Laboratori Nazionali di Frascati

LNF-59/13 (1959)

G. Morpurgo: A POSSIBLE EXPERIMENTAL TEST OF THE RELATIVE PAROTY OF CHARGED AND NEUTRAL k's.

Estratto dal: Nuovo Cimento, 11, 738 (1959)

IL NUOVO CIMENTO VOL. XI, N. 5 1° Marzo 1959

A Possible Experimental Test of the Relative Parity of Charged and Neutral K's.

G. MORPURGO

Istituto di Fisica dell'Università - Parma
Istituto Nazionale di Fisica Nucleare - Laboratori di Frascati

(ricevuto il 6 Febbraio 1959)

In some recent attempts by GELL-MANN (¹), SCHWINGER (²) and particularly by PAIS (³) the idea has been developed of examining the consequences of introducing in the Lagrangian of the strong interactions rather high symmetries. In particular PAIS (³) has noted that a too high degree of symmetry is incompatible with the experimental data, because it implies some incorrect relations between the observed rates of some processes and also the vanishing of certain experimentally non zero cross sections.

To avoid such unpleasant consequences of this excess of symmetry one has to destroy part of it. PAIS (⁴) investigates whether it is possible to do this by assuming opposite parity for the charged and neutral K and introducing an appropriate $KK\pi$ interaction (the strong interactions are still assumed to conserve parity).

Notice that if the charged and neutral K have opposite parity the [K] interactions destroy the charge symmetry.

The purpose of the present note is simply that of pointing out an experiment which is practically feasible and which should be appropriate to decide: *a*) whether charge symmetry is violated in the [K] interactions; *b*) whether such violation, if it exists, has to be attributed to a parity difference.

We start with some remarks: obviously the first possibility to which one may think for examining a parity difference between the charged and neutral K consists, as Pais has noted, in exploring the reaction $K+\text{Nucleon} \to K+\text{Nucleon}$, with and without charge exchange. A different low energy behaviour of the charge exchange versus the non charge exchange cross section should be indicative of opposite parities of charged and neutral K. However for incident K^- there are in such reactions, too many channels open; though events both of the kind $K^-+p \to K^-+p$ and of the kind $K^-+p \to K^0+n$, *have* been observed, a *quantitative* comparison of the energy dependence of the above reactions seems in practice to be dif-

(¹) M. GELL-MANN: *Phys. Rev.*, **106**, 1296 (1957).
(²) J. SCHWINGER: *Ann. Phys.*, **2**, 407 (1957).
(³) A. PAIS: *Phys. Rev.*, **110**, 574 (1958).
(⁴) A. PAIS: *Phys. Rev.*, **112**, 625 (1958); we shall use the notation of references (³) and (⁴).

ficult. The situation would be much better if it might be possible to perform the charge exchange and non exchange reactions of K^+ on free neutrons; there infact only the two channels $K^+ + n \to K^+ + n$ and $K^+ + n \to K^0 + p$ are open; however the most free neutrons of which we can dispose are to be found in the deuteron and there the effect of the Pauli principle introduces a spurious inhibition of the exchange reaction which has nothing to do with our problem.

The situation is, on the contrary, experimentally much more favourable and clean if we consider the reactions induced by pions. The obvious method for investigating the charge symmetry is that of bombarding a self conjugate nucleus with π^+ and π^- and compare the rates of the « mirror » [5] processes for equal energy of the π^+ or π^-; in our case the most favourable nuclei are probably D or ^4He. In this way it should be possible, very simply, to give an answer to question *a*). As to question *b*) the answer can be found simply in comparing the angular distributions and energy dependence of the various « mirror » processes induced by the π^+ and π^-; a difference in parity would certainly imply strong differences in these angular distributions and energy dependence near threshold. In particular, considering the reactions in ^4He the most appropriate and probably most frequent reactions of associated production induced by π^- and respectively π^+ below the Σ threshold should be:

$$(1) \quad \left\{ \begin{array}{l} \pi^- + {}^4\mathrm{He} \to {}^3\mathrm{H} + \Lambda^0 + K^0 , \\ \pi^+ + {}^4\mathrm{He} \to {}^3\mathrm{He} + \Lambda^0 + K^+ , \end{array} \right.$$

and also:

$$(2) \quad \left\{ \begin{array}{l} \pi^- + {}^4\mathrm{He} \to {}^4\mathrm{H}_\Lambda + K^0 , \\ \pi^+ + {}^4\mathrm{He} \to {}^4\mathrm{He}_\Lambda + K^+ : \end{array} \right.$$

Both the reactions (1) and (2) should be very clearly interpreted in a ^4He bubble chamber.

We conclude adding a few points:

1) It is clearly not very « aesthetical » to gain the high symmetry of the doublet approximation, [6] loosing the old good charge symmetry; so we cannot help from expressing our hope that the reactions considered above really behave as mirror reactions.

2) One way to conserve the advantages of the doublet approximation without renouncing to charge symmetry might consist in renouncing to parity conservation in some « moderately » strong interactions; writing the doublet approximation as it is written for even p(K), but adding, *for instance*, the $KK\pi$ interaction.

3) If it should however happen that in the reaction $\Sigma + N \to \Lambda + N$ parity is *too strongly* [7] violated, one would probably have to renounce also to the doublet approximation (at least without derivative couplings); infact if we insist on having charge independence and time reversal for the $[\Sigma\Sigma\pi]$ interaction, such interaction *must* conserve parity, and the same should be true, in the spirit of the doublet approximation, for the $[\Sigma\Lambda\pi]$ interaction.

Note added in proof.

The same experiment has been proposed by A. PAIS in the December 1, 1958 issue of *Phys. Rev. Letters*, which was available here only after this paper had been submitted for publication.

---

(5) The word « mirror » refers here to the simultaneous change of π^+ in π^-, p in n, K^+ in K^0, Σ^+ in Σ^-.

(6) Compare, in addition to ref. (3), J. TIOMMO; *Nuovo Cimento*, **6**. 69, (1957); N. DALLAPORTA; *International Conference on Mesons and Recently Discovered Particles*, V-3 and *Nuovo Cimento*, **7**, 200 (1958).

(7) This means: if it should be necessary to attribute such violation to the strong pion-baryon interaction.