FIZIKA, 2 (1970) 37-39

LETTERS TO THE EDITOR

THE ϱ^{o} MESON WIDTH AND THE VECTOR MESON DOMINANT MODEL

A. BRAMÓN

Instituto de Física Teórica, Barcelona
(Grupo Interuniversitario de Física Teórica)

Received 23 June 1969

The vector meson dominant model introduced by Gell-Mann, Sharp and Wagner[1] has been extensively used during the last years leading to an important amount of conclusions which are in reasonable agreement with the experiments.

In most of these cases the experimental value of the ϱ^{o} meson width or, equivalently, the $g_{\varrho\pi\pi}$ coupling constant has played a rather essential role in order to obtain the final numerical results[2]. Unfortunately, the experimental situation concerning the value of the ϱ^{o} width is not satisfactory. In fact, some recent experiments, performed with the technique of e^{+} e^{-} colliding beams, have lead to the values $\Gamma(\varrho^{o}\rightarrow\pi^{+}\pi^{-}) = 93 \pm 15$ MeV[3] and 105 ± 20 MeV[4] whereas several authors[5] have obtained during the last years and with different techniques values of the order of 170 MeV. This situation is clearly pictured with the value

$$\Gamma(\varrho^{o}\rightarrow\pi^{+}\pi^{-}) = 90 - 150 \text{ MeV} \tag{1}$$

quoted by the Particle Data Group[6].

As a consequence of this experimental ambiguity and taking into accoun the well known relation

$$\Gamma\ (\rho^{0}\rightarrow\pi^{+}\pi^{-}) = \frac{g^{2}_{\rho\pi\pi}}{4\pi}\,\frac{1}{12m^{2}_{\rho}}\,(m^{2}_{\rho} - 4m^{2}_{\pi})^{3/2}$$

the value of $g^{2}_{\varrho\pi\pi}/4\pi$ can vary from 1,8 to 3,3 and it is clear that all the calculations involving this coupling constant are considerably affected by its radger large uncertainty.

The aim of this paper is to derive, by the exclusive use of the vector meson dominance, the value of $g^2_{\rho\pi\pi}/4\pi$ vhich follows from another better established experimental data, namely, the branching ratio

$$R = \frac{\Gamma\,(\omega \to \pi^0 \gamma)}{\Gamma\,(\omega \to \pi^+ \pi^- \pi^0)}$$

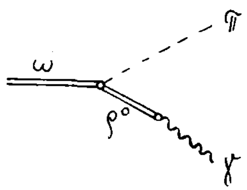
We hope to obtain a value of $g^2_{\rho\pi\pi}/\pi$ leading to a $\Gamma(\varrho^0 \to \pi^+\pi^-)$ in reasonable agreement with the actual worldaveraged experimental results but with a considerably smaller uncertainty. If this is the case we feel that the $g^2_{\rho\pi\pi}/4\pi$ value given by us can be considered as a good starting point in order to proceed to a further application of the Gell-Mann, Sharp and Wagner model.

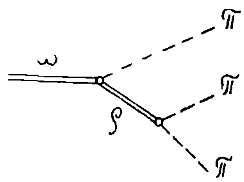
The branching ratio R has been measured by Barnin *et al*[7], Baglin *et al*[8] and Jacquet *et al*[9]. The result

$$R = 0{,}125 \pm 0{,}025 \tag{2}$$

was obtained by the first and then confirmed by the others.

According to the pole model the decays involved in the branching ratio R must be considered as two-step processes taking place through a ϱ intermediate meson, i. e.





We notice that the poles corresponding to the ω and φ vector mesons may be discarded because of G-parity conservation and isospin invariance.

In order to evaluate the rate $\Gamma(\omega \to \pi^0 \gamma)$ we shall also take into account the arguments of Gell-Mann and Zachariasen[10] concerning the ϱ^0 dominance of the isovector charge form factor. They lead to the relation $f_{\rho\gamma} = em^2_{\rho}/g_{\rho\pi\pi}$ between coupling constants and, after some calculations, we obtain

$$\Gamma\,(\omega \to \pi^0 \gamma) = f^2_{\rho\omega\pi} \frac{e^2}{g^2_{\rho\pi\pi}} \frac{1}{48(2\pi)} \frac{(m^2_{\omega} - m^2_{\pi})^3}{m^3_{\omega}} \tag{3}$$

where $f_{\omega\varrho\pi}$ s the coupling constant of the particles involved in the first vertex.

By the usual techniques[11] we also evaluate $\Gamma(\omega \to \pi^+ \pi^- \pi^0)$. This rate comes out to be

$$\Gamma(\omega \to \pi^+ \pi^- \pi^0) = f^2_{\omega\rho\pi} \frac{g^2_{\rho\pi\pi}}{2(2\pi)^3} \frac{m^2_\omega}{m^4_\rho} (29.5 \times 10^{10}) \text{ MeV}^5 \qquad (4)$$

From the ratio between expressions (3) and (4), using the experimental value of R quoted in equation (2) and taking $m_\rho = (765 \pm 10)$ MeV[12] we find

$$\frac{g^2_{\rho\pi\pi}}{4\pi} = 2.5 \pm 0.3 \qquad (5)$$

which leads to

$$\Gamma(\varrho^0 \to \pi^+ \pi^-) = (130 \pm 14) \text{ MeV}, \qquad (6)$$

in good agreement with the result given in equation (1) and other world-averaged results[12].

We finally notice that in the expression of the ratio R appears $g^4_{\rho\pi\pi}$ and, consequently, our results (5) and (6) would not be strongly affected by a possible variation of the experimental value adopted in equation (2).

References

1) M. Gell-Mann, D. H. Sharp and W. Wagner, Phys. Rev. Lett., **8**, (1962) 261;
2) A. Baracca and A. Bramón, Nuovo Cimento **51A** (1967) 873;
3) V. L. Auslander et al., Phys. Letters **25B** (1967) 433;
4) V. L. Auslander et al., Novosibirske Preprint — 1968, Revision of the preceeding reference;
5) E. West et al., Phys. Rev. **149** (1966) 1089;
C. Baltay et al., Phys. Rev. **143** (1966) 1103;
D. H. Miller et al., Phys. Rev. **153** (1967) 1423;
G. Wolf, Phys. Letters **19** (1965) 328;
Aachen, Berlin and CERN Collaboration, Nuclear Phys. **84** (1958) 501;
6) Particle Date Group UCRL — 8030, January and August 1968;
7) V. V. Barnin et al., Soviet Phys. JETP **18** (1964) 1289;
8) C. Baglin et al., Phys. Letters **23** (1966) 286;
9) F. Jacquet et al., Heidelberg Conference, August 1967;
10) M. Gell-Mann and F. Zachariasen. Phys. Rev. **124** (1961) 953;
11) H. Pilkuhn, »The interactions of hadrons«, North-Holland, Amsterdam 1967, Chapt. 5;
12) Particle Data Group, UCRL — 8030, January 1969.