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SU(6) PREDICTIONS FOR MESON-BARYON SCATTERING*

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Many of the notable predictions of SU(6) symmetry[1] also follow from simple alternative theoretical models. Sawyer[2] has recently pointed out that the Johnson-Treiman relations[3] can be derived from a vector-meson exchange model if the vector-meson octet has pure F-type coupling to the baryons. There are also indications that bootstrap calculations can reproduce the SU(6) results for magnetic moments and mass splittings.[4] For these reasons, it is desirable to systematically investigate predictions of the theory which do not appear to follow simply from other models. Such an investigation of meson-baryon scattering has led to a particularly simple result which can be compared with low-energy experimental data.

With the usual SU(6) assignments of the baryons (octet + decuplet) to the 56-dimensional representation and the mesons (pseudoscalar octet + vector octet + vector singlet) to the 35-dimensional representation, the general form of the scattering operator, S, for the reaction

$$M(1)+B(2)\to M(3)+B(4), \tag{1}$$

may be written as

$$S=A\{\overline{\psi}^{ABC}(4)\psi_{ABC}(2)\varphi_E{}^D(1)\varphi_D{}^E(3)\}+\tfrac{1}{6}B\{\overline{\psi}^{ABC}(4)\psi_{ABD}(2)[\varphi_E{}^D(1)\varphi_C{}^E(3)+\varphi_C{}^E(1)\varphi_E{}^D(3)]\}$$
$$+\tfrac{1}{6}C\{\overline{\psi}^{ABC}(4)\psi_{ABD}(2)[\varphi_E{}^D(1)\varphi_C{}^E(3)-\varphi_C{}^E(1)\varphi_E{}^D(3)]\}+(1/36)D\{\overline{\psi}^{ABC}(4)\psi_{ADE}(2)\varphi_B{}^D(1)\varphi_C{}^E(3)\}. \tag{2}$$

The explicit constructions of baryon (ψ) and meson (φ) wave functions are given by Belinfante and Cutkosky[5] and Capps.[5]

The scattering operator contains four independent amplitudes. Johnson and Treiman have considered the relations implied by SU(6) for elastic processes.[3] The relations which they obtained involved only the C amplitude (cf. Table I) and may be obtained by a simple alternative model.[2] However, sum rules which involve any of the other three amplitudes do not follow from the simple vector-meson exchange model.

The general inelastic meson-baryon reaction amplitude can be expressed in terms of three SU(6) amplitudes, as contrasted with seven independent amplitudes in SU(3) symmetry. In Table I the contributions to the coefficients B, C, and D of Eq. (2) are tabulated for various pseudoscalar meson-nucleon inelastic processes with incident charged K or π beams.[6] Only amplitudes which are not related by isospin conservation are given. We limit our present discussion to amplitude relations that are not derivable from SU(3)-symmetry considerations.[7]

The simple SU(6) cross-section equalities that can be read from the table are[8]

$$\begin{aligned}\tfrac{1}{4}\sigma(K^-+p\to K^++\Xi^-)&=\sigma(K^-+p\to K^0+\Xi^0)\\&=\sigma(K^-+n\to K^0+\Xi^-)\\&=\sigma(\pi^-+p\to K^++\Sigma^-),\end{aligned} \tag{3}$$

$$\sigma(K^-+p\to\eta+\Lambda)=3\sigma(K^-+p\to\eta+\Sigma^0). \tag{4}$$

Since two of these equalities relate amplitudes which involve essentially the same masses, these relations should provide a definitive test of SU(6) symmetry. Furthermore, should these relations be experimentally verified near thresh-

Table I. Scattering amplitudes for pseudoscalar meson-nucleon reactions in the SU(6) symmetry model [cf. Eq. (2)].

Reaction amplitude	A	B	C	D
$(\pi^+p\|\pi^+p)$	1	1	−1	0
$(\pi^-p\|\pi^-p)$	1	1	1	0
$(K^+n\|K^+n)$	1	3	−1	−3
$(K^-n\|K^-n)$	1	3	1	−3
$(K^+p\|K^+p)$	1	2	−2	0
$(K^-p\|K^-p)$	1	2	2	0
$(K^-p\|\pi^-\Sigma^+)$	0	1	1	0
$(K^-p\|\pi^+\Sigma^-)$	0	0	0	−3
$(K^-p\|K^0\Xi^0)$	0	0	0	3
$(K^-p\|K^+\Xi^-)$	0	0	0	−6
$2\sqrt{3}(K^-p\|\pi^0\Lambda)$	0	−3	−3	9
$2(K^-p\|\eta\Lambda)$	0	1	−3	3
$2\sqrt{3}(K^-p\|\eta\Sigma^0)$	0	1	−3	3
$(\pi^+p\|K^+\Sigma^+)$	0	1	−1	0
$(\pi^-p\|K^+\Sigma^-)$	0	0	0	−3
$6^{1/2}(\pi^-p\|K^0\Lambda)$	0	3	−3	−9
$6^{1/2}(\pi^-p\|\eta n)$	0	−2	0	12

old, then they would serve to determine the range of energy for which the symmetry remains valid. A similar experimental test of the range of momentum transfers can be made using the differential cross sections. The last equality in Eq. (3) is not likely to prove as fruitful due to the large mass differences involved.

Preliminary experimental results relevant to the K-cascade production cross section equality are[9]

$$\frac{\sigma(K^- + p \to K^+ + \Xi^-)}{\sigma(K^- + p \to K^0 + \Xi^0)} = 2.3 \pm 0.5,$$

averaged over the beam momentum band 1.81 to 1.95 BeV/c. An independent experimental determination of this ratio will also be available soon. In an earlier experiment[10] the ratio

$$\frac{\sigma(K^- + p \to K^+ + \Xi^-)}{\sigma(K^- + n \to K^0 + \Xi^-)} = 1.05 \pm 0.18$$

was found at an average beam momentum of 1.4 BeV/c. However, this experiment was performed in freon, C_2F_5Cl, in which there are no free nucleons.

In an expanded version of this Letter a further comparison of SU(6) predictions with experiment will be presented for the pseudoscalar meson-nucleon processes and for the vector-meson and isobar production reactions.

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