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Analysis of $\Xi(1620)$ resonance with chiral unitary approach

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While various theoretical studies have been performed for the excited $\Xi(1620)$ state, its nature was not well understood due to the lack of experimental data. Recently, new experimental results on $\Xi(1620)$ were reported.In 2019, Belle collaboration observed the invariant mass distribution of the $\pi\Xi$ system in the $\Xi_c \to \pi\pi\Xi$ decay [1].By fitting the invariant mass spectrum with the Breit-Wigner distribution, the mass and decay width of the $\Xi(1620)$ were obtained as $M_R = 1610$ MeV and $\Gamma_R = 30$ MeV, respectively. In 2021, ALICE collaboration determined the scattering length of $K^-\Lambda$ with femtoscopy in Pb-Pb collisions [2]. Because the $\Xi(1620)$ resonance locates near the $K^-\Lambda$ threshold, the ALICE result of the $K^-\Lambda$ scattering length constrains the property of the $\Xi(1620)$ resonance.Given the detailed experimental results are obtained, it is desired to perform detailed theoretical analysis of $\Xi(1620)$ based on the newly observed data.

In this talk, we study $\Xi(1620)$ as a dynamically generated resonance in the coupled-channel meson-baryon scattering amplitude using the the chiral unitary approach. In the previous study [3], the mass and width of $\Xi(1620)$ were predicted to be $M_R = 1607$ MeV and $\Gamma_R = 280$ MeV, with the natural values of the subtraction constants. Because the width is broader than the value reported by Belle, it is required to improve the model of $\Xi(1620)$.By adjusting the subtraction constants of the $\pi\Xi$ and $\bar{K}\Lambda$ channels, we successfully reproduce the mass and width of $\Xi(1620)$ by Belle. We, however, find that the threshold effect shifts the resonance peak of $\Xi(1620)$ from the simple Breit-Wigner distribution.We conclude that the cation must be paid to determine the resonance pole near the threshold [4].

Next, we construct a model by taking into account the $K^-\Lambda$ scattering length by ALICE.We show that the $K^-\Lambda$ scattering length can be reproduced by tuning the subtraction constants of the $\pi\Xi$ and $\bar{K}\Lambda$ channels. In this case, the pole of $\Xi(1620)$ in the scattering amplitude does not appear in the physically relevant Riemann sheet which is directly connected to the physical scattering on the real energy axis. We discuss the property of the near-threshold pole of the scattering amplitude in relation with the complex scattering length.

Finally, we search for the model which reproduces both the $K^-\Lambda$ scattering length by ALICE and the $\pi\Sigma$ spectrum by Belle within the experimental uncertainties. By analyzing the properties of the constructed model, we aim to find out the nature of the $\Xi(1620)$ resonance.

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Collaboration

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