Charm physics: hadronic width of $D^*_{S0}(2317)^+$

The modern theory of strong interactions is Quantum Chromo Dynamics (QCD), which is now well tested at high energy scale, but not so at low energy, since only in the high energy regime the coupling constant α_s is small and standard perturbative methods can be applied. However, in the sector of low and medium energy, a large number of open questions remain. For example, the sector of charm and charmonium physics is richer than expected from the quark model, as new resonant states with quite unusual properties have been observed (prominent examples amongst the more than 10 states are in the charm sector the $X(3872)$, the charged charmonia $Z_c^+(3900)$ and $Z_c^+(4020)$, and the D_s mesons). Many theoretical interpretations have been proposed for the new resonant states like hadro-charmonia, hybrids, tetraquarks and hadronic molecules — for a recent review see Ref. [1].

High quality calculations as well as measurements are compulsory for each state to allow one to decide amongst the various scenarios. The working group will focus on experimental and theoretical aspects in the context of the potentially exotic $D^*_{S0}(2317)^+$. The state is located by about 100 MeV below what is predicted by the quark model and only about 40 MeV below the KD threshold. While the state is an isoscalar, it can only decay strongly into the isovector final state πD_s which results in a width well below 1 MeV. The interpretations of the $D^*_{S0}(2317)^+$ range from a pure $c\bar{s}$ state [2], over tetraquark configurations [3] to a molecular state [4–7]. While within the former explanations the width of the state is predicted to be of the order of 10 keV, the molecular scenario predicts consistently a width of the order of or even larger than 100 keV — the enhancement stems from meson loops that are prominent for molecular states only [4–8]. Measuring that small widths is clearly a challenge but certainly worth the effort for such a measurement could for the first time unambiguously identify an exotic structure in the open charm sector.

The future fix-target experiment $\bar{P}ANDA$ can take the challenge to measure the width of resonant states. The project $\bar{P}ANDA$ aims to reach a mass resolution of 100 keV, which is 20 times better than attained at the B factories. From the experimental point of view, the measurement of the width will be performed by scanning the mass of the resonant state every 100 keV, and analyze the excitation function of the cross section in the process $\bar{p}p \to \bar{D}_S D_{SJ}$. The measurement of the cross section, the determination of the width and the study of the D_{SJ} mesons in $\bar{p}p$ interactions represent a highlight topic of the $\bar{P}ANDA$ physics program. Due to the high level of background in this process, this is a challenge.

Students joining this working group, are supposed to work out requirements to the detector that allows one to perform the measurement of the width of the $D^*_{S0}(2317)^+$, with special emphasis on ideas to reject backgrounds in order to make this data analysis feasible.

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