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Spectral parameters of the ρ resonance from lattice QCD

We present a lattice QCD investigation of the ρ resonance using nine $N_f = 2 + 1$ Wilson-Clover ensembles with three lattice spacings and various pion masses ranging from 135 to 320 MeV. For each ensemble, a large number of finite volume energy levels are determined and the energy dependence of the phase shift obtained from L\"uscher's finite volume method. The mass and width of the ρ resonance are then extracted by assuming the Breit-Wigner form. The mass and width are extrapolated to the physical pion mass and continuum limit ($\mathcal{O}(a^2)$) using a linear function of a^2 and m_π^2. The extrapolated values for the mass and width in the Breit-Wigner form are $(m_\rho,\, \Gamma_\rho) = (781.6 \pm 10.0,\, 146.5 \pm 9.9)$ MeV, which are in good agreement with experiment. An alternative method of analysis, based on Hamiltonian effective field theory, involves directly fitting the lattice energy levels and accounting for the quark mass dependence of the hadronic loop diagrams which yield the leading and next-to-leading non-analytic behaviour. This approach also yields consistent ρ parameters at the physical point. This represents the most precise determination to date of the mass and width of a hadron which is unstable under strong decay, achieved through comprehensive lattice QCD calculations and methods of analysis.

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