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V.G.Krivokhizhin, I.A.Savin

COMPATIBILITY OF THE K^+n AND K^-n TOTAL CROSS SECTION MEASUREMENTS, $K^0_L - K^0_S$ REGENERATION AMPLITUDE ON HYDROGEN AND CP-VIOLATING PARAMETER $|\eta_{+-}|$

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COMPATIBILITY OF THE K^+n AND K^-n TOTAL CROSS SECTION MEASUREMENTS, $K^0_L - K^0_S$ REGENERATION AMPLITUDE ON HYDROGEN AND CP-VIOLATING PARAMETER $|\eta_{+-}|$

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As is known[1], there still exists a contradiction in experimental data on the parameter $\eta_{+-} \equiv |\eta_{+-}| \cdot \exp(i\Phi_{+-})$ representing the ratio of the CP-violating decay amplitude $K_L^\circ \to \pi^+ + \pi^-$ and the CP-conserving decay amplitude $K_S^\circ \to \pi^+ \pi^-$. In a number of experiments[2] performed before 1972 the mean value of $|\eta_{+-}|$ was obtained as $|\eta_{+-}| = (1.96 \pm 0.03) \cdot 10^{-3}$, while the results of two recent most precise experiments[3,4] have given the value of $|\eta_{+-}| = (2.30 \pm 0.03) \cdot 10^{-3}$ calculated for the mean life time of K_S° : $\tau_S = 0.895 \cdot 10^{-10}$ sec.

There is no reasonable explanation of this contradiction and nobody has found any mistake in the published data. As a matter of fact, the mean value of $|\eta_{+-}| = (2.17 \pm \pm 0.07) \cdot 10^{-3}$ quoted in the particle properties data[5] has a scale factor $S = 3.4$. One can try to resolve the existing contradiction with the help of the $K_L^\circ - K_S^\circ$ regeneration experiments on hydrogen and the total K^+n and K^-n cross section measurements at high energies.

The transmission regeneration amplitude on hydrogen $f_{21}^\circ = |f_{21}^\circ| \exp(i\phi_{21}^\circ)$ by definition is equal to the semidifference of the kaon and antikaon forward elastic scattering amplitudes on protons

$$f^{\circ}_{21} = [f^{\circ}(K^{\circ}p) - \bar{f}^{\circ}(\bar{K}^{\circ}p)]/2. \quad (1)$$

Applying the optical theorem to both the parts of eq. (1) and using the isospin invariance hypothesis, one can obtain

$$2\,\mathrm{Im}\, f^{\circ}_{21} = [\sigma_T(K^{\circ}p) - \sigma_T(\bar{K}^{\circ}p)] \cdot k/4\pi = [\sigma_T(K^{+}n) - \sigma_T(K^{-}n)] \cdot k/4\pi, \quad (2)$$

or

$$\Delta\sigma_T = 4\pi[2|f^{\circ}_{21}|/k] \cdot \sin\phi^{\circ}_{21}, \quad (3)$$

where $k = p/\hbar$, p is the kaon momentum.

It is known from the regeneration experiments (see, for example, refs. [8,9]) that

$$2|f^{\circ}_{21}|/k = \mathrm{const} \cdot R \cdot |\eta_{+-}|, \quad (4)$$

where $R = |\rho/\eta_{+-}|$, ρ is the regeneration coefficient and const. is a value completely known for a set of variables: the kaon momentum, the length of the target and the weak interaction parameters of $K^{\circ}_L - K^{\circ}_S$ system (Δm, τ_S, τ_L and Φ_{+-}). From eqs. (3) and (4) it follows that

$$\Delta\sigma_T = \mathrm{const} \cdot |\eta_{+-}| \cdot R \cdot \sin\phi^{\circ}_{21}. \quad (5)$$

One can use eq. (5) for a consistent check of the total $K^{+}n$ and $K^{-}n$ cross section measurements, on the one hand, and the hydrogen $K^{\circ}_L - K^{\circ}_S$ transmission regeneration amplitude, on the other hand, with the existing data on $|\eta_{+-}|$.

In order to check this consistency we have used the Serpukhov [6] and Batavia [7] data on the cross sections fitted in these experiments as $\Delta\sigma = A \cdot p^{-n}$ and the values of and ϕ°_{21} from the regeneration experiments [8,9]. The following results have been obtained:

1) the IHEP data [6] alone fitted as $\Delta\sigma_T = (12.1 \pm 4.1) \cdot p^{-0,65 \pm 0,10}$ mb give $|\eta_{+-}| = (2.23 \pm 0.08) \cdot 10^{-3}$;

2) the FNAL data [7] alone fitted as $\Delta\sigma_T = (12.1 \pm 5.9) \cdot p^{-0,57 \pm 0,11}$ mb give $|\eta_{+-}| = (2.87 \pm 0.10) \cdot 10^{-3}$;

3) the data of both experiments fitted by expression

$$\Delta\sigma_T = (6,8 \pm 1,3) \cdot p^{-0,46 \pm 0,05}\ \mathrm{mb} \quad (6)$$

give the value $|\eta_{+-}| = (2.34 \pm 0.09) \cdot 10^{-3}$.

The total cross section data [6,7] fitted by expression (6) and the regeneration data [8,9] calculated for $|\eta_{+-}| = 2.35 \cdot 10^{-3}$ are shown in Fig. 1.

It is seen that the FNAL data are inconsistent with any published values of $|\eta_{+-}|$*. Experimental errors in determining the value of ϕ°_{21} and its possible weak energy dependence cannot explain the results obtained. So the FNAL data contain possible unknown systematic errors.

The Serpukhov data on the total cross section and regeneration are consistent with the new value of $|\eta_{+-}|$. If possible systematic errors of all experiments somewhat

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*If one excludes an assumption about its energy dependence.

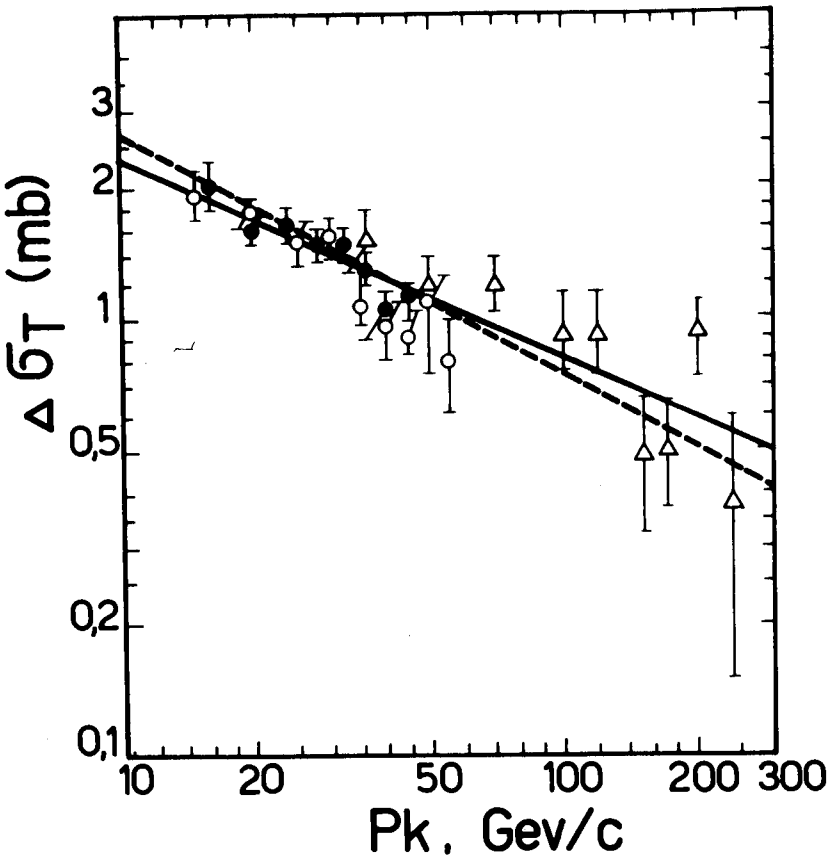

Fig. 1. The kaon and antikaon total cross section difference at high momentum: (•) - $\Delta\sigma_T = \sigma_T(K^\circ p) - \sigma_T(\bar{K}^\circ p)$ calculated from the regeneration experiments /8,9/ using the value of $|\eta_{+-}| = 2.35 \cdot 10^{-3}$; (0) and (Δ) - $\Delta\sigma_T = \sigma_T(K^- n) - \sigma_T(K^+ n)$ obtained in the experiments /6/ and /7/, respectively. The solid line represents the fit of the data by expression (6). The dashed line is the fit of data /8,9/ by expression $\Delta\sigma_T = (8.4 \pm 3.2) \cdot p^{-0,55 \pm 0,11}$ mb.

"compensate" each other, then data on the total cross sections and $K_S^\circ - K_L^\circ$ regeneration on hydrogen existing at high energies are in good agreement with the value of $|\eta_{+-}| = (2.30 \pm 0.03) \cdot 10^{-3}$ obtained in the experiments /3,4/.

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