

## 70. $\rho(770)$

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  $\delta_1^1$ , or the pole position. It is, therefore, not surprising that a study of  $\rho(770)$  dominance in the decays of the  $\eta$  and  $\eta'$  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  $\tau$ -lepton decays. Analysis of ALEPH [5] showed that the charged  $\rho(770)$  parameters measured from  $\tau$ -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  $\tau$  decays, and the  $e^+e^- \rightarrow \pi^+\pi^-$  cross section, gave indications of discrepancies between the overall normalization:  $\tau$  data are about 3% higher than  $e^+e^-$  data [7,9]. A detailed analysis using such two-pion mass spectra from  $\tau$  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  $\rho$  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  $\tau$  data for the missing  $\rho - \gamma$  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  $\tau$  based and  $e^+e^-$  based evaluations including more recent BaBar [28] and KLOE [29] data. Further proof of the consistency of the data on  $\tau$  decays to two pions and  $e^+e^-$  annihilation is given by the global fit of the whole set of the  $\rho$ ,  $\omega$ , and  $\phi$  decays, taking into account mixing effects in the hidden local symmetry model [30].

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