On the double pole structure of the $\Lambda(1405)$

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In the last decade increased theoretical and experimental evidences about the existence of two poles associated to the $\Lambda(1405)$ resonance have rised up to the point that this double pole nature is going to be included in the next PDG edition.

After a brief summary of how this double pole nature arises within the chiral unitary based theories, I will summarize several recent works [1,2] presenting a successful strategy to extract the position of the two $\Lambda(1405)$ poles from experimental photoproduction data on the $\gamma p \to K\pi\Sigma$ reaction at Jefferson Lab. The idea is based on considering a production mechanism as model independent as possible and implementing the final state interaction of the final meson-baryon pair based on small modifications of the unitary chiral perturbation theory amplitudes. Good fits to the data are obtained with this procedure, by means of which we can also predict the cross sections for the $K^- p \to \bar{K}N$, $\pi\Sigma$, $\pi\Lambda$ reactions for the different charge channels. Precise values for the two the two poles of the $\Lambda(1405)$ resonance are then provided.

On the other hand, we also present another work [3] where we calculate the shape of the $\pi\Sigma$ and $\bar{K}N$ invariant mass distributions in the $\Lambda_b \to J/\psi\,\pi\Sigma$ and $\Lambda_b \to J/\psi\,\bar{K}N$ decays that are dominated by the $\Lambda(1405)$ resonance. The weak interaction part is the same for both processes and the hadronization into the different meson-baryon channels in the final state is given by symmetry arguments. The most important feature is the implementation of the meson-baryon final-state interaction using two chiral unitary models from different theoretical groups. Both approaches give a good description of antikaon-nucleon scattering data, the complex energy shift in kaonic hydrogen and the line shapes of $\pi\Sigma K$ in photoproduction, based on the two-pole scenario for the $\Lambda(1405)$. We find that this reaction reflects more the higher mass pole and we make predictions of the line shapes and relative strength of the meson-baryon distributions in the final state.

[1] L. Roca and E. Oset, Phys. Rev. C **87** (2013) 5, 055201

[2] L. Roca and E. Oset, Phys. Rev. C **88** (2013) 5, 055206

[3] Phys. Rev. C **88** (2013) 5, 055206 [arXiv:1307.5752 [nucl-th]].

Figure 1: Japanese characters indicating the pronunciation of HYP2015.