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COMMENT ON MASS RELATION
OF ρ - AND α_1 -MESONS

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

$$m_{a_1}^2 = 2 \frac{g_a^2}{g_\rho^2} m_\rho^2, \quad (1)$$

where g_a and g_ρ are defined through

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

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

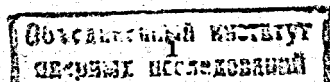
and can be determined from $\Gamma(\rho \rightarrow l^+ l^-)$ and $\Gamma(\tau \rightarrow a_1 \nu)$ widths, respectively.

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]

$$g_a = g_\rho. \quad (2)$$

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

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



and the KSRF relation [4]

$$\frac{f_{\pi}^2 g_{\rho\pi\pi}^2}{m_{\rho}^2} = \frac{1}{2} \quad (4)$$

(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:

$$\frac{f_{\pi}^2 g_{\rho\pi\pi}^2}{m_{\rho}^2} = \frac{m_K}{2\sqrt{2}\pi f_{\pi}} \quad (5)$$

Nevertheless it is fulfilled by the same accuracy ($\sim 10\%$) 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:

$$m_{a_1}^2 = \frac{2m_{\rho}^2}{2 - \frac{m_K}{\pi\sqrt{2}f_{\pi}}} \quad (6)$$

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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