the formulas of R. B. Curtis and R. R. Lewis [Phys. Rev. 107, 543 (1957)] with appropriate changes. The electron functions ($\kappa = \pm 1$) used are the solutions of the Dirac equation corresponding to a finite nuclear charge distribution, using the formalism of Z. Matumoto and M. Yamada [Progr. Theoret. Phys. Japan 19, 285 (1958)]. The less important electron functions ($\kappa = \pm 2$), which appear in the terms L_1 and L_1', have been taken as their "point nucleus" values. In particular, we assume $L_1 = c_0 + c_2 W^2$ and $L_1' = (p/W)L_1$, which are considered satisfactory approximations for the present purposes.

[4] E. Plassmann and L. Langer, Phys. Rev. 96, 1593 (1954).

K-MESON-NUCLEON INTERACTIONS AND THE RELATIVE Σ-Λ PARITY*

Saul Barshay†

Brookhaven National Laboratory,
Upton, New York

(Received June 27, 1958)

In this note we wish to add to some recent theoretical considerations concerning the nature of the strong interactions of pions, nucleons, K mesons and hyperons.[1-6] The main conjecture that we want to make is the following: the K-Λ relative parity is odd relative to the nucleon and the K-Σ relative parity is even relative to the nucleon. In more specific terms, we conjecture that the interaction Hamiltonian has the form ($g_\Lambda \bar{N}\gamma_5 \Lambda K$ + Hermitian conjugate) for the Λ particle, nucleon, and K meson; and the form ($g_\Sigma \times \bar{N}\tau_a \Sigma_a K$ + Herm. conj.) for the Σ particle, nucleon, and K meson (the symbol for a particle denotes the operator that destroys it and the decomposition into charge states is to be understood). In the following we will make some arguments for our conjecture which will be based on perturbative estimates including certain higher-order effects.[2,7] These considerations are nonrelativistic in the sense that baryon-antibaryon pair states will not be considered; in other words, the γ_5 coupling will be reduced to the familiar P-wave vertex and the coupling with unity will be an S-wave vertex. The insights into low-energy K-meson phenomena so gained may compare favorably with the insights into low-energy pion phenomena gained with a similar approach in the early days of pion physics.

We consider first K^+ scattering by nucleons. In a recent calculation we estimated the scattering at low energies via a mechanism involving the exchange of a pion pair between the K meson and nucleon.[1,2] This mechanism gave rise to predominant S-wave scattering of K^+ by protons and neutrons equally and no charge exchange scattering. Call the amplitude for this scattering in either isotopic spin state, λ. This corresponds to an effective repulsive potential. Now let us introduce the scattering via the sequence $K+N \to K+K+\Sigma \to K+N$. This will be an attractive S-wave interaction. The amplitudes for the isotopic spin states zero and one will be $a_0 = g_\Sigma^2 \times C$, $a_1 = 3g_\Sigma^2 C$, where C is essentially the matrix element. Then the total amplitudes for the three reactions we are concerned with are as follows:

(1) $K^+ + p \to K^+ + p : \lambda - g_\Sigma^2 C$,

(2) $K^+ + n \to K^+ + n : \lambda - 2g_\Sigma^2 C$,

(3) $K^+ + n \to K^0 + p : g_\Sigma^2 C$.

These amplitudes are compounded from the total amplitudes for the two isotopic spin states, $A_0 = \lambda - 3g_\Sigma^2 C$ and $A_1 = \lambda - g_\Sigma^2 C$. We see that the S-wave scattering in the isotopic spin zero state is depressed. For example, if $\lambda \sim 3g^2{}_\Sigma C$, the charge exchange to non-charge exchange ratio would be ~ 0.2. If we now consider the scattering via the sequence $K+N \to K+K+\Lambda \to K + N$, we find that this will contribute to scattering in the P states. There will be an effective repulsion in the $P_{\frac{1}{2}}$ state of isotopic spin one, and an effective attraction in the $P_{\frac{1}{2}}$ state of isotopic spin zero (these signs are reversed for the $P_{\frac{3}{2}}$ states), the amplitudes being proportional to g_Λ^2. What is significant here is that of the two "small" cross sections at low energies, corresponding to reactions (2) and (3) above, the P-wave scattering through the intermediate Λ state will contribute in lowest order only to the charge exchange process. This could account for the experimentally observed striking rise in the charge exchange to non-charge exchange ratio at the same time as P-wave scattering appears to be making its appearance in the isotopic spin zero state.[8,9] That the P-wave scattering should be felt first in the isotopic spin zero state is, of course, a natural consequence of the depressed S-wave scattering in this state relative to that in the isotopic spin one state, but we should expect some S-P interference in K^+-p scattering as well, at the higher energies now under study.

We now want to remark upon the surprising infrequency of Λ particles produced in low-energy K^--p interactions relative to any of the Σ particles produced by this reaction.[10] If one accepts the conjecture of odd relative Σ-Λ parity, one readily sees that very low-energy S-wave K^--p

interactions will produce the Σ-π system (in an isotropic $P_{\frac{1}{2}}$ state), whereas the Λ-π system (in a $P_{\frac{1}{2}}$ or $P_{\frac{3}{2}}$ state) will result from the interaction of P-wave K^-. Thus, we would expect the Λ production on free protons to become more frequent as the K^- energy is raised, and also to be more frequent in interactions with protons in heavy nuclei, as appears to be the case experimentally.[11]

Finally, we remark that the absence of a strong polarization of the Σ particles produced in π^--p collisions at ~1 Bev, as contrasted with the strong polarization of the Λ particles produced in these collisions,[12] may have a simple origin in the absence and presence, respectively, of a dominant spin dependence in the $N\Sigma K$ and $N\Lambda K$ vertices.

If the conjecture presented here is correct, there would certainly be a difference in the dynamics of the various meson-baryon and baryon-baryon interactions, even if the neglect of certain phenomena depending on baryon mass differences happens to be a reasonable approximation. There might still be an over-all strength of "bare" coupling approximately common to what we call the strong interactions.

I wish to thank Dr. F. Gursey for a vital discussion upon the possible theoretical formulations of these ideas, other aspects of which Dr. Gursey will discuss in a forthcoming paper. I wish to express sincere appreciation to Professor Abraham Pais for a number of very stimulating discussions and for his continuing advice and encouragement.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

† A National Science Foundation Postdoctoral Fellow.

1 Saul Barshay, Phys. Rev. 109, 2160 (1958).
2 Saul Barshay, Phys. Rev. 110, 743 (1958).
3 A. Pais, Phys. Rev. 110, 574 (1958).
4 A. Pais, Phys. Rev. 110, 1480 (1958).
5 Saul Barshay, Phys. Rev. 107, 1454 (1958); 108, 1648(E) (1957).
6 M. Gell-Mann, Phys. Rev. 106, 1296 (1957).
7 G. F. Chew, Phys. Rev. 94, 1755 (1954).
8 Preprint from D. Prowse on work at the University of California at Los Angeles, Padua, and Bristol (to be published). I would like to thank Dr. Prowse for correspondence on the course of this work.
9 B. Sechi-Zorn and G. Zorn, Phys. Rev. 108, 1098 (1957).
10 Alvarez, Bradner, Falk-Vairant, Gow, Rosenfeld, Solmitz, and Tripp, Nuovo cimento 5, 1026 (1957).
11 Preprint by Eisenberg, Koch, Lohrmann, Nikolic, Schneeberger and Winzeler, Physikalisches Institut der Universität Bern (to be published).
12 F. Eisler *et al*, Phys. Rev. 108, 1353 (1957).

POSSIBLE CONNECTION BETWEEN STRANGENESS AND PARITY*

Feza Gürsey†
Brookhaven National Laboratory,
Upton, New York
(Received July 1, 1958)

In this note it will be shown that a connection between strangeness and parity can be conjectured in such a way that predictions become possible on the relative parities of strongly interacting particles. Some connection between the two conservation laws has been suspected and discussed by several authors.[1-3] Here we wish to point out that the idea due to Yang and Tiomno,[4] of considering four kinds of spinor fields with respect to their behaviour under P (parity), seems to provide the generalization of the parity operation ($P^2 = \pm 1$) needed for establishing a one-to-one correspondence between the isotopic parity and the space parity of charge multiplets. This leads one to assign opposite parities to Λ and $\vec{\Sigma}$ as well as to N and Ξ for baryons, and to K and $\bar{K}$ for mesons.

Under P, the 4-spinor fields of types A, B, C, and D transform respectively according to the laws

$$\vec{r}\to-\vec{r};\ \psi_A\to\gamma_4\psi_A,\ \psi_B\to-\gamma_4\psi_B,$$
$$\psi_C\to i\gamma_4\psi_C,\ \psi_D\to-i\gamma_4\psi_D. \tag{1}$$

It follows that by combining such spinors, one can also construct four types of Lorentz invariant functions ϕ, which, under P transform according to the laws

$$\vec{r}\to-\vec{r};\ \phi_A\to\phi_A,\ \phi_B\to-\phi_B,$$
$$\phi_C\to i\phi_C,\ \phi_D\to-i\phi_D. \tag{2}$$

We note immediately that, although a real scalar ϕ_A and a real pseudoscalar ϕ_B can be constructed, the fields ϕ_C and ϕ_D are necessarily complex. Hence, a neutral boson field that is identical with its charge conjugate (up to a sign difference) will belong to the types A, B, whereas a neutral boson field different from its charge conjugate will be described by the types C, D. Using charge independence, we assume that fields describing members of the same charge