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Kh.M.Chernev, O.V.Dumbrajs, Z.M.Zlatanov

ANALYSIS OF EXPERIMENTAL DATA ON THE DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING USING ANALYTICITY

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Kh.M.Chernev,[1] O.V.Dumbrajs,[2] Z.M.Zlatanov

ANALYSIS OF EXPERIMENTAL DATA ON THE DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING USING ANALYTICITY

[1] Institute of Nuclear Research and Nuclear Energy, Sofia, Bulgaria.

[2] On leave of absence from the Institute of Nuclear Physics, Moscow State University, USSR

Чернев Х.М., Думбрайс О.В., Златанов З.М. E2 - 8053

Анализ экспериментальных данных по дифференциальному сечению упругого рассеяния с использованием аналитичности

Анализируются экспериментальные данные по дифференциальным сечениям методом, учитывающим аналитические свойства амплитуды рассеяния, с целью извлечения значения отношения реальной части амплитуды к ее мнимой части и значения параметра наклона дифференциального сечения.

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Chernev Kh.M., Dumbrajs O.V., Zlatanov Z.M. E2 - 8053

Analysis of Experimental Data on the Differential Cross Section for Elastic Scattering Using Analyticity

The parametrization incorporating correct analytic properties of the differential cross section is used to reanalyze some recent data on $\pi^- p$, $K^- p$ and $\bar{p}p$ elastic scattering outside the region of Coulomb interference. Extrapolation to the forward direction by means of the new expansion does not lead to values below the optical point, contrary to the results of ordinary extrapolations. An evidence has been found for the increase of the slope of the differential cross section as the forward direction is approached.

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Recently we have proposed to use the optimized polynomial expansions of an analytic function for "parametrization" of the differential cross section for elastic scattering. The procedure incorporates correct analytic properties of the differential cross section and is believed to lead to the most unbiassed predictions outside the fit region as long as one believes in analyticity only.

In this work we reanalyze some recent data on the differential cross section for elastic $\pi^- p$ [2,3], $K^- p$ [2,4] and $\bar{p}p$ [2,5,6] scattering by means of the new method. The results are presented in Tables I, II and III, respectively.

Two main conclusions can be drawn from the comparison between the old and new fits.

1) Extrapolation to the forward direction even from such relatively remote distances using the new "parametrization" never gives values of the differential cross section below the optical point, contrary to ordinary exponential extrapolations. Therefore we think that our procedure should be used when an attempt is made to put a good face on a bad business: to estimate the modulus of the real part of the amplitude in the forward direction on the basis of data at large momentum transfer. In this respect it is of interest to note recent speculations [7] and their criticism [8] about possible violations of the optical theorem based on analyses of the values of $(d\sigma/dt)_0$ obtained by exponential extrapolations.

Table I. π^-p scattering. The number of terms in the expansion (18) of ref.[1] has been chosen to be optimal according to the χ^2-criterion introduced into the same work. The slope increase is marked by arrow. The first number corresponds to the slope of the minimal value of $|t|$ used in the fit, and the last number is the value of the slope at $t = 0$.

P GeV/c	Optical point mb/(GeV/c)^2	Region of fit $\|t\|$ (GeV/c)^2	Number of points	Old parametrization: Form	χ^2	$(d\sigma/dt)_0$ mb/(GeV/c)^2	b (GeV/c)$^{-2}$	c (GeV/c)$^{-4}$	New parametrization: Number of terms	χ^2	$(d\sigma/dt)$ mb/(GeV/c)^2	Slope (GeV/c)$^{-2}$
25.2	3I.43	0.07-0.80	38	exp(bt)	55	25.0±0.5	7.76±0.09		4	32	3I.4±3.6	9.22±0.05 →
				exp(bt+ct^2)	34	28.6±I.I	9.07±0.32	2.4±0.6				II.13±0.02
40.I	3I.I8	0.07-0.80	38	exp(bt)	69	25.5±0.5	8.06±0.09		3	38	36.3±I.I	I0.04±0.04 →
				exp(bt+ct^2)	38	29.8±I.I	9.63±0.3I	2.9±0.5				I4.06±0.0I
50	30.I7	0.03-0.40	37	exp(bt)	46	30.6±0.9	9.I$\pm^{0.2}_{0.4}$		2	3I	33.4±0.6	I0.22±0.07 → II.95±0.05

Table II. K^-p scattering. The conventions are the same as in Table I.

P GeV/c	Optimal point mb/(GeV/c)^2	Region of fit $\|t\|$ (GeV/c)^2	Number of points	Old parametrization: Form	χ^2	$(d\sigma/dt)$ mb/(GeV/c)^2	b (GeV/c)$^{-2}$	c (GeV/c)$^{-4}$	New parametrization: Number of terms	χ^2	$(d\sigma/dt)_0$ mb/(GeV/c)^2	Slope (GeV/c)$^{-2}$
I0.I	25.87	0.06-0.2	6	exp(bt)		23.5±0.8	7.7±0.3		2	0.2	25.5±2.8	8.0I±0.59 →
				exp(bt+ct^2)		25.8±I.0	9.3±0.7	7.I±2.3				I0.26±0.66
		0.06-0.5	I5	exp(bt)		22.I±0.5	7.2±0.I		3	8	25.7±I.8	8.I6±0.I0 → I0.27±0.08
				exp(bt+ct^2)		24.0±0.4	8.I±0.I	I.7±0.3				
		0.06-0.8	I8	exp(bt)		2I.3±0.4	7.0±0.I		4	I2	25.8±2.5	8.I9±0.I2 → I0.32±0.I0
				exp(bt+ct^2)		23.8±0.4	8.0±0.I	I.5±0.3				
		0.06-2.5	26	$P_{exp}(Qt)+R_{exp}(st)$		23.2±I.5			5	22	28.0±I.4	8.34±0.02 → II.30±0.0I
25.2	2I.89	0.07-0.80	38	exp(bt)	69	I7.3±0.3	7.4±0.I		4	28	22.6±2.3	8.98±0.05 → II.80±0.02
				exp(bt+ct^2)	34	I9.9±0.6	8.9±0.2	2.4±0.4				
40.I	2I.68	0.07-0.80	38	exp(bt)	93	I6.I±0.3	7.3±0.I		4	33	20.4±2.0	8.83±0.04 → I0.32±0.02
				exp(bt+ct^2)	36	I9.0±0.5	8.9±0.2	2.8±0.4				

Table III. $\bar{p}p$ scattering. The conventions are the same as in Table I.

P GeV/c	Optical point mb/(GeV/c)^2	Region of fit |t| (GeV/c)^2	Number of points	Old parametrization: Form	χ^2	$(d\sigma/dt)_0$ mb/(GeV/c)^2	b (GeV/c)$^{-2}$	c (GeV/c)$^{-4}$	New parametrization: Number of terms	χ^2	$(d\sigma/dt)_0$ mb/(GeV/c)^2	Slope (GeV/c)$^{-2}$
2.33	366.6	0.04–0.21	31	exp(bt)	40	402.5±11.2	13.8±0.3		2	30	564.4±27.8	16.74±0.28 29.63±0.19
				exp(bt+ct^2)	40	404.3±27.0	13.9±1.3					
		0.04–0.35	42	exp(bt)	79	430.1±10.3	14.6±0.2		3	41	466.5±44.5	14.88±0.16 21.57±0.18
				exp(bt+ct^2)	48	359.8±16.7	11.3±0.8					
		0.04–1.60	58	$P_{exp}(Qt)$ + $R_{exp}(st)$	54	375.6±93.3	10.2±0.5		5	617	534±22	17.15±0.01 21.40±0.01
2.05	312.5	0.04–0.215	35	exp(bt)	33	305.9±7.0	12.7±0.2		2	27	356.1±18.0	13.48±0.27 24.20±0.28
				exp(bt+ct^2)	18	251.5±13.8	8.5±1.1	−18.2±4.6				
		0.04–1.8	75	$P_{exp}(Qt)$ + $R_{exp}(st)$	70	292.7±5.5			5	321	373 ±14	14.66±0.01 15.72±0.01
25.2	108.6	0.07–0.6	33	exp(bt)	35	99 ± 2	11.8±0.1		3	29	204 ± 7	15.11±0.04 33.68±0.02
				exp(bt+ct^2)	25	108 ± 4	12.8±0.4	2.3± 0.8				
40.1	101.2	0.07–0.6	33	exp(bt)	30	79 ±2	11.3±0.2		3	36	164±10	14.78±0.06 33.27±0.03
				exp(bt+ct^2)	23	85 ± 5	12.2±0.7	2.0±1.4				

2) We find an evidence for the increase of the slope of the differential cross section as the forward direction is approached.

The results of the fits seem to be stable enough with respect to the fit region.

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