THE $\rho(770)$

Updated May 2012 by S. Eidelman (Novosibirsk) and G. Venanzoni (Frascati).

The determination of the parameters of the $\rho(770)$ is beset with many difficulties because of its large width. In physical region fits, the line shape does not correspond to a relativistic Breit-Wigner function with a P-wave width, but requires some additional shape parameter. This dependence on parameterization was demonstrated long ago [1]. Bose-Einstein correlations are another source of shifts in the $\rho(770)$ line shape, particularly in multiparticle final state systems [2].

The same model-dependence afflicts any other source of resonance parameters, such as the energy-dependence of the phase shift δ_1^1, or the pole position. It is, therefore, not surprising that a study of $\rho(770)$ dominance in the decays of the η and η' reveals the need for specific dynamical effects, in addition to the $\rho(770)$ pole [3,4].

The cleanest determination of the $\rho(770)$ mass and width comes from e^+e^- annihilation and τ-lepton decays. Analysis of ALEPH [5] showed that the charged $\rho(770)$ parameters measured from τ-lepton decays are consistent with those of the neutral one determined from e^+e^- data [6]. This conclusion is qualitatively supported by the later studies of CLEO [7] and Belle [8]. However, model-independent comparison of the two-pion mass spectrum in τ decays, and the $e^+e^- \to \pi^+\pi^-$ cross section, gave indications of discrepancies between the overall normalization: τ data are about 3% higher than e^+e^- data [7,9]. A detailed analysis using such two-pion mass spectra from τ decays measured by OPAL [10], CLEO [7], and ALEPH [11,12], as well as recent pion form factor measurements in e^+e^- annihilation by CMD-2 [13,14], showed that the discrepancy can be as high as 10% above the ρ meson [15,16]. This discrepancy remains after recent measurements of the two-pion cross section in e^+e^- annihilation at KLOE [17,18] and SND [19,20]. This effect is not accounted for by isospin breaking [21–24], but the accuracy of its calculation may be overestimated [25,26].

This problem seems to be solved after a recent analysis in [27] which showed that after correcting the τ data for the missing ρ - γ mixing contribution, besides the other known isospin symmetry violating corrections, the $\pi\pi$ I=1 part of the hadronic vacuum polarization contribution to the muon g - 2 is fully compatible between τ based and e^+e^- based evaluations including more recent BaBar [28] and KLOE [29] data. Further proof of the consistency of the data on τ decays to two pions and e^+e^- annihilation is given by the global fit of the whole set of the ρ, ω, and ϕ decays, taking into account mixing effects in the hidden local symmetry model [30].

References

1. J. Pisut and M. Roos, Nucl. Phys. **B6**, 325 (1968).
2. G.D. Lafferty, Z. Phys. **C60**, 659 (1993).
3. A. Abele *et al.*, Phys. Lett. **B402**, 195 (1997).
4. M. Benayoun *et al.*, Eur. Phys. J. **C31**, 525 (2003).
5. R. Barate *et al.*, Z. Phys. **C76**, 15 (1997).
6. L.M. Barkov *et al.*, Nucl. Phys. **B256**, 365 (1985).
7. S. Anderson *et al.*, Phys. Rev. **D61**, 112002 (2000).
8. M. Fujikawa *et al.*, Phys. Rev. **D78**, 072006 (2008).
9. S. Eidelman and V. Ivanchenko, Nucl. Phys. (Proc. Supp.) **B76**, 319 (1999).
10. K. Ackerstaff *et al.*, Eur. Phys. J. **C7**, 571 (1999).
11. M. Davier *et al.*, Nucl. Phys. (Proc. Supp.) **B123**, 47 (2003).
12. S. Schael *et al.*, Phys. Reports **421**, 191 (2005).
13. R.R. Akhmetshin *et al.*, Phys. Lett. **B527**, 161 (2002).
14. R.R. Akhmetshin *et al.*, Phys. Lett. **B578**, 285 (2004).
15. M. Davier *et al.*, Eur. Phys. J. **C27**, 497 (2003).
16. M. Davier *et al.*, Eur. Phys. J. **C31**, 503 (2003).
17. A. Aloisio *et al.*, Phys. Lett. **B606**, 12 (2005).
18. F. Ambrosino *et al.*, Phys. Lett. **B670**, 285 (2009).
19. M.N. Achasov *et al.*, Sov. Phys. JETP **101**, 1053 (2005).
20. M.N. Achasov *et al.*, Sov. Phys. JETP **103**, 380 (2006).
21. R. Alemany *et al.*, Eur. Phys. J. **C2**, 123 (1998).
22. H. Czyz and J.J. Kuhn, Eur. Phys. J. **C18**, 497 (2001).
23. V. Cirigliano *et al.*, Phys. Lett. **B513**, 361 (2001).
24. V. Cirigliano *et al.*, Eur. Phys. J. **C23**, 121 (2002).

25. K. Maltman and C.E. Wolfe, Phys. Rev. **D73**, 013004 (2006).
26. C.E. Wolfe and K. Maltman, Phys. Rev. **D80**, 114024 (2009).
27. F. Jegerlehner and R. Szafron, Eur. Phys. J. **C71**, 1632 (2011).
28. B. Aubert *et al.*, Phys. Rev. Lett. **103**, 231801 (2009).
29. F. Ambrosino *et al.*, Phys. Lett. **B700**, 102 (2011).
30. M. Benayoun *et al.*, Eur. Phys. J. **C72**, 1848 (2012).