Table 40.2: Total hadronic cross section. Analytic $\boldsymbol{S}$-matrix and Regge theory suggest a variety of parameterizations of total cross sections at high energies with different areas of applicability and fits quality.

A ranking procedure, based on measures of different aspects of the quality of the fits to the current evaluated experimental database allows one to single out the following parameterization of highest rank [1].

$$\sigma^{\overline{a}b} = Z^{ab} + B\log^2\left(\frac{s}{s_0}\right) + Y_1^{ab}\left(\frac{s_1}{s}\right)^{\eta_1} + Y_2^{ab}\left(\frac{s_1}{s}\right)^{\eta_2}, \quad \sigma^{ab} = Z^{ab} + B\log^2\left(\frac{s}{s_0}\right) + Y_1^{ab}\left(\frac{s_1}{s}\right)^{\eta_1} - Y_2^{ab}\left(\frac{s_1}{s}\right)^{\eta_2},$$

where $\boldsymbol{Z^{ab}, B, Y_i^{ab}}$ are in mb, $\boldsymbol{s}$, $\boldsymbol{s_1}$, and $\boldsymbol{s_0}$ are in GeV$^{\mathbf{2}}$. The scales $\boldsymbol{s_0}$, $\boldsymbol{s_1}$, the rate of universal rise of the cross sections $\boldsymbol{B}$, and exponents $\boldsymbol{\eta_1}$, and $\boldsymbol{\eta_2}$ are independent of the colliding particles. The scale $\boldsymbol{s_1}$ is fixed at $\mathbf{1}$ GeV$^{\mathbf{2}}$. Terms $\boldsymbol{Z^{ab} + B\log^2(s/s_0)}$ represent the pomerons. The exponents $\boldsymbol{\eta_1}$, and $\boldsymbol{\eta_2}$ represent lower-lying C-even and C-odd exchanges, respectively. Requiring $\boldsymbol{\eta_1 = \eta_2}$ results in somewhat poorer fits. In addition to total cross sections $\boldsymbol{\sigma}$, the measured ratios of the real-to-imaginary parts of the forward scattering amplitudes $\boldsymbol{\rho = Re(T)/Im(T)}$ were included in the fits by using $\boldsymbol{s}$ to $\boldsymbol{u}$ crossing symmetry. Global fits were made to the 2005-updated data for $\boldsymbol{\overline{p}(p)\,p}$, $\boldsymbol{\Sigma^-\,p}$, $\boldsymbol{\pi^\mp\,p}$, $\boldsymbol{K^\mp\,p}$, $\boldsymbol{\gamma\,p}$, and $\boldsymbol{\gamma\,\gamma}$ collisions. Exact factorisation hypothesis was used for both $\boldsymbol{Z^{ab}}$ and $\boldsymbol{\log^2(s/s_0)}$ to extend the universal rise of the total hadronic cross sections to the $\boldsymbol{\gamma\,p \to hadrons}$ and $\boldsymbol{\gamma\,\gamma \to hadrons}$ collisions. The asymptotic parameters thus obtained were then fixed and used as inputs to a fit to a larger data sample that included cross sections on deuterons $\boldsymbol{(d)}$ and neutrons $\boldsymbol{(n)}$. All fits were produced to data above $\boldsymbol{\sqrt{s_{\min}} = 5}$ **GeV**.

Fits to $\overline{p}(p)\,p$, Σ^-p, $\pi^\mp p$, $K^\mp p$, γp, $\gamma\gamma$: Z	Y_1	Y_2	Beam/ Target	Fits to groups: Z	Y_1	Y_2	B	$\frac{\chi^2}{dof}$ by groups
35.45(48)	42.53(1.35)	33.34(1.04)	$\overline{p}(p)/p$	35.45(48)	42.53(23)	33.34(33)	0.308(10)	
			$\overline{p}(p)/n$	35.80(16)	40.15(1.59)	30.00(96)	0.308(10)	1.029
35.20(1.46)	$-199(102)$	-264(126)	Σ^-/p	35.20(1.41)	$-199(86)$	-264(112)	0.308(10)	0.565
20.86(40)	19.24(1.22)	6.03(19)	$\pi^\mp/p$	20.86(3)	19.24(18)	6.03(9)	0.308(10)	0.955
17.91(36)	7.1(1.5)	13.45(40)	$K^\mp/p$	17.91(3)	7.14(25)	13.45(13)	0.308(10)	
			$K^\mp/n$	17.87(6)	5.17(50)	7.23(28)	0.308(10)	0.669
	0.0317(6)		γ/p		0.0320(40)		0.308(10)	
	-0.61(62)E-3		γ/γ		-0.58(61)E-3		0.308(10)	0.766
$\chi^2/dof = 0.971$	$B = 0.308(10)$ mb,		$\overline{p}(p)/d$	64.35(38)	130(3)	85.5(1.3)	0.537(31)	1.432
$\eta_1 = 0.458(17)$,	$\eta_2 = 0.545(7)$		$\pi^\mp/d$	38.62(21)	59.62(1.53)	1.60(41)	0.461(14)	0.735
$\delta = 0.00308(2)$,	$\sqrt{s_0} = 5.38(50)$ GeV		$K^\mp/d$	33.41(20)	23.66(1.45)	28.70(37)	0.449(14)	0.814

The fitted functions are shown in the following figures, along with one-standard-deviation error bands. When the reduced χ^2 is greater than one, a scale factor has been included to evaluate the parameter values and to draw the error bands. Where appropriate, statistical and systematic errors were combined quadratically in constructing weights for all fits. On the plots only statistical error bars are shown. Vertical arrows indicate lower limits on the $p_{\rm lab}$ or $E_{\rm cm}$ range used in the fits. One can find the details of the global fits and ranking procedure in the paper [1]. Database is practically the same as for the 2004 edition (it was slightly changed in the low energy regions not used in the fits).

Recently the statement of paper [1] that the models with $\log^2(s/s_0)$ asymptotic terms work much better than the models with $log(s/s_0)$ or $(s/s_0)^\epsilon$ terms was repeatedly confirmed by two studies [2] and [3] tried to match asymptotic parameterization with low energy data in different ways. However, these both studies made questional the other statement of paper [1] on the universality in rates of the $\log^2(s/s_0)$ terms for all collisions with nucleon and gamma targets. Unfortunately they give different predictions for superhigh energies: $\sigma^{as}_{\pi N} > \sigma^{as}_{NN}$ [2] and $\sigma^{as}_{\pi N} \sim 2/3\sigma^{as}_{NN}$ [3]. Having additional recent claim on the rate universality of the σ^{as}_{tot} [4], we safely postponed the expansion of ranking procedures below $\sqrt{s} = 5\,GeV$ until stability in predictions based on the low energy constraints will be achieved. It should be noted that asymptotic rate universality does not revealed yet in hadron deuteron collisions at available energies.

Computer-readable data files extracted from the PPDS (`http://wwwppds.ihep.su:8001/ppds.html`) are also available at `http://pdg.lbl.gov`. (Courtesy of the COMPAS group, IHEP, Protvino, August 2005.)

On-line "Predictor" to calculate σ and ρ for any energy from five high rank models is also available at http://nuclth02.phys.ulg.ac.be/compete/predictor.html/

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