Contribution ID: **200** Type: **Oral report**

Molecular tetraquarks and pentaquarks in chiral effective field theory

Tuesday, 9 August 2022 16:30 (20 minutes)

We generalize the framework of chiral effective field theory to study the interactions of the isovector $D^*\bar{D}^{(*)}$ and $B^*\bar{B}^{(*)}$ systems up to the next-to-leading order, in which the long-, mid-, and short-range force contributions as well as the S-D wave mixing are incorporated. Based on the Lippmann-Schwinger equation, we fit the invariant mass distributions of the elastic channels measured by the BESIII and Belle Collaborations. Our results indicate that the four charged charmoniumlike and bottomoniumlike states $Z_c(3900)$, $Z_c(4020)$ and $Z_b(10610)$, $Z_b(10650)$ can be well identified as the $D\bar{D}^*$, $D^*\bar{D}^*$ and $B\bar{B}^*$, $B^*\bar{B}^*$ molecular resonances. The bound state explanations are vetoed in our framework. Our study favors the Z_c and Z_b states are the twin partners under the heavy quark symmetry.

The newly observed $P_c(4312)$, $P_c(4440)$ and $P_c(4457)$ at the LHCb experiment are very close to the $\Sigma_c\bar{D}$ and $\Sigma_c\bar{D}^*$ thresholds. In this work, we perform a systematic study and give a complete picture on the interactions between the $\Sigma_c^{(*)}$ and $\bar{D}^{(*)}$ systems in the framework of heavy hadron chiral effective field theory, where the short-range contact interaction, long-range one-pion-exchange contribution, and intermediate-range two-pion-exchange loop diagrams are all considered.

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Session Classification: Parallel Session II (2)：Hadron and Flavor Physics

Track Classification: 强子物理与味物理