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Type: **Talk**

## Heavy quark spin partners of the $\psi(4230)$ and their decay properties

Tuesday 2 August 2022 15:00 (30 minutes)

The charmoniumlike state  $\psi(4230)$  is now widely considered as predominantly a  $D\bar{1}D$  hadronic molecule. The heavy quark spin symmetry (HQSS) thus implies the possible emergence of its heavy quark spin partners with molecular configuration as  $D\bar{1}D^*$  and  $D^*ZD^*$  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  $Z_b$ s.

Studying the spin partners of the  $\psi(4230)$  leads to explore the full heavy quark spin multiplet involving one P- and one S-wave charmed mesons. A remarkable feature is that the

$$m\psi(4360) - m\psi(4230) \approx mD^* - mD, \quad (1)$$

$$m\psi(4415) - m\psi(4360) \approx mD^{*2} - mD1, \quad (2)$$

which is a natural consequence of HQSS if  $\psi(4230)$ ,  $\psi(4360)$ , and  $\psi(4415)$  are identified as the isoscalar molecules of  $D\bar{1}D$ ,  $D\bar{1}D^*$  and  $D^*ZD^*$ , respectively.

We analyze the probabilities of various intermediate charmed meson components for  $J^P C = 1^{--}$  exotic state  $\psi(4360)$  and find that the channel  $D\bar{1}D^*$  couples more strongly around its mass regime, and the coupling behavior remains the same even if the mass of  $\psi(4360)$  is pushed closer to  $D\bar{1}D^*$  threshold. This enlightens that the most favorable molecular scenario for the  $\psi(4360)$  could be  $D\bar{1}D^*$ , and hence it can be interpreted as HQSS partner of the  $\psi(4230)$ . We also find the strong coupling behavior of  $D^*ZD^*$  channel with the  $\psi(4415)$ , which makes it a good candidate for a dominant  $D^*ZD^*$  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 multi-quarks.

### Preferred track

Hadron Spectroscopy

### Subfield

HEP theory

### Attending in-person?

Yes

### On behalf of collaboration?

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