III. If it is assumed that only the π^0 meson is an "elementary" particle, then (4) takes the form

$$\frac{a_{\pi^0}}{\mu^2_{\pi^0}} \cong \frac{0{,}187}{m} . \qquad (6)$$

That is to say, we find that $\alpha_{\pi^0} > 0$. Expression (6) corresponds to $\tau_{\pi^0} = 0.63 \times 10^{-16}$ sec, whereas the latest experimental data [11] yield $\tau^{exp}_{\pi^0} = (0.73 \pm 0.105) \times 10^{-16}$ sec.

Since, first, the results of [10] favor the choice $\alpha_{\pi^0} < 0$, and second, the lifetime τ_η in variant II is smaller by one order of magnitude than that expected from symmetry theory, it must apparently be assumed that π^0, η, and X^0 are "elementary" particles and not reggeons.

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ELECTROMAGNETIC PROCESSES AND INTEGER QUARK CHARGE

A. A. Komar and L. M. Slad'
P. N. Lebedev Physics Institute, USSR Academy of Sciences

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It is well known that an integer quark charge corresponds to the following choice of transformation properties of the electromagnetic current in accord with the SU(3) group:

$$j_{el} = j_3 + \frac{j_8}{\sqrt{3}} + \frac{j_0}{3} , \qquad (1)$$

which contains besides the octet components j_3 and j_8 also the term with j_0, which has the properties of a unitary singlet. The contribution from the term with j_0 of (1) alters in many cases the usual relations (derivable from unitary symmetry) between the amplitudes of the electromagnetic processes, and it is not excluded that a thorough analysis of these processes can reveal the character of the electric charge of the quarks.

One of the consequences of choosing the current in the form (1), pertaining to the processes $\omega \to e^+ + e^-$ and $\varphi \to e^+ + e^-$, was metnioned by A. Salam at the Dubna conference [1]. L. B. Okun' has noted [2] that (1) leads to violation of the usual connection between the magnetic moments of the Λ particle and the neutron ($\mu_\Lambda = \frac{1}{2}\mu_n$). 1) The character of the electromagnetic charge of quarks was recently investigated in an interesting paper by Khanna and Okubo [3] by means of the current algebra formalism. In this note, to reveal the possible effects of j_0, we analyze by group methods a number of electromagnetic processes. These include: radiative decays of vector mesons, photoproduction of pseudoscalar and vector mesons from nucleons, and processes in colliding electron-positron beams proceeding via production of ω and φ mesons.

It is found that the presence of the singlet component j_0 in (1) has no effect whatever on the relations between meson photoproduction amplitudes. On the other hand, the relation between the amplitudes of the radiative decays of vector mesons turns out to be quite sensitive to the presence of j_0.

The widths of the vector-meson radiative decays can be expressed in the form

$$\Gamma_{V \to P + \gamma} = {}^4\!/_3\, \mu^2{}_{VP}(k\gamma^3)_{VP}. \tag{2}$$

The table lists the relations between the magnetic moments μ_{VP} of the transitions, which follow from the SU(3) and SU(6) groups when j_{el} is taken in the form (1). (Radiative decays of mesons without account of j_0 were considered in [4] (SU(3) group) and in [5-7] (SU(6) group and the quark model).) Here

$$\begin{aligned} \omega &= \omega_0 \operatorname{Cos}\theta + \phi_8 \operatorname{Sin}\theta; \\ \phi &= -\omega_0 \operatorname{Sin}\theta + \phi_8 \operatorname{Cos}\theta; \end{aligned} \tag{3}$$

and y is the ratio of the reduced matrix elements corresponding to the singlet and octet terms in (1).

In the case of the SU(3) group, relations arise only for the linear combinations of the magnetic moments of the transitions $\omega \to \pi^0 + \gamma$ and $\varphi \to \pi^0 + \gamma$ or $\omega \to \eta + \gamma$ and $\varphi \to \eta + \gamma$. In the SU(6) group we have $\Gamma(\varphi \to \pi^0 + \gamma) = 0$, which yields separate relations between all the magnetic moments of the transitions (see the third column of the table. In this column $\operatorname{Cos}\theta = \sqrt{2/3}$).

In this analysis, y remains undetermined. If only very heavy particles have the new quantum number connected with the appearance of the j_0 term in (1), then y is expected to be a small quantity. This, however, is not always the case. The radiative decays of vector mesons were considered in [8] in a concrete model involving three different species of quarks with integer charge. The results obtained there for two different choices of integer quark charges correspond in our case to values y = 2 and y = -4, i.e., in this particular case the contribution of the singlet part of (1) to the vector-meson decays is quite appreciable.

Process	$\mu'_{VP} = \mu_{VP}/\mu_{\rho\pi}$		$\frac{(k^3_\gamma)_{VP}}{(k^3_\gamma)_{\rho\pi}}$
	SU(3)	SU(6)	
$\rho^+ \to \pi^+ + \gamma$	1	1	1
$\rho^\circ \to \pi^\circ + \gamma$	1	1	1
$\rho^\circ \to \eta + \gamma$	$\sqrt{3}/(1+y)$	$\sqrt{3}/(1+y)$	0,13
$K^{*+} \to K^+ + \gamma$	1	1	0, 58
$K^{*\circ} \to K^\circ + \gamma$	$(-2+y)/(1+y)$	$(-2+y)/(1+y)$	0,58
$\omega \to \pi^\circ + \gamma$	$\mu'_{\omega\pi^\circ} \mathrm{Sin}\theta + \mu'_{\phi\pi^\circ}\mathrm{Cos}\theta =$	$3/(1+y)$	1,1
$\phi \to \pi^\circ + \gamma$	$= \sqrt{3}/(1+y)$	0	2,5
$\omega \to \eta + \gamma$	$\mu'_{\omega\eta}\mathrm{Sin}\theta + \mu'_{\phi\eta}\mathrm{Cos}\theta =$	$1/\sqrt{3}$	0,16
$\phi \to \eta + \gamma$	$= (-1+y)/(1+y)$	$\sqrt{2/3}[(-2+y)/(1+y)]$	0,96

In comparison with experiment it is essential to take into account the difference in the energy release, given by the factor $(k^3_\gamma)_{VP}$. The ratio of the factors k^3_γ is given in the fourth column of the table.

The radiative decays of the η' meson, $\eta' \to \rho + \gamma$ and $\eta' \to \omega + \gamma$, along with the decay $\varphi \to \eta' + \gamma$, can also be useful in checking the form of j_{el}; this was already pointed out in [5].

Allowance for the term j_0 in j_{el} leads to the following relation (T-invariance is assumed)

$$\mu_{\eta'\omega} = \frac{\mu_{\eta'\rho}}{3}(1+z),$$
$$\mu_{\phi\eta'} = \frac{\sqrt{2}\mu_{\eta'\rho}}{3}(1-z/2) \qquad (4)$$

where z, as usual, is the ratio of the singlet and octet contributions to the amplitude.

The result of [8] corresponds to the choice z = -1 or z = 5.

Processes in colliding electron-positron beams, proceeding via the resonant states of ω and φ, of the type

$$
\begin{aligned}
&\text{a)}\ e^+ + e^- \to \gamma \to \omega \to \pi^+ + \pi^- + \pi^0 \\
&\text{b)}\ e^+ + e^- \to \gamma \to \phi \begin{cases} \to K^+ + K^- \\ \to K_1^0 + K_2^0 \end{cases}
\end{aligned}
\tag{5}
$$

are essentially inversions of the decays

$$\omega \to e^+ + e^- \quad \text{and} \quad \varphi \to e^+ + e^-. \tag{6}$$

The ratio of the yields of the processes 5a and 5b are closely related with the factor R, which appears in the ratio of the widths $\Gamma(\omega \to e^+ + e^-)$ and $\Gamma(\varphi \to e^+ + e^-)$.

Taking into account the differences in the phase volumes

$$\frac{\Gamma(\omega \to e^+ + e^-)}{\Gamma(\phi \to e^+ + e^-)} = R\,\frac{m_\omega}{m_\phi}\,,\ \text{where}\quad R = \left|\frac{\tan\theta - x}{1 + x\tan\theta}\right|^2 \tag{7}$$

x has the same meaning as above. In the resonance regions the cross sections of the processes (5) is $\sim(1/E^2_{res})(\Gamma_i\Gamma_f/\Gamma^2)$, which gives a factor $(m^2_\varphi\Gamma_{\omega\to e^+e^-}\Gamma_{\omega\to 3\pi}\Gamma^2_\varphi)/(m^2_\omega\Gamma_{\varphi\to e^+e^-}\Gamma_{\varphi\to K\tilde{K}}\Gamma^2_\omega)$. The numerical value of $(m_\varphi\Gamma_{\omega\to 3\pi}\Gamma^2_\varphi)/(m_\omega\Gamma_{\varphi\to K\tilde{K}}\Gamma^2_\omega)$ is 0.48. The factor R must therefore be multiplied additionally by 0.48. It is possible that the processes (5) will turn out to be more convenient for a check on the transformation properties of the electromagnetic current than the decays (6).

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1) It is actually easy to show that in this case $\mu_\Lambda = [(1 - x)/(2 - x)]\mu_n$, and in addition $\mu_{\Sigma^+} + \mu_{\Sigma^-} = \mu_{\Sigma^0} = 2[(1 + x)/(-2 + x)]\mu_n$, where x is the ratio of the contributions of the singlet and octet components in (1).