Evaluation of the Radiative Decay of the Vector Mesons in the Spectrum-Generating $SU_4$ Scheme.

S. Amir-Arjomand

Physics Department, Teheran University - Teheran, Iran

A. A. Golestaneh

High Energy Physics, Argonne National Laboratory (*) - Argonne, Ill. 60439

(riccuto 1' Dicembre 1978)

Summary. — We have studied the radiative-decay rate formula of the vector mesons which is derived on the basis of the $SU_4$ spectrum-generating group. Due to the mass symmetry breaking, this formula contains a suppression factor which depends on the mass operator and the transformation properties of the electromagnetic current in the group. Inasmuch as these properties are not known, we determine the suppression factor by the phenomenological method. In doing this, we note that no acceptable function can be found which could resolve the differences between the observed and calculated decay rates of $\rho, \omega, \varphi$ and $\psi$ simultaneously. However, the combination of the $SU_4$ formalism and the deviation from the ideal mixing between the $\rho, \omega, \varphi$ and $\eta, \eta'$ systems can account for all existing radiative-decay rates, except for the $\rho \rightarrow \pi \gamma$. With this scheme we have the suppression factor $(m_\gamma^2 + m_\rho^2)^{-1}$, where $m_\gamma$ and $m_\rho$ are the masses of the vector and pseudoscalar mesons involved in the decay. We predict reasonable decay rates for $\psi \rightarrow \pi \gamma$ and $\varphi \rightarrow \eta \gamma$. However, for the lack of experimental information, we do not make a full evaluation of the effect of all mixing processes involved in the $\psi$ radiative-decay rates. The present results suggest that the decay rate for the $\rho \rightarrow \pi \gamma$ should be reinvestigated before further theoretical work is attempted.

(*) Work supported by the U.S. Department of Energy.
1. Introduction.

Recently the radiative-decay rates of the $\omega \rightarrow \pi \gamma$ and $\rho \rightarrow \eta \gamma$ have been published together with a new value for the well-established $\phi \gamma \gamma$ decay (1). These data, and the already observed small limit for the $\phi \eta \gamma$ decay rate (2), have enhanced the interest in finding a theoretical model by which all these decay rates can be evaluated. For this purpose, the $SU_4$ formalism has been used previously as a spectrum-generating group for the vector and pseudoscalar mesons mainly for explaining the decay rates of newly found particles such as $J(\psi)$ (3,4). However, from the theoretical argument in ref. (4), it can be deduced that the above decay rate cannot be computed with acceptable approximations from the $SU_4$ matrix elements alone. The main reason is that the mass symmetry-breaking corrections have larger effect in the rate formula than the consequences of the property of the $SU_4$-group. To take a systematic account of these symmetry-breaking corrections, it has been assumed that the $SU_4$ is a spectrum-generating group of the 4-velocity operator $P_\mu M^{-1}$, where $P_\mu$ and $M$ are the momentum and mass operators, respectively (5). Consequently, in addition to the Clebsch-Gordan coefficients, a suppression factor $G(m_v, m_p)$ appears in the formula, where $m_v$ and $m_p$ are the masses of the vector and pseudoscalar mesons involved in the decay. It is assumed that the current operators have well-specified transformation properties under the group, and that these properties determine the structure of the $G$-factor (6). However, since these properties are unknown, the suppression factor has to be determined by the fitting of the observed decay rates with the decay formula. Following this approach, the previous authors (4,5) have found some suppression functions by which the approximations involved in the calculated rates are improved. Nevertheless, in the light of the new decay rate data and for more

---

(6) This assumption has been discussed in ref. (7), and by A. Bohm in ref. (5).
(7) We do not consider the $\tau$ and $\eta$ mixing because of the large difference in their $m_{\pi}$ and $m_{\eta}$ masses. This is in agreement with the mixing scheme used in $\eta \rightarrow 3\pi$ decay by A. A. Goléstaneh: Phys. Rev. D, 15, 121 (1977).