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Theoretical limitations of amplitudes and their decisive influence on the parameters of resonances

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Recent years have shown how important a role in resonance spectroscopy is played by theoretical limits imposed on amplitudes. They are unitarity and crossing symmetry. Generally, it is about the analysis of the analytical structure of complex amplitudes, which are so important that, for example, they eliminate long-existing ambiguities in experimental data and dramatically change the resonance parameters. These changes strongly affect the interpretation of the resonance structure, which is crucial in searching for e.g. exotic states, so important in testing the Standard Model. These searches are the main or one of the main lines of research carried out by, for example, the GlueX, Compass and Nica projects. There is no doubt now that the decisive conclusions about these important and sometimes key topics come from theoretical analysis - much more accurate and demanding than even the data from a well-conducted and analyzed experiment. This indicates a new and often accepted, even by definition, conservative collective Particle Data Group, method of analyzing experimentally determined data and amplitudes and drawing very often revolutionary but certain conclusions so very important today for the evaluation of effects beyond the Standard Model. The presentation will show the greatest achievements of the above-mentioned methods for mesons to about 2 GeV and prospects for their further development. As an example, the results of $f_0(500)$, $\rho(1450)$ and $K^*(800)$ resonance analyzes [1,2,3] will be presented. The presentation will also encourage all physicists - experimentalists and theorists to use the presented methods and to abandon the long-known e.g. isobar models violating unitarity. Modern physics (especially after the discovery of Higgs) and its requirements, force us to apply the above-mentioned methods and undoubtedly represent the future of physics.

[1] "The Pion-pion scattering amplitude. IV: Improved analysis with once subtracted Roy-like equations up to 1100 MeV", R. Garcia-Martin, R. Kaminski, J.R. Pelaez, J. Ruiz de Elvira, F.J. Yndurain, Phys. Rev. D 83 (2011) 074004.

[2] "Strong evidence of the $\rho(1250)$ from a unitary multichannel reanalysis of elastic scattering data with crossing-symmetry constraints", N. Hammoud, R. Kaminski, V. Nazari, G. Rupp, Phys. Rev. D 102 (2020) 5, 054029.

[3] "Determination of the lightest strange resonance $K_0^*(700)$ or κ, from a dispersive data analysis", J.R. Peláez, A. Rodas, Phys. Rev. Lett. 124 (2020) 17, 172001.

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