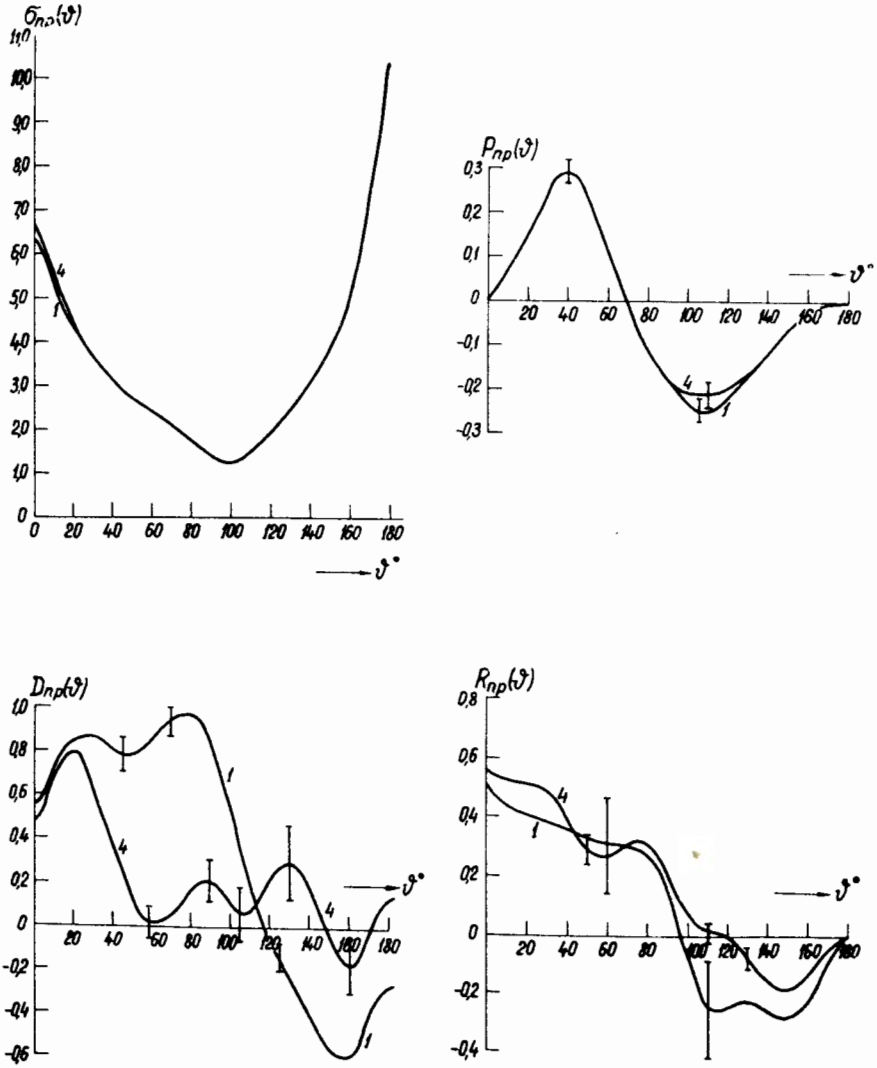
Received by Publishing Department
on May 14, 1966.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$P_{np}(\vartheta)$
$D_{np}(\vartheta)$
$R_{np}(\vartheta)$
ϑ°
1
4

Fig. 1.

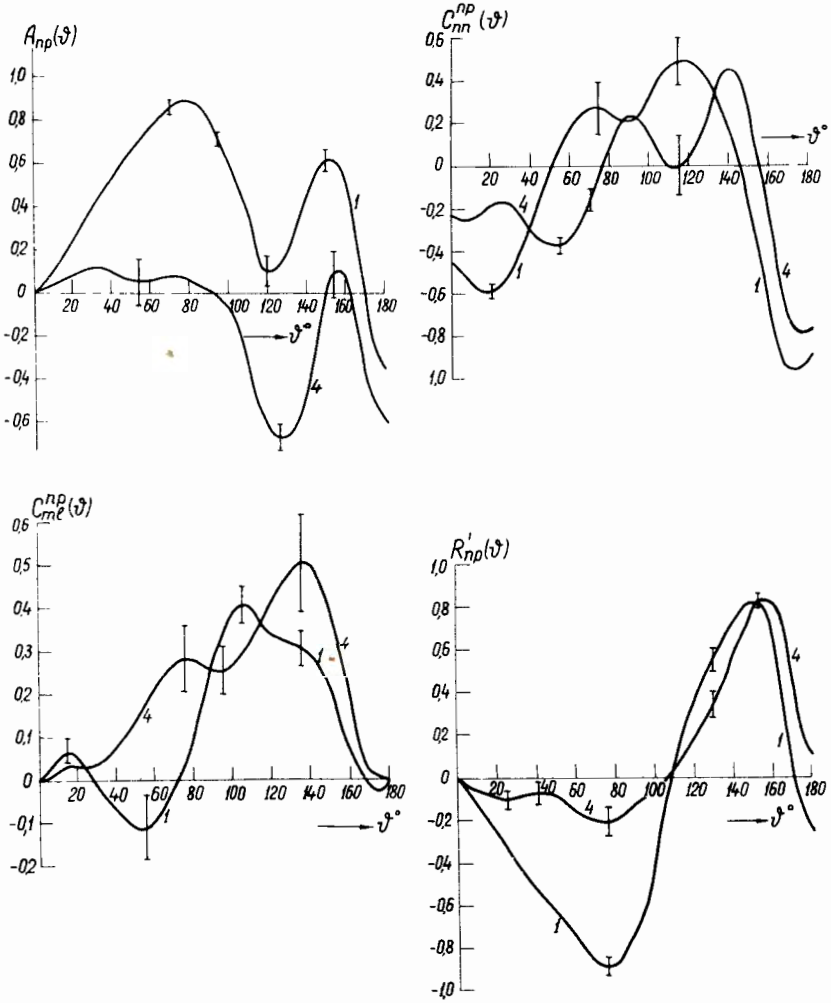
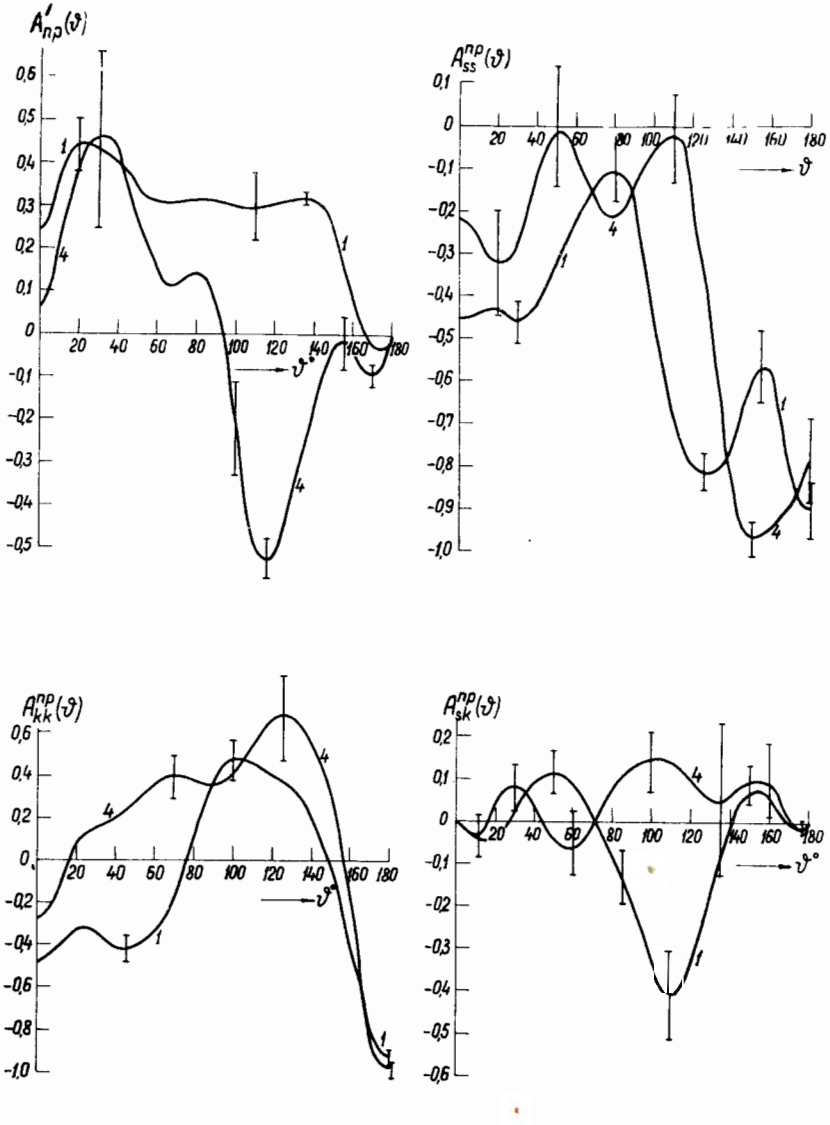

$A_{np}(\vartheta)$
$C_{nn}^{np}(\vartheta)$
$C_{m\ell}^{np}(\vartheta)$
$R'_{np}(\vartheta)$
ϑ°
1
4

Fig. 2.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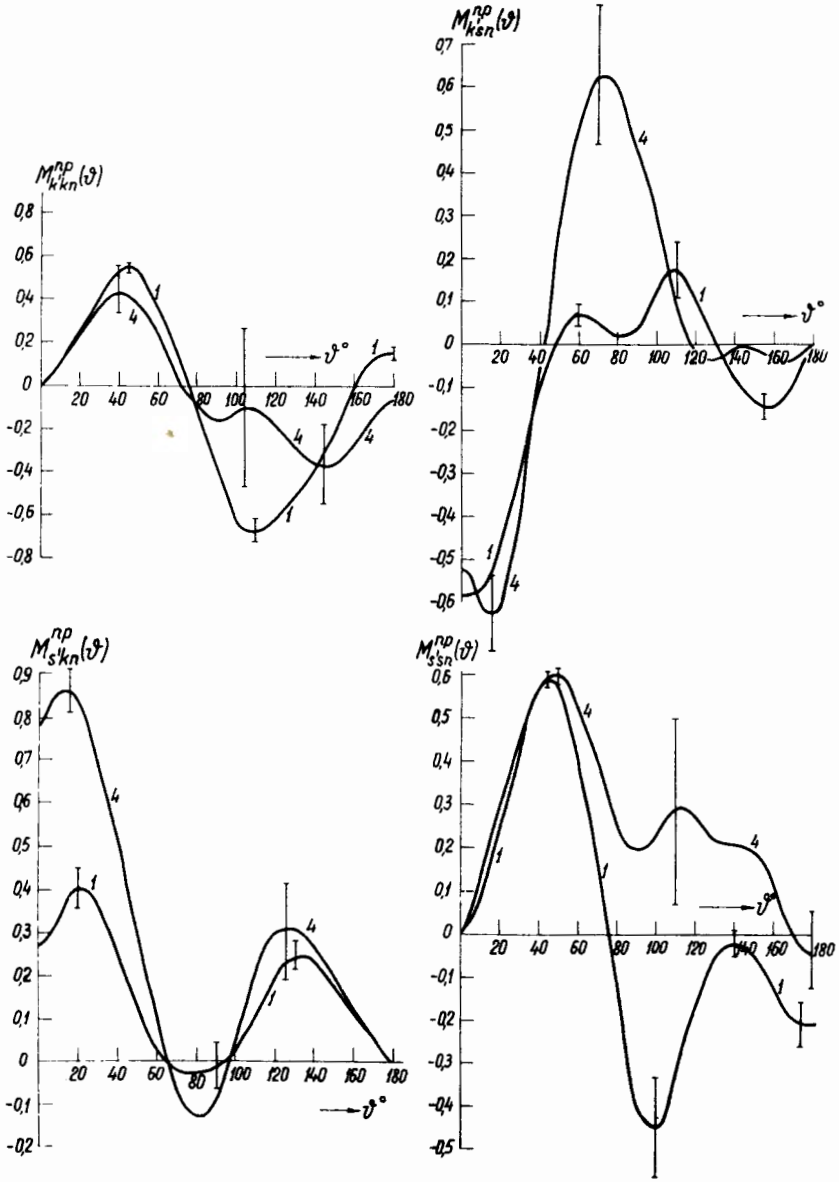
$A^{np}_{ss}(\vartheta)$
$A^{np}_{kk}(\vartheta)$
$A^{np}_{sk}(\vartheta)$
ϑ°
1
4

Fig. 3.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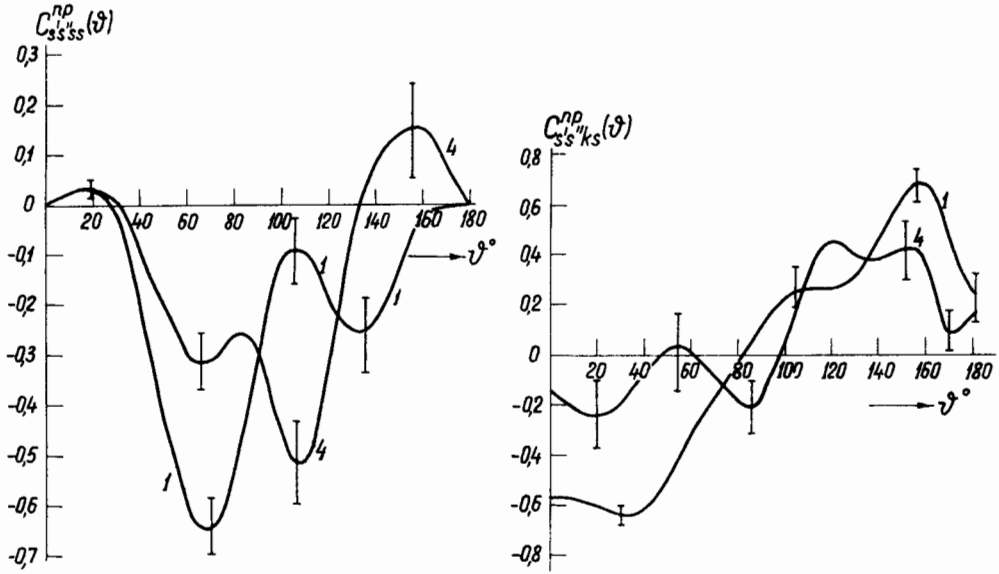
$M^{np}_{k'ksn}(\vartheta)$
$M^{np}_{s'kn}(\vartheta)$
$M^{np}_{s'sn}(\vartheta)$
ϑ°
1
4

Fig. 4.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-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
20
40
60
80
100
120
140
160
180
$\vartheta°$
1
1
1
4
4
$C^{np}_{s's''ks}(\vartheta)$
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
20
40
60
80
100
120
140
160
180
$\vartheta°$
1
4

Fig. 5.

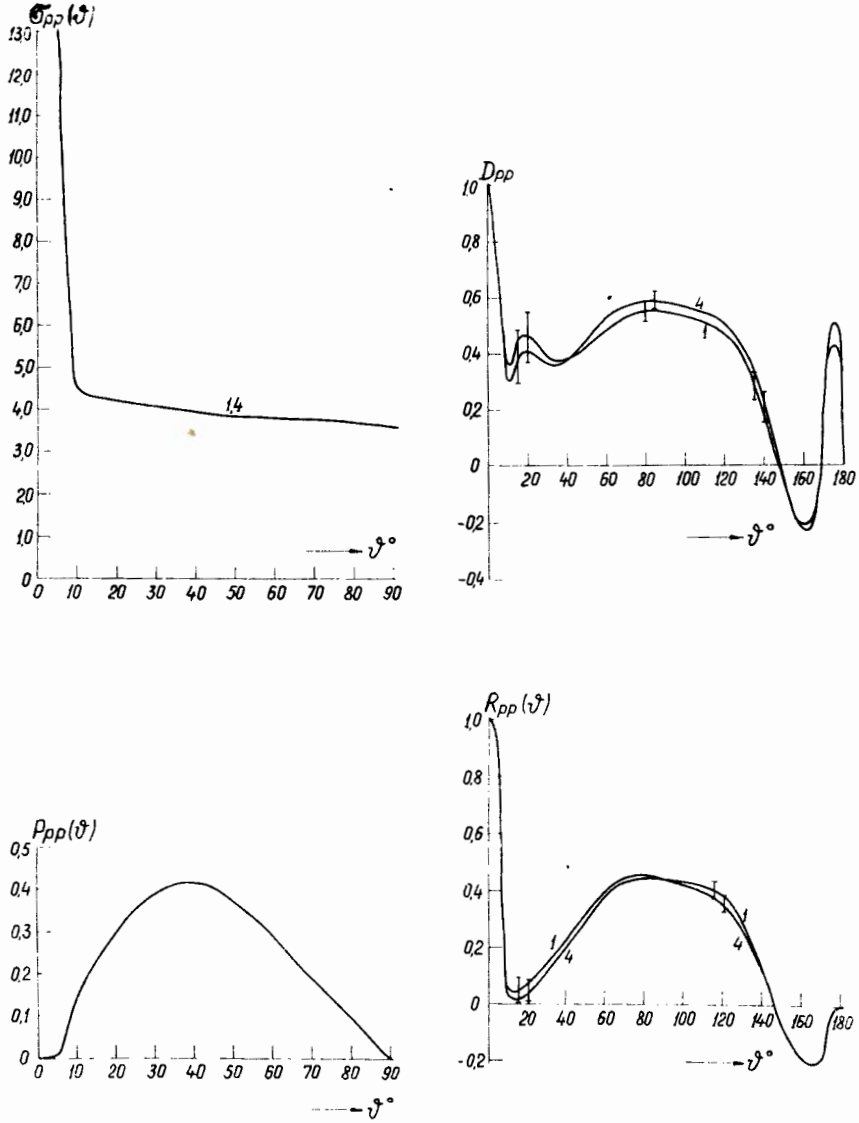
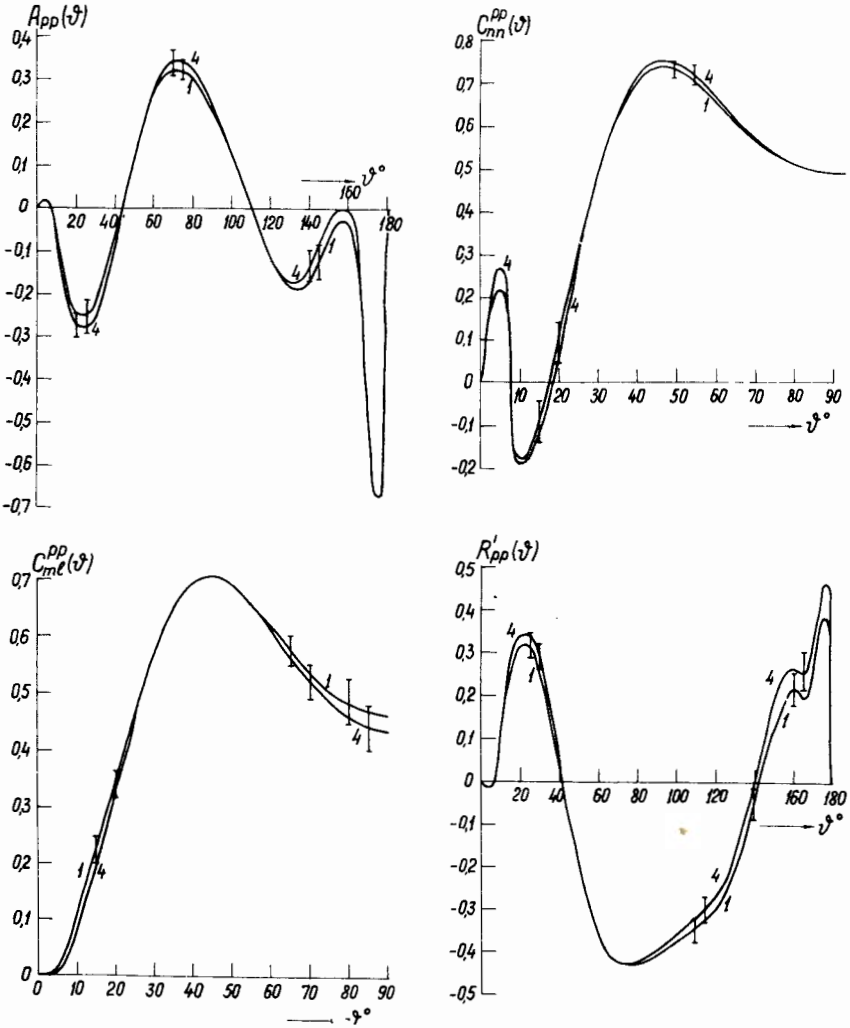

$\sigma_{pp}(\vartheta)$
1,4
$\vartheta°$
D_{pp}
4
1
$\vartheta°$
$P_{pp}(\vartheta)$
$\vartheta°$
$R_{pp}(\vartheta)$
1
4
1
4
$\vartheta°$

Fig. 6.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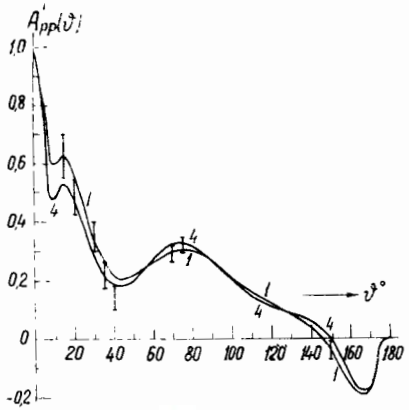
$C_{nn}^{pp}(\vartheta)$
$C_{m\ell}^{pp}(\vartheta)$
$R'_{pp}(\vartheta)$
ϑ°

Fig. 7.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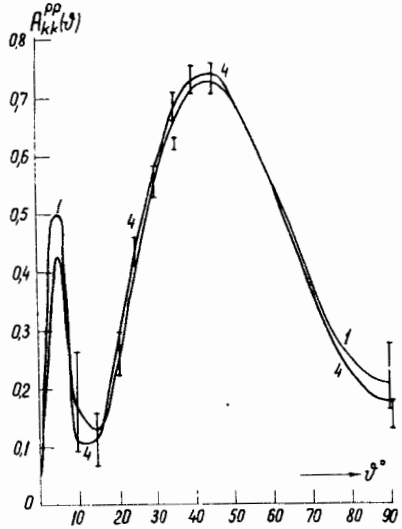
0,6
0,4
0,2
0
-0,2
20 40 60 80 100 120 140 160 180
$\vartheta°$
1
4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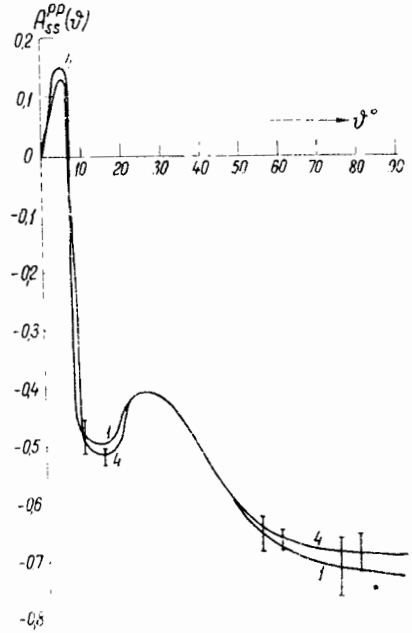
0,3
0,2
0,1
0
10 20 30 40 50 60 70 80 90
$\vartheta°$
1
4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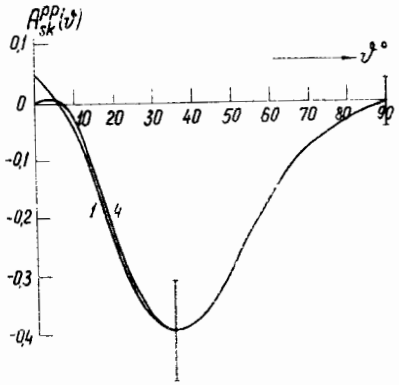
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
10 20 30 40 50 60 70 80 90
$\vartheta°$
1
4


$A^{pp}_{sk}(\vartheta)$
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0
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-0,2
-0,3
-0,4
10 20 30 40 50 60 70 80 90
$\vartheta°$
1
4

Fig. 6.

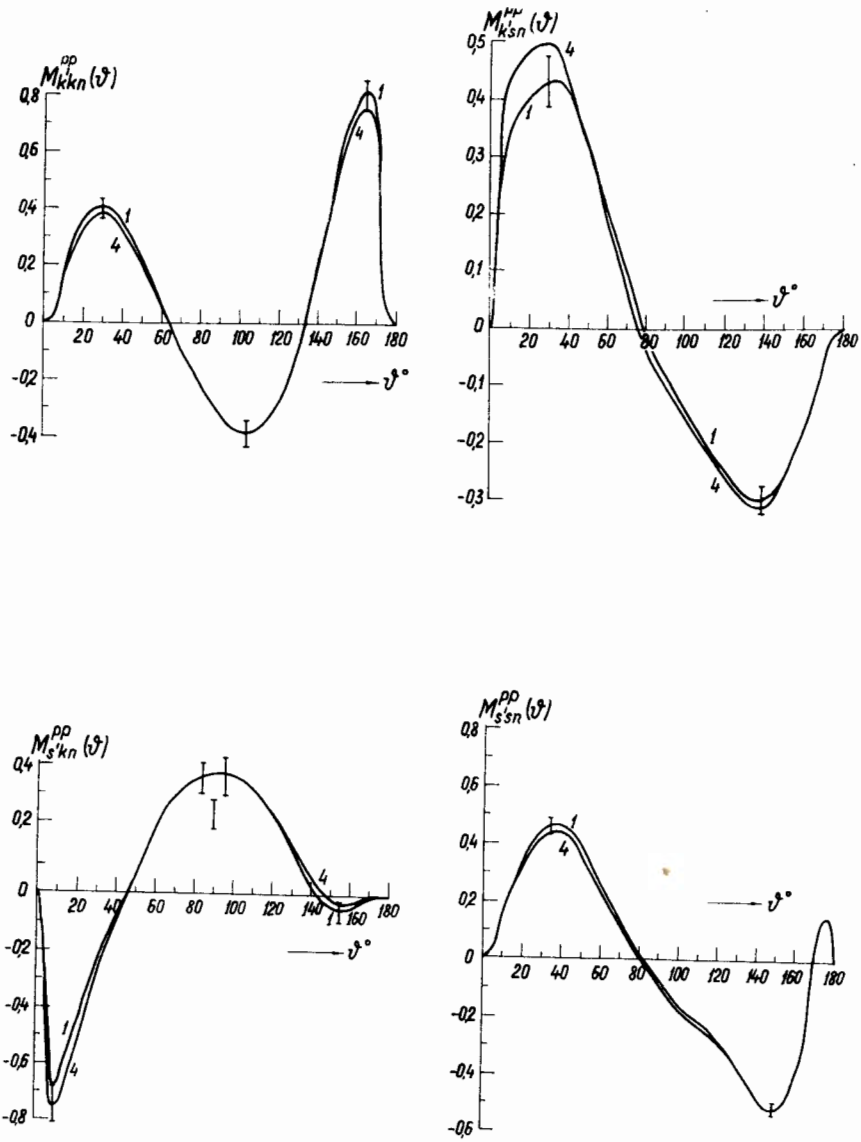
$M^{pp}_{kkn}(\vartheta)$
$M^{np}_{k'sn}(\vartheta)$
$M^{pp}_{s'kn}(\vartheta)$
$M^{pp}_{s's n}(\vartheta)$
ϑ°
1
4

Fig. 9.

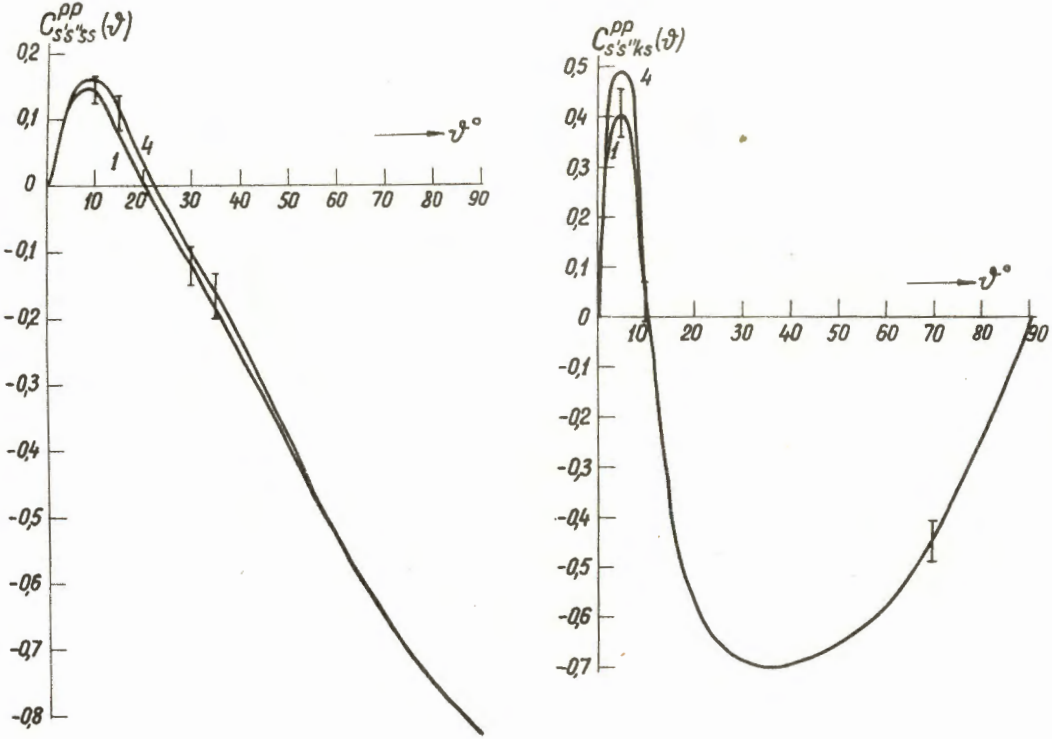
$C^{pp}_{s's''ss}(\vartheta)$
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
10 20 30 40 50 60 70 80 90
ϑ°
1
4
$C^{pp}_{s's''ks}(\vartheta)$
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
10 20 30 40 50 60 70 80 90
ϑ°
1
4

Fig. 10.