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Machine learning-based line shape analysis of exotic hadron candidates

Most recently discovered exotic hadron candidates appear close to two-hadron thresholds, making it challenging to probe the quantum states associated with these near-threshold signals. This difficulty arises from potential contamination due to coupled-channel effects, and the observed signal might also originate from purely kinematical effects. In this talk, I will discuss how machine learning can supplement conventional line shape analysis. Specifically, I will demonstrate that a deep neural network can be trained to distinguish between enhancements in the observable that result from a dynamical pole and those due to kinematical effects, such as the triangle singularity, even in the presence of experimental uncertainties. Our focus is on interpreting the Pc(4312) state, as observed by LHCb in 2019. After ruling out the triangle singularity interpretation, we examine the pole structure of the Pc(4312) more closely. Interestingly, there are several pole structures that produce nearly identical line shapes. To resolve this ambiguity, we incorporated the off-diagonal elements of the S-matrix into the training dataset used for generating line shapes. Our findings indicate that the experimental data favors a three-pole structure interpretation for the Pc(4312), with one pole in each unphysical Riemann sheet. This pole structure suggests a compact resonance contaminated by the presence of a virtual state in the higher mass channel.

Primary author(s) : SOMBILLO, Denny Lane (University of the Philippines Diliman)

Presenter(s) : SOMBILLO, Denny Lane (University of the Philippines Diliman)