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Production of Exotic States in Electron-positron Collisions Based on a Transport and Coalescence Model

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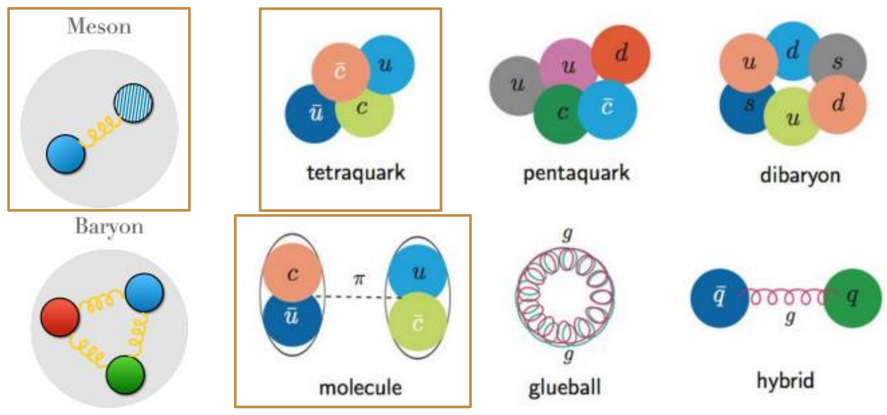
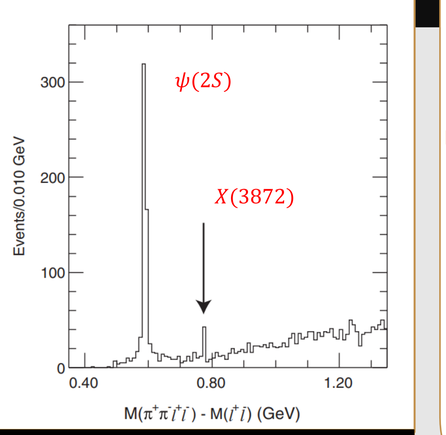
Introduction

What are exotic hadrons?

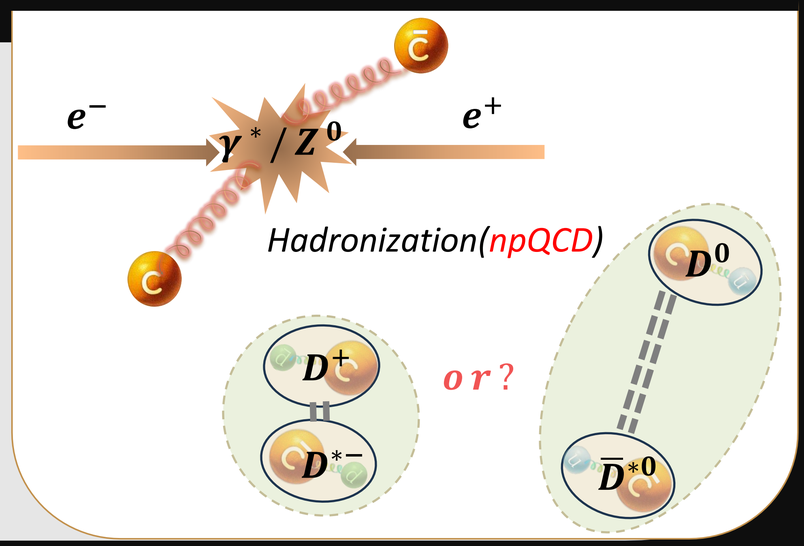


A unique probe to characterize the effect in Quantum Chromodynamics(QCD).



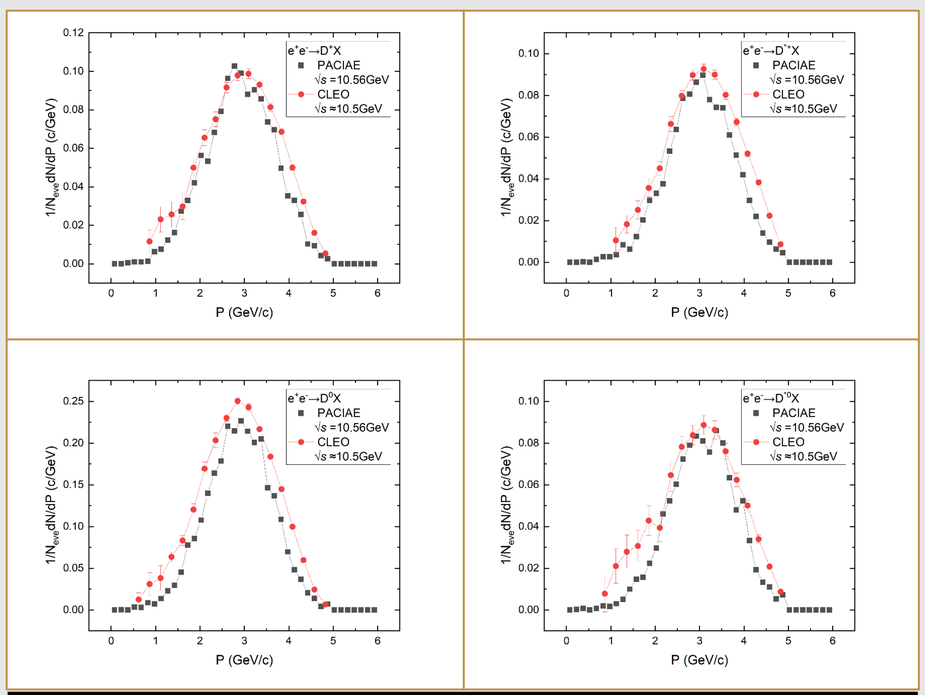
*In 2003, **X(3872)** was first observed by the Belle Exp.*

How exotic hadrons are produced?

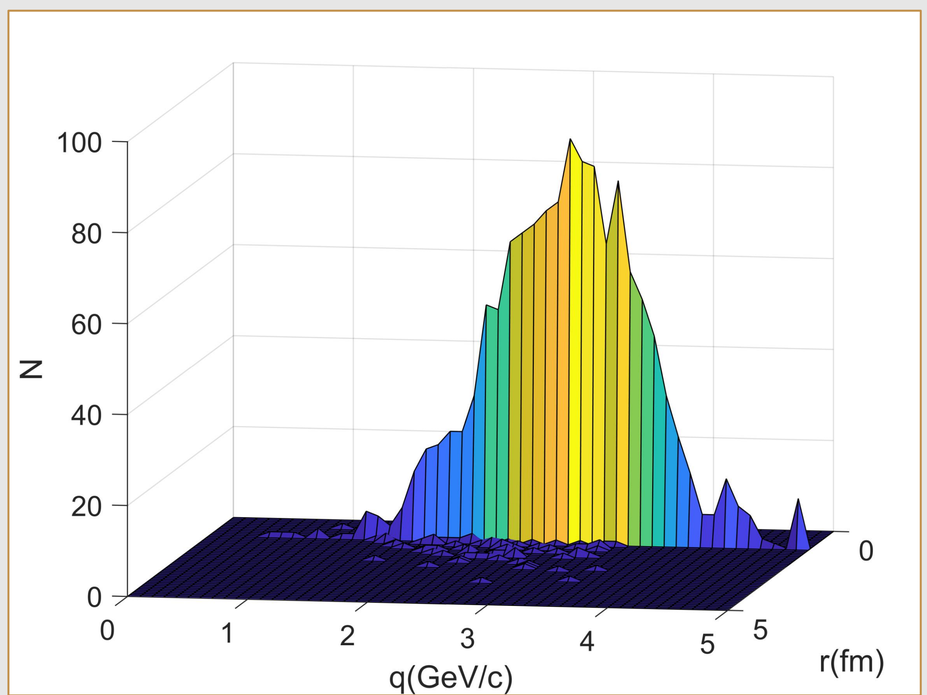


Transport Model PACIAE

Parton initiation → Parton rescattering → Hadronization → Hadron rescattering (until freeze-out)

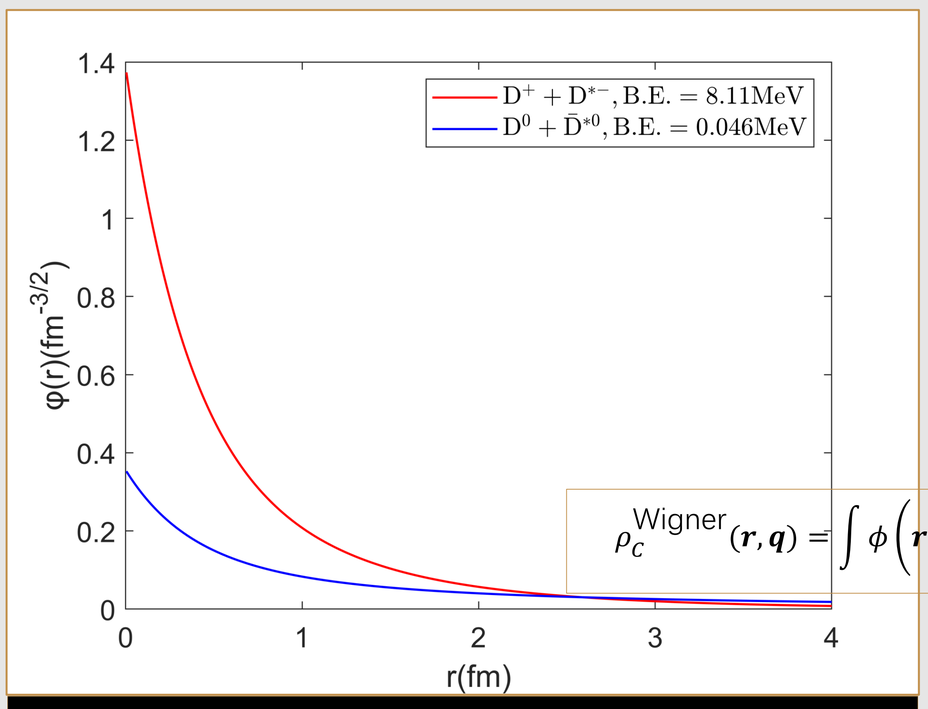


*Momentum distribution of **D** mesons*



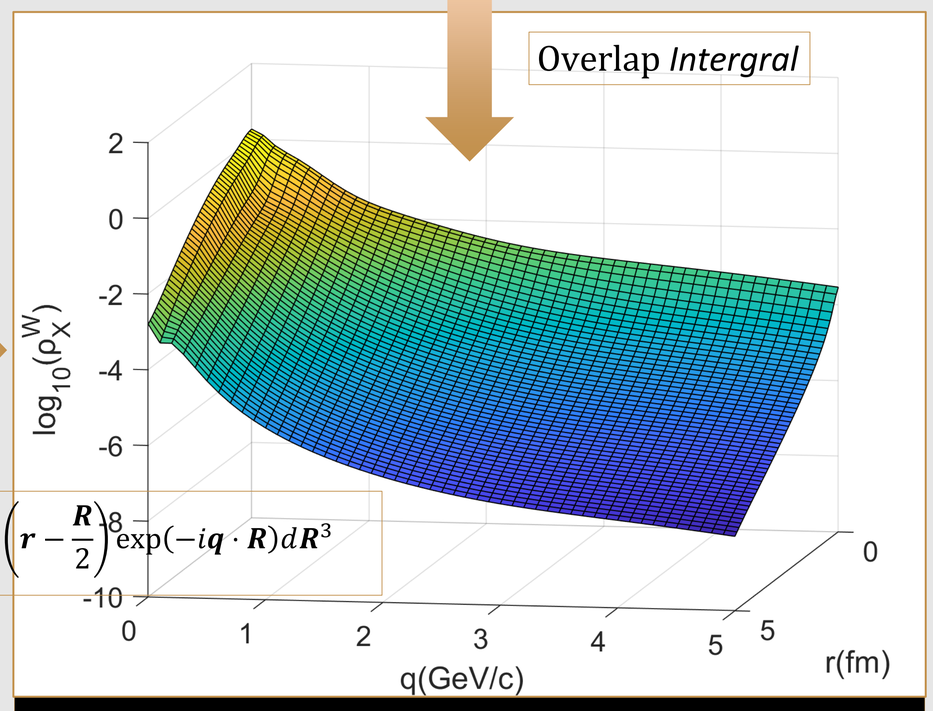
*Phase distribution of **D** mesons*

Coalescence Model Wigner Approach



Hulthen wave functions of $X(3872)$

$$\rho_C^{\text{Wigner}}(\boldsymbol{r},\boldsymbol{q}) = \int \phi\left(\boldsymbol{r}+\frac{\boldsymbol{R}}{2}\right)\phi\left(\boldsymbol{r}-\frac{\boldsymbol{R}}{2}\right)\exp(-i\boldsymbol{q}\cdot\boldsymbol{R})d\boldsymbol{R}^3$$



Wigner functions of $X(3872)$ as a molecule

Conclusion

- ✓ The PACIAE Model (after hadron rescattering) can **reproduce the experimental data well**
- ✓ The average relative momentum between D and $\bar{D}^*$ is **large**, due to their **back-to-back** motion
- ✓ The yield of $X(3872)$ as hadronic molecules is of the order of $10^{-6}\sim10^{-7}$, consistent with experimental non-observation of direct production

Results

$$N_h^{\text{coal}} = g\int\prod_{i=1}^{n}\frac{d\boldsymbol{x}_n d\boldsymbol{p}_n}{(2\pi)^3} f(\boldsymbol{x}_1,\boldsymbol{p}_1,\cdots,\boldsymbol{x}_n,\boldsymbol{p}_n)\rho_C^W(\boldsymbol{r}_1,\boldsymbol{q}_1,\cdots,\boldsymbol{r}_{n-1},\boldsymbol{q}_{n-1})$$

Channel	$D^+ + D^{*-} \to X(3872)$
Yield	2.29E-06
Channel	$D^0 + \bar{D}^{*0} \to X(3872)$
Yield	7.53E-07