Contribution ID: **731** Type: **Parallel**

Probing of exotic multiquark states in hadron and heavy ion collisions

Wednesday 9 July 2025 09:10 (20 minutes)

The spectroscopy of charmonium-like mesons with masses above the 2_mD open charm threshold has been full of surprises and remains poorly understood. The currently most compelling theoretical descriptions of the mysterious XYZ mesons attribute them to hybrid structure with a tightly bound cc\bar diquark or cq(cq)\bar tetraquark core that strongly couples to S-wave D*D*\bar molecular like structures. In this picture, the production of a XYZ states in high energy hadron collisions and its decays into light hadron plus charmonum final states proceed via the core component of the meson, while decays to pairs of open-charmed mesons proceed via the D*D*\bar component.

These ideas have been applied with some success to the XYZ states, where a detailed calculation finds a cc\bar core component that is only above 5% of the time with the DD*bar component (mostly D0D0*\bar) accounting for the rest. In the hybrid scheme, XYZ mesons are produced in high energy proton-nuclei collisions via its compact (r_rms < 1 fm) charmonium-like structure and this rapidity mixes in a time (t ~ ħ/δM) into a huge and fragile, mostly D0D0*\bar, molecular-like structure. δM is the difference between the XYZ meson mass and that of the nearest cc\bar mass pole core state.*

The experiments with proton-proton and proton-nuclei collisions with √S_pN up to 27 Gev and luminosity up to 10^32 cm^-2s^-1 planned at NICA may be well suited to test this picture for the X(3872) and other XYZ mesons. In near threshold production experiments in the √S_pN ≈ 8 GeV energy range, XYZ mesons can be produced with typical kinetic energies of a few hundred MeV. In the case of X(3872), its decay length will be greater than 50 fm while the distance scale for the cc\bar ⟶ D0D0\bar transition would be 2 ~ 3 fm. Since the survival probability of an r_rms ~ 9 fm "molecular"inside nuclear matter should be very small, XYZ meson production on a nuclear target with r_rms ~ 5 fm or more (A ~ 60 or larger) should be strongly quenched. Thus, if the hybrid picture is correct, the atomic number dependence of XYZ production at fixed √S_pN should have a dramatically different behavior than that of the ψ', which is long lived compact charmonium state.

The current experimental status of XYZ mesons together with hidden charm tetraquark can-didates and present simulations what we might expect from A-dependence of XYZ mesons in proton-proton and proton-nuclei collisions are summarized.

Secondary track

T04 - Ultra-relativistic Nuclear Collisions

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Session Classification: Joint T04+T05

Track Classification: T04 - Ultra-relativistic Nuclear Collisions