Charmonia and Exotic Hadrons in Jets at LHCb

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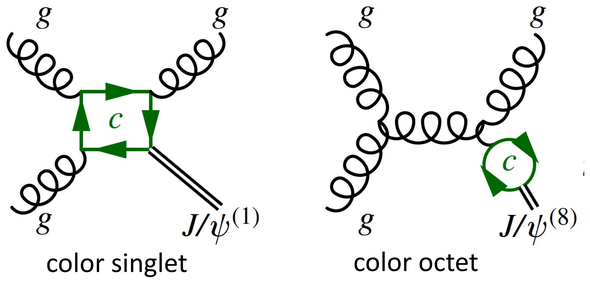
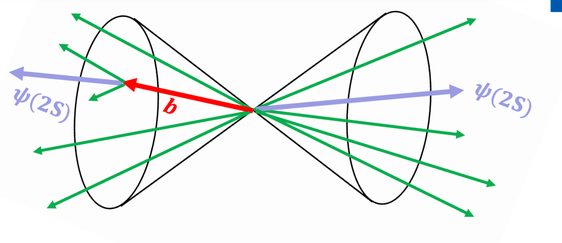
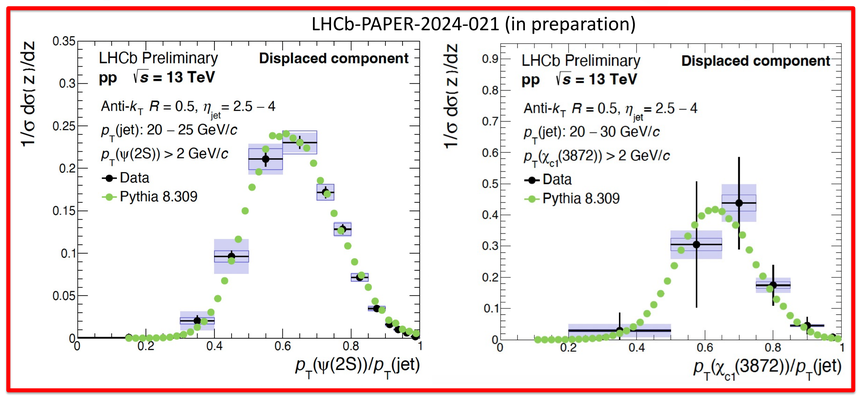
The enduring charmonia puzzle

Production of heavy quarkonia probes both the perturbative and non-perturbative regimes of QCD. A simultaneous description of the cross-section and polarization of charmonia remains a challenge. The exact mechanisms behind production of bound $c\bar{c}$ states are unknown.





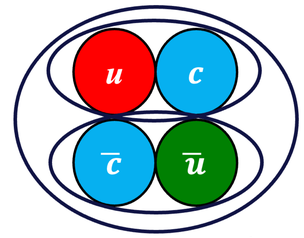
Measurements in jets provide new probes of hadron production mechanisms and properties



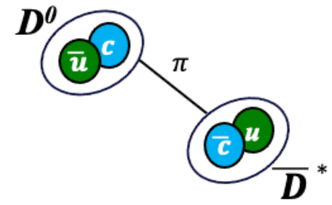
Non-prompt $\psi(2S)$ and $X(3872)$: momentum fractions consistent with each other and with PYTHIA8 calculations – *b* quark fragmentation modeled accurately

Mysterious exotic hadrons

In the past 20 years, dozens of hadrons have been discovered that do not fit into the conventional model of two-quark mesons and three-quark baryons. The structure and production mechanisms of these exotic hadrons remain unknown.



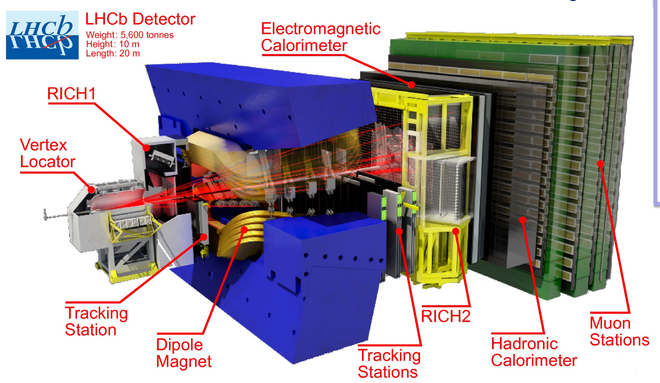
compact tetraquark

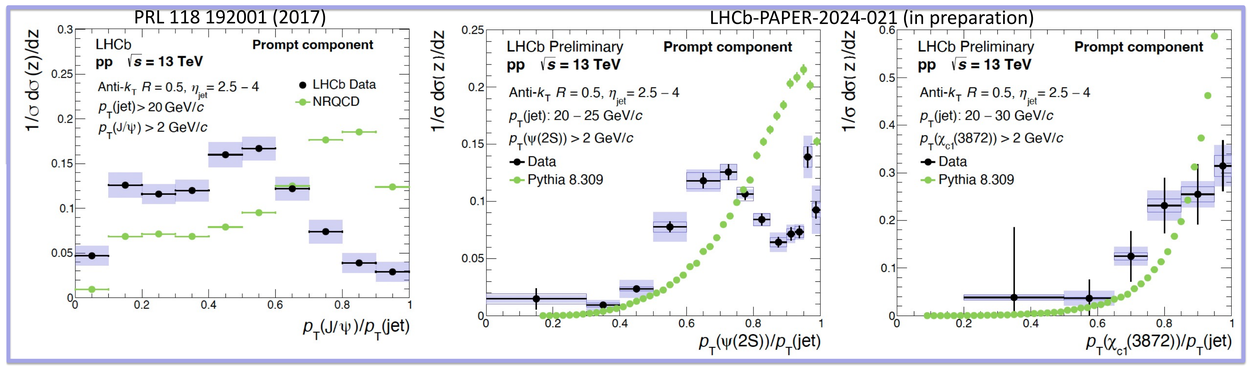


hadronic molecule

LHCb detector

With full particle ID, precise vertexing, EM and hadronic calorimetry, and a fast DAQ, the LHCb detector is uniquely well-suited to measure charmonia in jets





Prompt J/ψ: less isolated than expected from NRQCD models as implemented in PYTHIA

Prompt $\psi(2S)$: two components, potentially indicating different $\psi(2S)$ production mechanisms

Prompt $\chi_{c1}(3872)$: exotic hadron production in jets more isolated than conventional charmonia states $\psi(2S)$

Conclusions

The LHCb collaboration has performed the first measurements of prompt and non-prompt $\psi(2S)$ and $\chi_{c1}(3872)$ production in jets. The non-prompt component, which represent *b* quark fragmentation, is described well by PYTHIA8 calculations. The charmonium state $\psi(2S)$ shows evidence of two distinct production mechanisms, while the exotic $\chi_{c1}(3872)$ exhibits clear differences with conventional charmonia.

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