Letters to the Editor

On the Absorption of K^-–Mesons by Helium Nuclei

S. G. Matinian
Institute of Physics,
Academy of Sciences, Georgian SSR
(Submitted to JETP editor May 27, 1956)
J. Exptl. Theoret. Phys.(U.S.S.R.) **31**, 528-529
(September, 1956)

THE hypothesis of isobaric invariance in strong interactions plays an important role in the well-known scheme of Gell-Mann,[1] which satisfactorily describes a whole set of facts about heavy mesons and hyperons. As is known, experiments confirm irobaric invariance in strong pion-nucleon and nucleon-nucleon inetractions.[2]

Great interest exists concerning the experimental verification of this hypothesis in situations involving the creation, scattering and absorption of heavy mesons and hyperons. One of the means to this end consists in the experimental verification of relations between cross sections for different processes, when the difference is only in the charge states of the participating particles.

A whole series of such relations was derived by Okun'.[3] Recently, Lee proposed some experiments to verify charge independence in the strong interactions of K^--mesons with the nuclei of deuterium and helium, and established various relations between the cross sections of different processes occurring upon the absorption of K^--mesons.

The purpose of this note is to derive further relations between the cross sections of different reactions occurring when helium absorbs K^--mesons. Upon the absorption of K^--mesons by helium, the following reactions take place, with the emission of Σ-hyperons and π-mesons:

$$\begin{aligned} &K^- + He^4 \to \Sigma^0 + He^3 + \pi^-; \\ &K^- + He^4 \to \Sigma^- + He^3 + \pi^0; \\ &K^- + He^4 \to \Sigma^- + H^3 + \pi^+; \\ &K^- + He^4 \to \Sigma^0 + H^3 + \pi^0; \\ &K^- + He^4 \to \Sigma^+ + H^3 + \pi^-. \end{aligned} \qquad (1)$$

The intitial particles appear in a state of isotopic spin $T = 1/2$.

Decomposing the appropriate wave functions into the final state wave functions, and taking account of the conservation of total isobaric spin, we obtain the following differential cross-sections:

$$\sigma_1 (\Sigma^+ + H^3 + \pi^-) = {}^1/_3 \mid A_0^{1/2} + 2^{-1/2} A_1^{1/2} \mid^2; \qquad (2)$$

$$\sigma_2 (\Sigma^0 + H^3 + \pi^0) = {}^1/_3 \mid A_0^{1/2} \mid^2;$$

$$\sigma_3 (\Sigma^0 + He^3 + \pi^-) = {}^1/_3 \mid A_1^{1/2} \mid^2;$$

$$\sigma_4 (\Sigma^- + He^3 + \pi^0) = {}^1/_3 \mid A_1^{1/2} \mid^2;$$

$$\sigma_5 (\Sigma^- + H^3 + \pi^+) = {}^1/_3 \mid A_0^{1/2} - 2^{-1/2} A_1^{1/2} \mid^2,$$

where $A_t^{1/2}$ is the transition amplitude from a state of total isobaric spin 1/2 to a state of isobaric spin t of the system: π-meson $-\Sigma$-hyperon.

Thus in particular there follows the result of Lee:[4]

$$\sigma_3 (\Sigma^0 + He^3 + \pi^-) = \sigma_4 (\Sigma^- + He^3 + \pi^0). \qquad (3)$$

In addition, we obtain the following relations among cross sections:

$$\begin{aligned} &\sigma_1 (\Sigma^+ + H^3 + \pi^-) + \sigma_5 (\Sigma^- + H^3 + \pi^+) \\ &= 2\sigma_2 (\Sigma^0 + H^3 + \pi^0) + \sigma_4 (\Sigma^- + He^3 + \pi^0) \end{aligned} \qquad (4)$$

and the inequality

$$\begin{aligned} &\sigma_2 (\Sigma^0 + H^3 + \pi^0) + \sigma_4 (\Sigma^- + He^3 + \pi^0) \\ &\geqslant {}^2/_3\, \sigma_5 (\Sigma^- + H^3 + \pi^+). \end{aligned} \qquad (5)$$

Additional inequalities appear as consequences of (4) and (5):

$$\begin{aligned} &\sigma_1 (\Sigma^+ + H^3 + \pi^-) + \sigma_3 (\Sigma^0 + He^3 + \pi^-) \\ &\geqslant {}^1/_3\, \sigma_5 (\Sigma^- + H^3 + \pi^+), \end{aligned} \qquad (5')$$

$$\begin{aligned} &\sigma_1 (\Sigma^+ + H^3 + \pi^-) + {}^1/_3\, \sigma_5 (\Sigma^- + H^3 + \pi^+) \\ &\geqslant \sigma_2 (\Sigma^0 + H^3 + \pi^0). \end{aligned} \qquad (5'')$$

The author expresses his gratitude to G. R. Khutsishvili for his valuable advice and guidance.

[1] M. Gell-Mann, *Report of Pisa Conference on Elementary Particles*, NYO 7138, 1955 (unpublished).

[2] E. Fermi, Nuovo Cimento Suppl. **1**, 17 (1955).

[3] L. B. Okun', J. Exptl. Theoret. Phys. (U.S.S.R.) **30**, 1172 (1956); Soviet Phys. JETP **3**, 944 (1956).

[4] T. D. Lee, Phys. Rev. **99**, 337 (1955).

Translated by C. R. Lubitz
106