The role of high spin hyperon resonances in the Ξ production meson-baryon reactions

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Unitarized Chiral Perturbation Theory (UχPT), which combines chiral dynamics with unitarization techniques in coupled channels, has shown to be a very powerful tool that permits extending the validity of χPT to higher energies and to describe the physics around dynamically generated resonances. Nowadays the aim for precision and the extension of the approach to higher energies has motivated the introduction of the next-to-leading order (NLO) terms of the chiral Lagrangians in the kernel of the meson-baryon interaction, and new fits to extended data have been performed to determine the parameters of the higher order chiral potential [1-5].

In a recent paper [6] we study the $S = -1$ meson-baryon interaction with the aim to provide well constrained values of the NLO parameters of the chiral Lagrangian. We employ elastic and inelastic cross section data for different channels and the precise SIDDHARTA value of the energy shift and width of kaonic hidrogen. In particular, we constrain the parameters of our model to also reproduce the $K\Xi$ production data via the reactions $K^-p \to K^+\Xi^-, K^0\Xi^0$, which were not taken into account in other works [1-5]. The motivation lies in the fact that the lowest-order Lagrangian does not contribute directly to these reactions, which then become especially sensitive to the NLO terms. And indeed, as we will show, the results completely confirm the idea that the $K\Xi$ cross sections are crucial ingredients for determining the values of the low-energy constants of the NLO Lagrangian.

Furthermore, we will also show that certain structures present in the $K^-p \to K^+\Xi^-, K^0\Xi^0$ cross sections cannot be accounted for by the UχPT even at NLO. In fact, several resonance-based models have studied the photoproduction of Ξ particles off the proton [7,8] or via the strong reactions $K^-p \to K^+\Xi^-, K^0\Xi^0$ investigated here [9-11] . These works have found a non-negligible contribution from high-spin hyperon resonances. Guided by these findings, we also implement phenomenological resonant contributions from high spin resonances, in particular $\Sigma(2030)$ and $\Sigma(2250)$. We will show that this is a necessary exercise to obtain a higher accuracy and stability of the obtained NLO parameters.

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