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Near-threshold hadron scattering using effective field theory

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In this work, we study the general properties of the scattering amplitude with the channel couplings using the effective field theory. Recently, exotic hadrons have drawn intensive attention. Internal structure of these hadrons is related to the scattering lengths and effective range. When an exotic hadron locates near the threshold with channel couplings, we must consider the threshold effect. Based on this observation, the Flatte amplitude [1,2] has been often used to determine the scattering length and effective range [3]. In more general frameworks, how are the expressions of those?

As one of the general frameworks, we consider the effective field theory(EFT) [4]. The scattering amplitude from EFT satisfies the optical theorem which is derived from the conservation of probability. We find, however, the Flatte amplitude does not satisfy the optical theorem. In order to verify the validity of the Flatte results, we compare the scattering length and the effective range in the Flatte amplitude with those in the EFT amplitude. As a result, we find that the scattering length and the effective range in the Flatte amplitude are different from those in the EFT amplitude.

We also discuss the determination of parameters of the scattering amplitude from the slopes of the cross section around the threshold. It is known that three parameters in the Flatte amplitude reduce to two independent combinations near the threshold [2]. In contrast, the near-threshold behavior of the EFT amplitude depends on three parameters independently. From this feature, we can determine the EFT parameters uniquely, from the slopes of the cross section. Finally, we present an alternative representation of the EFT scattering amplitude up to first order of the momentum,which can be expressed by the complex scattering length and one real parameter.

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Collaboration

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