Coupled-channel study of baryon resonances with charm

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Empirically the QCD spectrum of charmed baryon states is poorly studied so far. It is important to correlate the properties of charmed states to those firmly established, applying a unified and quantitative framework. Our strategy is to extend previous works [1, 2, 3, 4] that performed a coupled-channel study of the s-wave scattering processes where a Goldstone boson hits an open-charm baryon ground state. The results of [1, 2, 3, 4] were based on the leading order chiral Lagrangian, that predicts unambiguously the s-wave interaction strength of Goldstone bosons with baryon states in terms of the pion decay constant. Including the light vector mesons as explicit degrees of freedom in a chiral Lagrangian gives an interpretation of the leading order interaction in terms of the t-channel exchange of vector mesons.

Extending those computations to include D- and η_c-mesons in the intermediate states leads to additional baryon resonances [5]. Identifying a zero-range exchange of vector mesons as the driving force for the s-wave scattering of pseudo-scalar mesons off the baryon ground states, a rich spectrum of molecules is formed. We argue that chiral symmetry and large-N_c considerations determine that part of the interaction which generates the spectrum. The latter couple universally to any matter field in this type of approach. Given the assumption that the interaction strength of D- and η_c-mesons with the baryon ground states is also dominated by the t-channel exchange of the light vector mesons, we are in a position to perform a quantitative coupled-channel study of charmed baryon resonances.

The interaction strengths of the channels that drive the resonance generation are predicted by chiral and large-N_c properties of QCD. The spectrum of s-wave molecules obtained is amazingly rich of structure. Results are obtained in all charm sectors [5]. Particularly striking are the crypto-exotic resonances in the charm-zero sector. The spectrum is shown in Fig. 1 in terms of coupled-channel speed plots. In the charm one sector we recover the $\Lambda_c(2593)$ as a narrow state coupling strongly to the $(D\,N)$ and $(D_s\,\Lambda)$ states. The $\Xi_c(2790)$ is interpreted as a bound state of the $(\bar{K}\,\Sigma_c), (\eta\,\Xi_c')$ system. We argue that the $\Lambda_c(2880)$ discovered by the CLEO collaboration can not be a s-wave state. About ten additional narrow s-wave states are predicted in this sector with masses below 3 GeV (see Fig. 2).

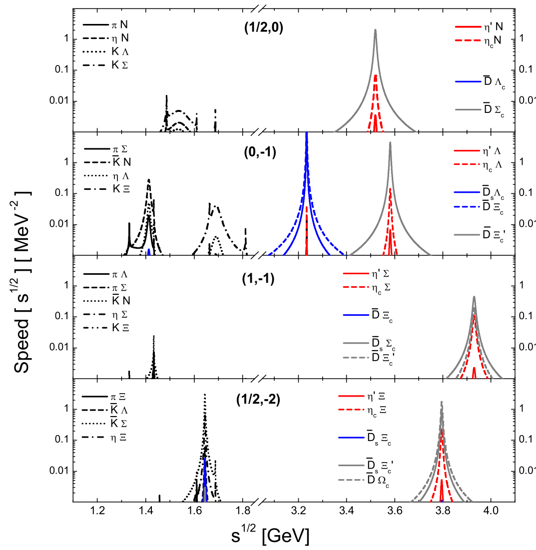

Figure 1: Spectrum of $J^P = \frac{1}{2}^-$ molecules with $C = 0$.

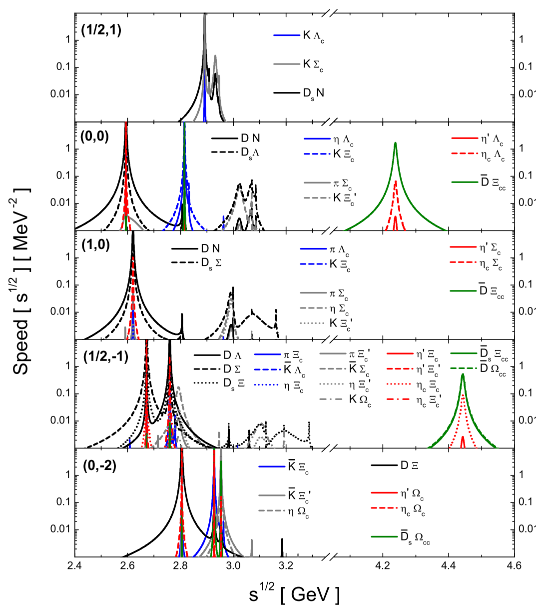

Figure 2: Spectrum of $J^P = \frac{1}{2}^-$ molecules with $C = 1$.

References

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