Resonances in the Meson and Higgs Sectors: Analysing Multichannel Data

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December 22, 2024

Contribution to *European Strategy for Particle Physics*

Abstract

Resonance signals in elementary particle physics are usually analysed with Breit-Wigner parametrisations, which have serious deficiencies when dealing with states that are very broad, close to decay thresholds, or overlapping with other resonances. Moreover, in spectroscopic applications, for instance to mesons, further shortcomings become evident even in improved approaches like Flatté or K-matrix analyses, such as the neglect of often large mass shifts or even the appearance of additional, dynamical resonances (see Ref. [1]) for a review.)

In 2015, I was invited to an LHCb workshop in Rio de Janeiro on "Multibody Decays of D and B Mesons" [2] focusing, among other topics, on improvements to Breit-Wigner analyses of resonances as well as distinguishing them from non-resonant threshold effects. In a written contribution [3] to the workshop proceedings [2], co-authored by the late Eef van Beveren, we reviewed the Resonance-Spectrum Expansion (RSE) for elastic scattering and production processes involving non-exotic mesons. The RSE approach allows for a manifestly unitary and analytic description of multichannel processes involving genuine meson resonances as well as threshold phenomena. Although in our successful RSE applications [1] we used specific model-based inputs, model-independent RSE generalisations would allow for much improved data analyses of such processes, with a reduced number of adjustable parameters. These conclusions remain valid for current and future experiments in hadronic physics at the LHC and SPS by the LHCb, CMS, ATLAS, and COMPASS collaborations.

As for the Higgs sector, Maurizio Consoli and I recently published a paper [4] with theoretical, lattice, and multiple experimental evidence of a second resonance of the SM scalar field at about 690 GeV, arising as a non-perturbative phenomenon in 4D ϕ^4 theory. Also here the RSE is useful to predict and possibly analyse multichannel decays of such a resonance when better ATLAS and CMS data will become available at the LHC.

References

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