СООБЩЕНИЯ
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Дубна

E2-95-404

Z.K.Silagadze*

COMMENT ON MASS RELATION OF ρ- AND α_1-MESONS

*JINR, Laboratory of Nuclear Problems, 141980, Dubna, Russia
and Budker Institute of Nuclear Physics, 630090, Novosibirsk, Russia
E-mail address: silagadze@vxsnd.inp.nsk.su

1995

Recently a new mass relation between ρ and a_1 mesons was suggested [1]:

$$m_{a_1}^2 = 2\frac{g_a^2}{g_\rho^2} m_\rho^2 , \tag{1}$$

where g_a and g_ρ are defined trough

$$< 0|V_\mu^a|\rho_b^{(\lambda)} >= \epsilon_\mu^{(\lambda)}\delta_{ab}g_\rho$$

$$< 0|A_\mu^a|a_b^{(\lambda)} >= \epsilon_\mu^{(\lambda)}\delta_{ab}g_a$$

and can be determined from $\Gamma(\rho \to l^+l^-)$ and $\Gamma(\tau \to a_1\nu)$ widths, respectively.

The resulting value $m_{a_1} = 1.36$ GeV is somewhat higher than the experimental one [2] $m_{a_1} = (1.23 \pm 0.04)$ GeV, but fits it better than Weinberg's mass relation $m_{a_1}^2 = 2m_\rho^2$, which follows from (1) under assumption of the validity of Weinberg's second sum rule [3]

$$g_a = g_\rho \, . \tag{2}$$

The mass relation (1) was obtained by invoking Weinberg's first sum rule [3]

$$\frac{g_\rho^2}{m_\rho^2} - \frac{g_a^2}{m_{a_1}^2} = f_\pi^2 \;\; , \;\; f_\pi \approx 93\text{MeV} \, , \tag{3}$$

and the KSRF relation [4]

$$\frac{f_\pi^2 g_{\rho\pi\pi}^2}{m_\rho^2} = \frac{1}{2} \tag{4}$$

(note that $g_\rho = \frac{m_\rho^2}{g_{\rho\pi\pi}}$ is the photon-rho meson coupling constant in the vector meson dominance model [5]).

In [6] a modified KSRF relation was obtained from rather nonrigorous grounds:

$$\frac{f_\pi^2 g_{\rho\pi\pi}^2}{m_\rho^2} = \frac{m_K}{2\sqrt{2}\pi f_\pi} . \tag{5}$$

Nevertheless it is fulfilled by the same accuracy (~10%) as the KSRF relation itself.

This generalized KSRF relation can be combined with Weinberg's sum rules (2) and (3) to obtain one more mass relation of ρ and a_1 mesons:

$$m_{a_1}^2 = \frac{2m_\rho^2}{2 - \frac{m_K}{\pi\sqrt{2}f_\pi}} . \tag{6}$$

Using $m_K = 494$ MeV, $m_\rho = 770$ MeV and $f_\pi = 93$ MeV, the r.h.s. of Eq.6 gives $m_{a_1} = 1.21$ GeV in excellent agreement with experiment.

References

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Received by Publishing Department
on September 18, 1995.