# Comments and Addenda

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## $K^+$ Charge Form Factor and the Chou-Yang Model*

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The Chou-Yang model is used to calculate the $K^+$ charge form factor.

It was suggested by Chou and Yang[1–3] that a relationship exists between the asymptotic differential cross sections for hadron scattering and the form factors of the hadrons involved in the scattering. Using this relationship, they calculated from $pp$ scattering data the proton form factor and from $\pi p$ data the pion form factor. The calculated proton form factor agreed very well with the proton form factor obtained from $ep$ scattering experiments. The calculated pion form factor was consistent with the meager experimental results[4] and the vector-meson–dominance prediction.[5] In this paper, we apply the Chou-Yang model to $K^+p$ scattering and calculate the $K^+$ change form factor.

The available data for $K^+p$ scattering have been compiled by Price *et al.*[6] These authors have also fitted the data at each laboratory momentum $P_{\rm lab}$ above 1 GeV/$c$ with a function of the form

$$d\sigma/dt = Ae^{bt},$$

obtaining excellent fits for values of $|t|$ less than 0.6 (GeV/$c$)$^2$. The values of $A$ and $b$ for $P_{\rm lab}>6.0$ GeV/$c$ are shown in Table I.[7–9] We see that, so far as one can tell from the data, the differential cross section has reached its asymptotic limit.

We define the limiting value of the scattering amplitude by

$$a_{K^+p}=\left[\frac{1}{\pi}\left(\frac{d\sigma}{dt}\right)_\infty\right]^{1/2}$$

with the parametrization $a_{K^+p}=ce^{gt}$. We tried several methods of determining $(d\sigma/dt)_\infty$, all of which gave

TABLE I. Parameters of the fit $d\sigma/dt+Ae^{bt}$ in $K^+p$ scattering (Ref. 6).

| $P_{\rm lab}$ (GeV/$c$) | $A$ [mb$^{1/2}$(GeV/$c$)$^{-1}$] | $b$ (GeV/$c$)$^{-2}$ |
|---|---|---|
| 6.8 | 16.2±2.6 | 5.1±0.4 |
| 7.3 | 20.9±2.3 | 5.4±0.2 |
| 9.8 | 18.9±1.8 | 5.7±0.2 |
| 12.8 | 21.2±1.9 | 6.3±0.2 |
| 14.8 | 19.8±1.8 | 6.0±0.2 |

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[1] T. T. Chou and C. N. Yang, in *High Energy Physics and Nuclear Structure*, edited by G. Alexander (North-Holland, Amsterdam, 1967), pp. 348–359.

[2] T. T. Chou and C. N. Yang, Phys. Rev. **170**, 1591 (1968).

[3] T. T. Chou and C. N. Yang, Phys. Rev. **188**, 2469 (1969).

[4] C. W. Akerlof, W. W. Ash, K. Berkelman, C. A. Lichtenstein, A. Ramanauskas, and R. H. Siemann, Phys. Rev. **163**, 1482 (1967); C. Mistretta, D. Imrie, J. A. Appel, and R. Budnitz, Phys. Rev. Letters **20**, 1523 (1968); M. M. Block, I. Kenyon, J. Keren, D. Koetke, P. Malhotra, R. Walker, and H. Winzeler, Phys. Rev. **169**, 1074 (1968).

[5] A. Minten, CERN Report No. 69-22, 1969 (unpublished).

[6] L. R. Price, N. Barasch-Schmidt, O. Benary, R. W. Bland, A. H. Rosenfeld, and C. G. Wohl, LRL Report No. UCRL-20000, 1969 (unpublished).

[7] W. DeBaere, J. Debaisieux, P. Dufour, F. Grard, J. Heughebaert, L. Pape, P. Peeters, F. Verbeure, R. Windmolders, R. George, Y. Goldschmidt-Clermont, V. P. Henri, B. Longejans, D. W. Leith, A. Moissev, F. Muller, J. M. Perreau, and V. Yarba, Nuovo Cimento **45A**, 885 (1966).

[8] K. J. Foley, S. J. Lindenbaum, W. A. Love, S. Ozaki, J. J. Russell, and L. C. L. Yuan, Phys. Rev. Letters **11**, 503 (1963).

[9] Chih-yng Chien, E. Malamud, D. J. Mellema, P. E. Schlein, W. E. Slater, D. H. Stork, and H. K. Ticho, Phys. Letters **28B**, 615 (1969).

essentially the same results (within 5% of the values of $c$ and $g$). By fitting the data[8] at 9.8, 12.8, and 14.8 GeV/$c$ simultaneously, using only values of $|t|$ less than 0.6 (GeV/$c$)$^2$, we obtained[10]

$$c=2.52\pm0.04\ \mathrm{mb}^{1/2}/(\mathrm{GeV}/c)\,,$$
$$g=3.03\pm0.06\ (\mathrm{GeV}/c)^{-2}\,,$$

with a $\chi^2$ of 21 for 30 data.

We then calculated $F_{K^+}(t)$ from[2,3]

$$F_p(t)F_{K^+}(t)=(\mathrm{const})[a_{K^+p}(t)+\tfrac{1}{2}a_{K^+p}\otimes a_{K^+p}|_t+\cdots]\,,$$

using 200 terms in the sum. The numerical values[10] for the various form factors are listed in Table II.

From Table II it is easily seen that the kaon form factors fall off slower than either the proton or pion form factors. Thus, the kaon is smaller than either the proton or the pion. The rms radius of the kaon is found to be 0.39±0.03 F.[10] This is not in good agreement with the vector-dominance model,[5] which gives

$$F_K(t)=\frac{1}{2}\frac{M_\rho^2}{M_\rho^2-t}+\frac{1}{6}\frac{M_\omega^2}{M_\omega^2-t}+\frac{1}{3}\frac{M_\phi^2}{M_\phi^2-t}\,,$$

and

$$\langle r^2\rangle^{1/2}=[6F_K'(0)]^{1/2}=0.58\ \mathrm{F}\,.$$

[10] Only statistical errors are included.

TABLE II. List of the proton form factor $F_p$, the pion form factor $F_\pi$, and the kaon form factor $F_K$. Values of $F_p$ and $F_\pi$ are from Ref. 3.

| $\|t\|$ (GeV/$c$)$^2$ | $F_p$ | $F_\pi$ | $F_K$ |
|---|---|---|---|
| 0.0 | 1.000 | 1.000 | 1.000 |
| 0.1 | 0.810 | 0.846 | 0.948±0.006 |
| 0.2 | 0.665 | 0.728 | 0.892±0.011 |
| 0.3 | 0.553 | 0.636 | 0.833±0.014 |
| 0.4 | 0.466 | 0.564 | 0.773±0.018 |
| 0.5 | 0.399 | 0.505 | 0.712±0.020 |
| 0.6 | 0.347 | 0.455 | 0.651±0.021 |

# Current Algebra and the Weak Radiative Decays of Hyperons*

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The recently reported measurement of the asymmetry parameter in the weak radiative decay $\Sigma^+\to p\gamma$ suggests that the parity-violating amplitude in the decay may be large. Here we show that no known theories can account for this result.

THE first experimental determination of the asymmetry[1] parameter for $\Sigma^+\to p\gamma$ suggests that the decay distribution of the proton may exhibit a large asymmetry ($\alpha=-1.03_{-0.42}^{+0.52}$). Even though the measurement is based on very few events, the result is rather surprising. The authors of Ref. 1 point out that of more than six theoretical studies of weak radiative decay, only one, by Ahmed,[2] predicts a large asymmetry for $\Sigma^+\to p\gamma$. Here we wish to show that Ahmed's result arises from an inconsistency in his analysis; and that when the inconsistency is removed, his theory yields a small asymmetry in accord with all the other theories. Thus there are at present no theories in good agreement with the experimental result of Ref. 1.

With the usual assumptions of octet dominance and $CP$ invariance for the weak Hamiltonian, Hara[3] has shown that the parity-violating (p.v.) amplitudes for $\Sigma^+\to p\gamma$ and $\Xi^-\to\Sigma^-\gamma$ are zero for a current×current weak interaction. Further, if $R$ conjugation is also imposed, then all the p.v. amplitudes are zero in the symmetry limit.[4] In the presence of symmetry breaking, the p.v. amplitudes can be evaluated by using the baryon pole model[4,5] with phenomenologically determined p.v. weak-vertex parameters. The procedure leads to very small p.v. amplitudes and asymmetry parameters which are two orders of magnitude smaller than the reported experimental value.[1]

Although Ahmed[2] uses the current×current model of weak interactions and current algebra, his p.v. amplitudes for $\Sigma^+\to p\gamma$ and $\Xi^-\to\Sigma^-\gamma$ do not vanish in the symmetry limit. The inconsistency arises from his extrapolation procedure for the amplitudes, and this is explicitly pointed out in the following.

By applying the reduction technique and the hypothesis of partial conservation of axial-vector current (PCAC), Ahmed relates the amplitudes for the process $\alpha\to\beta+\pi^0+\gamma$ to the amplitudes for $\alpha\to\beta+\gamma$ in the soft-pion limit.[6,7] Thus

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[1] L. K. Gershwin, M. Alston-Garnjost, R. O. Bangerter, A. Barbaro-Galtierei, T. S. Mast, F. T. Solmitz, and R. D. Tripp, Phys. Rev. **188**, 2077 (1969).

[2] M. A. Ahmed, Nuovo Cimento **58A**, 728 (1968).

[3] Y. Hara, Phys. Rev. Letters **12**, 378 (1964).

[4] R. H. Graham and S. Pakvasa, Phys. Rev. **140**, B1144 (1965).

[5] G. Calcucci and G. Furlan, Nuovo Cimento **21**, 679 (1961); J. C. Pati, Phys. Rev. **130**, 2097 (1963); L. R. Ram Mohan, *ibid.* **179**, 1561 (1969).

[6] We are using the Dirac-Pauli metric: $p^2=(\mathbf{p},iE)^2=-m^2$, and Hermitian Dirac matrices $\gamma_\mu^\dagger=\gamma_\mu$.

[7] H. Sugawara, Phys. Rev. Letters **15**, 870 (1965); M. Suzuki, *ibid.* **15**, 986 (1965); Y. Hara, Y. Nambu, and J. Schechter, *ibid.* **16**, 380 (1966); L. S. Brown and C. M. Sommerfield, *ibid.* **16**, 751 (1966); S. Badier and C. Bouchiat, Phys. Letters **20**, 529 (1966).