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Heavy quark spin partners of the ψ(4230) and their decay properties

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The charmoniumlike state ψ(4230)1 is now widely considered as predominantly a D1̄D hadronic molecule. The heavy quark spin symmetry (HQSS) thus implies the possible emergence of its heavy quark spin partners with molecular configuration as D1̄D∗ and D∗ 2̄D∗ below these charmed mesons'thresholds. Similar heavy quark spin patterns are already identified for instance for recently observed LHCb pentaquarks and for charged exotic states in the bottom sector, namely Zbs.

Studying the spin partners of the ψ(4230) leads to explore the full heavy quark spin multiplet involving one P- and one S-wave charmed mesons. A remarkable feature is that the
mψ(4360) − mψ(4230) ≈ mD∗ − mD , (1)
mψ(4415) − mψ(4360) ≈ mD∗2 − mD1 , (2)
which is a natural consequence of HQSS if ψ(4230), ψ(4360), and ψ(4415) are identified as the isoscalar molecules of D1̄D, D1̄D∗ and D∗2̄D∗, respectively.

We analyze the probabilities of various intermediate charmed meson components for JP C = 1−− exotic state ψ(4360) and find that the channel D1̄D∗ couples more strongly around its mass regime, and the coupling behavior remains the same even if the mass of ψ(4360) is pushed closer to D1̄D∗ threshold. This enlightens that the most favorable molecular scenario for the ψ(4360) could be D1̄D∗, and hence it can be interpreted as HQSS partner of the ψ(4230). We also find the strong coupling behavior of D∗2̄D∗ channel with the ψ(4415), which makes it a good candidate for a dominant D∗2̄D∗ molecule.

In this contribution, we plan to present the extended version of our study in which we explore the full HQSS multiplet of P - and S-wave charmed mesons. Along with the predictions for the mass spectrum, we intend to provide predictions for the important decay patterns of these resonances in hadronic configurations to disentangle their long- and short-distance structures. Once the predicted
patterns are confirmed by future experiments, it will enrich our understanding of QCD and its facet of forming hadronic matter by arranging multiquarks.

Preferred track

Hadron Spectroscopy

Subfield

HEP theory

Attending in-person?

Yes

On behalf of collaboration?

Primary author: ANWAR, Muhammad Naeem (Forschungszentrum Jülich)

Presenter: ANWAR, Muhammad Naeem (Forschungszentrum Jülich)

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