Several recent papers\textsuperscript{1} have shown that experimental observations on hadron rest masses, scattering cross sections, and annihilation processes are in remarkably good agreement with a simple additive quark model in which the quarks and antiquarks interact with each other nonrelativistically.\textsuperscript{2} However, the difficult question immediately arises as to why quarks are not easily knocked out of nucleons and observed by themselves. It is apparent that a selection principle that restricts the baryon number to integer values would accomplish this if properly applied. What is needed is not only that the over-all baryon number be an integer, but that the baryon number for each mutually interacting cluster of quarks be an integer. At the same time, the quarks should be able to move freely within each interacting cluster, without being greatly inhibited by the selection principle.

The present paper proposes a phenomenological model for such a selection principle in terms of many-particle interactions between quarks. We write the potential energy of a cluster consisting of \( n \) quarks and \( m \) antiquarks that are within interaction range of each other in the form

\[
V = V_0 \sum_{s=0}^{n} \sum_{t=0}^{m} a(s, t) \nu_s \nu_t
\]

where \( \nu_s \) is the number of ways in which \( s \) quarks can be chosen from the \( n \) that are present:

\[
\nu_s = n!/(n-s)!s!
\]

For example, with \( n = 3 \) and \( m = 2 \), Eqs. (1) and (2) give

\[
V = V_0 [5a(1, 0) + 4a(2, 0) + 6a(1, 1) + a(3, 0) + 9a(2, 1) + 2a(3, 1) + 3a(2, 2) + a(3, 2)].
\]

It is, of course, possible to choose the interaction coefficients \( a(s, t) \) so that only those clusters for which the baryon number \( \frac{1}{3}(n-m) \) is a positive or negative integer or zero are energetically favored; however, the coefficients then become unrealistically large for the larger values of \( s \) or \( t \).

We therefore assume that all coefficients that correspond to interactions of more than three particles are zero. Our approach consists in generalizing a two-particle interaction for which the particles have zero potential energy when close together and potential energy \( V_0 \) otherwise. Such an interaction is of the type (1) for \( n = 2, m = 0 \) if we take \( a(1, 0) = \frac{1}{3}, a(2, 0) = -1 \). We choose the coefficients such that the following clusters have zero potential energy and all others have positive potential energy:

\[
n = 3, m = 0; \quad n = 1, m = 1; \quad n = 0, m = 3.
\]

With \( a(1, 0) \) arbitrarily chosen equal to unity, the other coefficients are easily seen to satisfy the relations

\[
-2 < a(2, 0) < -\frac{4}{3}, \quad a(1, 1) = -2,
\]

\[
a(3, 0) = -3[1 + a(2, 0)], \quad a(2, 1) > 1 - a(2, 0).
\]

A reasonable set of values is

\[
a(1, 0) = 1, \quad a(2, 0) = -\frac{2}{3}, \quad a(1, 1) = -2,
\]

\[
a(3, 0) = \frac{2}{3}, \quad a(2, 1) = 3.
\]

It is interesting to note that the unlike-particle interactions \( a(1, 1) \) and \( a(2, 1) \) are stronger than the corresponding like-particle interactions \( a(2, 0) \) and \( a(3, 0) \).

Several comments can be made on the foregoing model. (a) With \( V_0 \) chosen to be large, clusters that have nonintegral baryon numbers, as well as single quarks, will be difficult to produce. At the same time, particles in the allowed clusters (3) can move nonrelativistically with zero potential energy and be assigned rest masses unrelated to \( V_0 \). It is then reasonable to assume that the quark rest mass is roughly equal to one-third of a baryon mass or one-half of a meson mass (these are of the same order of magnitude). (b) \( V_0 \) can be thought of as the rest energy of a quark excited state rather than that of the ground state of the quark which is a constituent of hadrons. (c) Each coefficient in the potential energy (1) is characterized by a range, but the ranges associated with the last four coefficients in (4) need not
all be the same. It seems likely that crossover of quarks from one hadron to another during a collision will be facilitated by making the pair-interaction ranges slightly greater than the three-particle ranges and adjusting the strength accordingly. (d) The model can be used for explicit calculations of hadron processes by assuming particular forms for the space dependences of the two- and three-particle interactions, so that they lead to the potential energy given by (1) and (4). (e) There must be an additional potential energy that is much weaker than (1) and of longer range, which is responsible for the bulk of the interactions between hadrons.

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EXTRAPOLATION OF THE AMPLITUDES OF NONLEPTONIC DECAYS OF K MESONS*

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In the calculation of nonleptonic decay amplitudes of K mesons from partially conserved axial-vector current (PCAC) and the current algebra of SU(3) ⊗ SU(3), it has been recognized that large effects are to be expected in extrapolating from the physical amplitudes with the pions on their mass shells to the off-shell amplitudes evaluated at the vanishing pion momenta. One of the purposes of this note is to show that such an approximation can be justified by rather simple assumptions. It is also interesting to find that this linear approximation is equivalent to introducing the derivative coupling,

\[ f[\pi^+(\bar{\mu} - \mu)\pi^0] \equiv K^+ + \text{H.c.}, \]

which, first considered by Cabibbo and Gatto in relation to the radiative K⁺ decay, satisfies |Δ| = 1/2 but vanishes on mass shells. The antisymmetric property shown in (1) is clearly seen in (3). This argument will be a good answer to a possible criticism that it is difficult to imagine a dynamical mechanism for a large

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