Report on PhD Application

Applicant： Dongsheng Li (SA22004019)

Discipline：Particle and Nuclear Physics

Supervisor：Prof. Yifei Zhang

Contents

Academic Performance

李东升 ♂

学号： SA22004019　　年级： 2022级　　培养层次： 硕士研究生

学生类别： 学术硕士　　院系： 近代物理系　　专业： 070200 物理学

导师姓名： 张一飞　　预计毕业时间： 2025-08-30　　在校标识： 在校

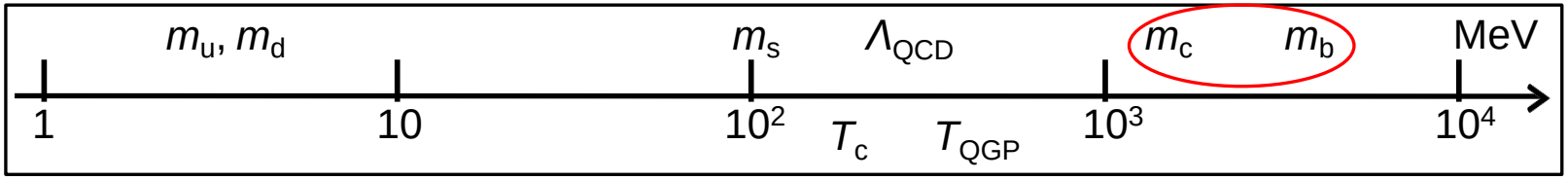
学籍状态： 正常　　入学年月： 2022-09-01　　注册状态： 已注册

培养计划校验

计算时间：2024-04-21 22:30:00

您适用的培养计划标准		2022年级070200物理学硕士	校验结果:尚未合格
培养计划校验详情		未完成必修环节：学位论文开题报告(2学分) 您的成绩课程类别有空值，对校验结果有影响，请联系教学秘书修改	
培养计划备注		老系统迁移	
培养计划要求		**已经获得学分**	**是否合格**
总学分(带必修环节)>=35		总学分=35	合格
基础课【加权平均】>=75		基础课【加权平均】=84	合格
公共课程学分>=7（<=7）		公共课程学分=7	合格
其他课程学分>=0		其他课程学分=3	合格
课程类别合并组学分>=16	专业基础课学分>=0	专业基础课学分=12 合格	合格
	学科基础课学分>=8	学科基础课学分=16 合格	
学位论文开题报告(2学分)			尚未合格

Research A：b quark at LHC

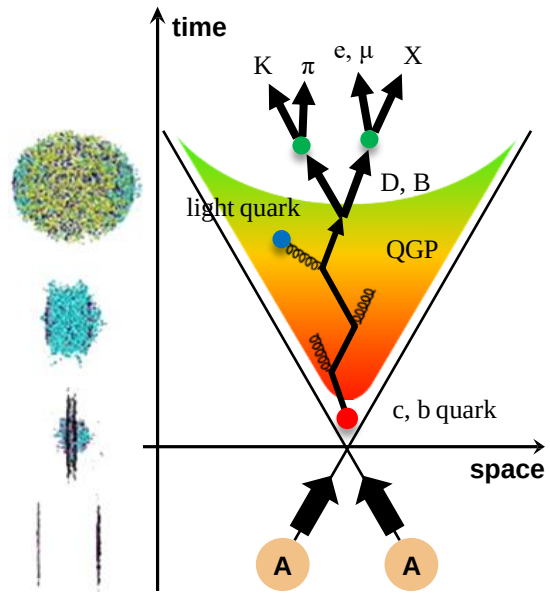


- **Relativistic heavy-ion collision**
  - Au+Au / Pb+Pb at $\sqrt{s_{NN}} \sim$ GeV/TeV
  - A little bang
    - Extremely hot and dense
    - Formation of quark-gluon-plasma (QGP)

- **Heavy flavor quark**
  - Produced via hard scattering at early stage
  - Sensitive probe to QGP properties

- **b quark**
  - Small production cross section and hadronic decay B.R.
  - A data driven method to study the b decay electrons
    - $(b \to e) = (c, b \to e) - (c \to e)$

from data — open charm and J/psi from data + decay simulation

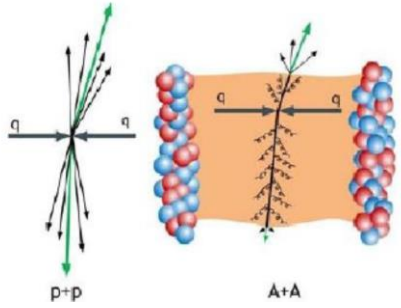


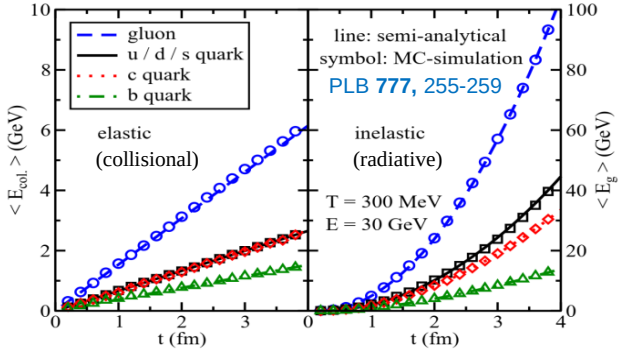
$B^0 \to D^- + \pi^+$, B. R. ~0.1%

$B^0 \to e^+ + \nu_e + X$, B. R. ~10%

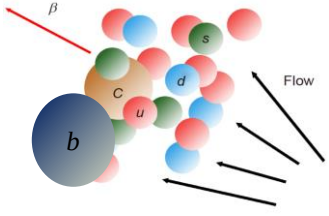
Research A：b quark at LHC

- **Experimental observables**
  - Nuclear modification factor R_{AA}
    - $R_{\mathrm{AA}}(p_{\mathrm{T}}) = \frac{1}{\langle N_{\mathrm{bin}} \rangle} \frac{dN_{\mathrm{AA}}/dp_{\mathrm{T}}}{dN_{\mathrm{pp}}/dp_{\mathrm{T}}}$
    - A normalized relative yield between AA collision (w/ QGP) and the pp reference (w/o QGP)
    - Driven by energy loss in medium
    - Expectation: the higher quark mass, the smaller energy loss





  - Elliptic flow v_2
    - Describing the anisotropic momentum distribution
    - Probing the hydrodynamic properties of the medium



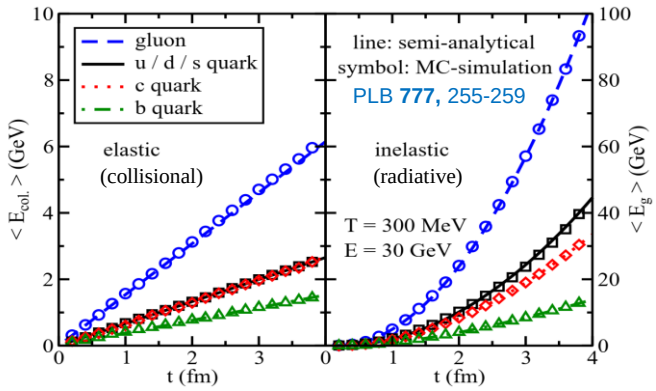
Brownian motion

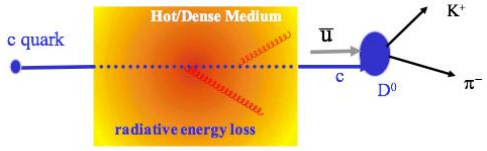
$$\frac{\partial \rho}{\partial t} \sim D \frac{\partial^2 \rho}{\partial x^2}$$

D – Diffusion coefficient

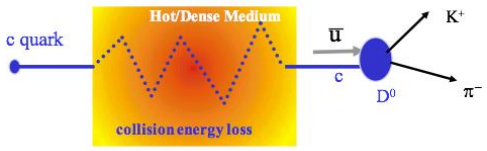
Research A：b quark at LHC

- **Results**
  - Nuclear modification factor R_{AA}
    - Energy loss in medium: b quark < c quark
    - Consistent with mass-dependent energy loss scenario

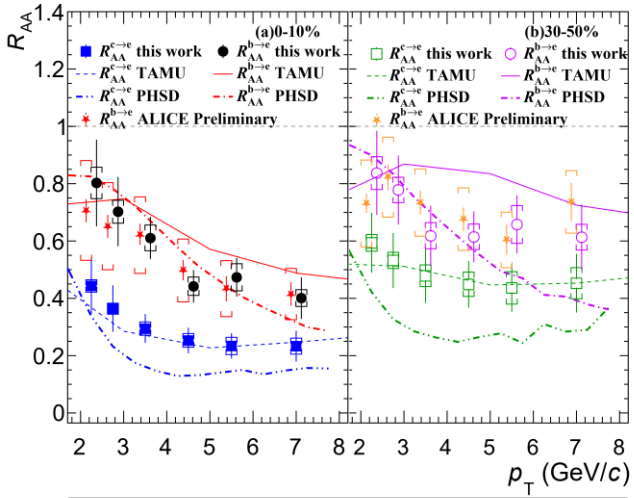


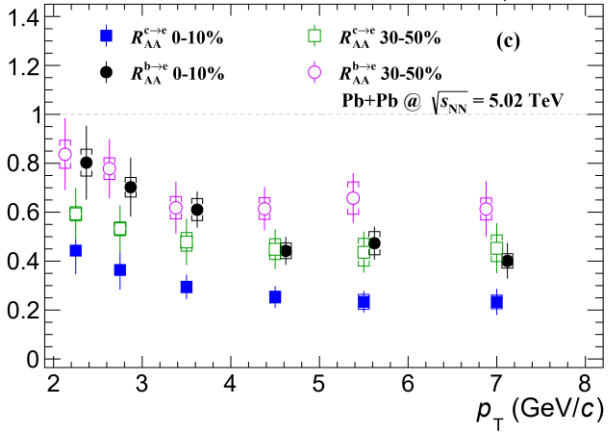


(Baier *et al*, Kharzeev *et al*, Djordjevic *et al*, Wiedemann *et al*.)



(Teaney *et al*, Rapp *et al*, Molnar *et al*, Gossiaux *et al*.)





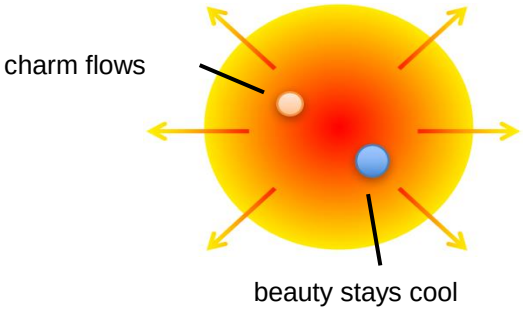
Physics Letters B 832, 137249 (2022)

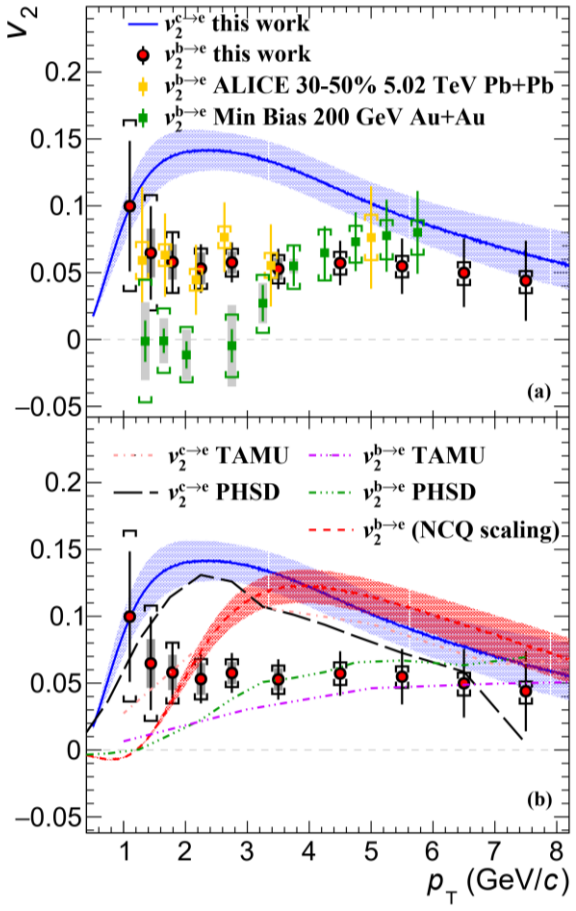
Dongsheng Li, Fan Si (First Co-author) *et al.*, "Charm and beauty isolation from heavy flavor decay electrons in p+p and Pb+Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV at LHC"

Research A：b quark at LHC

- **Results**
  - Elliptic flow v_2
    - Strong deviation (4.5σ) from the Number-of-Consitituent-Quark scaling hypothesis at p_{T} = 3-7 GeV/c
    - b quark is not thermalized in HIC at LHC energy

      (in contrast to c quark, already thermalized at RHIC energy)





Physics Letters B 832, 137249 (2022)

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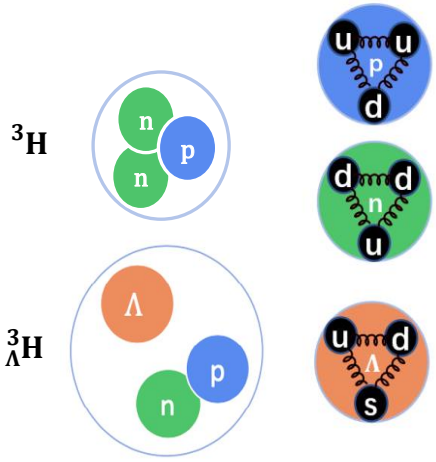
Research B：Hypernuclei at STAR

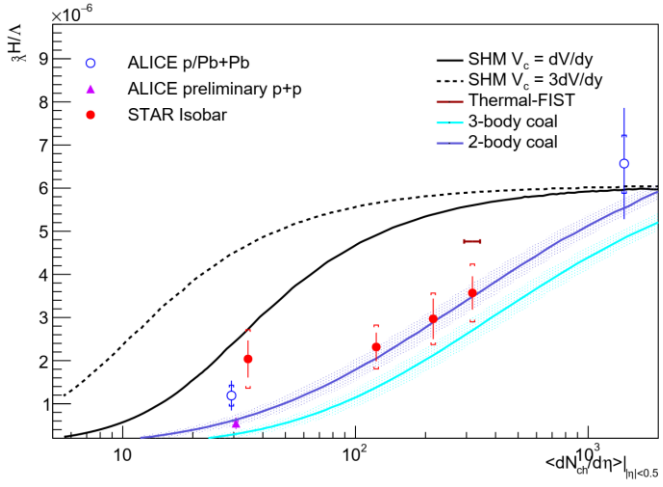
- **Hypernuclei production mechanism in HIC**
  - Nucleon coalescence model v.s. Thermal model
  - Both qualitatively describe hypernuclei yields in HIC



- A Powerful tool to distinguish between two models:

Multiplicity dependence of yield ratios

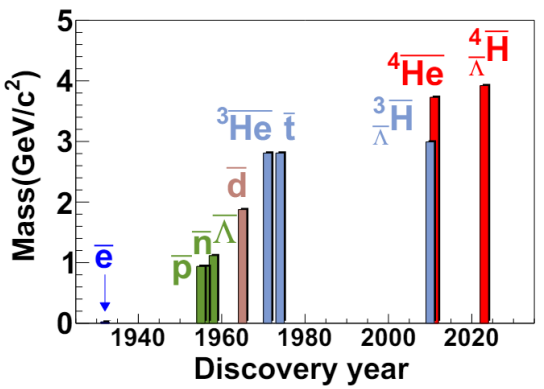
$^3_\Lambda\mathrm{H}/\Lambda$ $\quad S_3 = \dfrac{^3_\Lambda\mathrm{H}/^3\mathrm{He}}{\Lambda/p}$



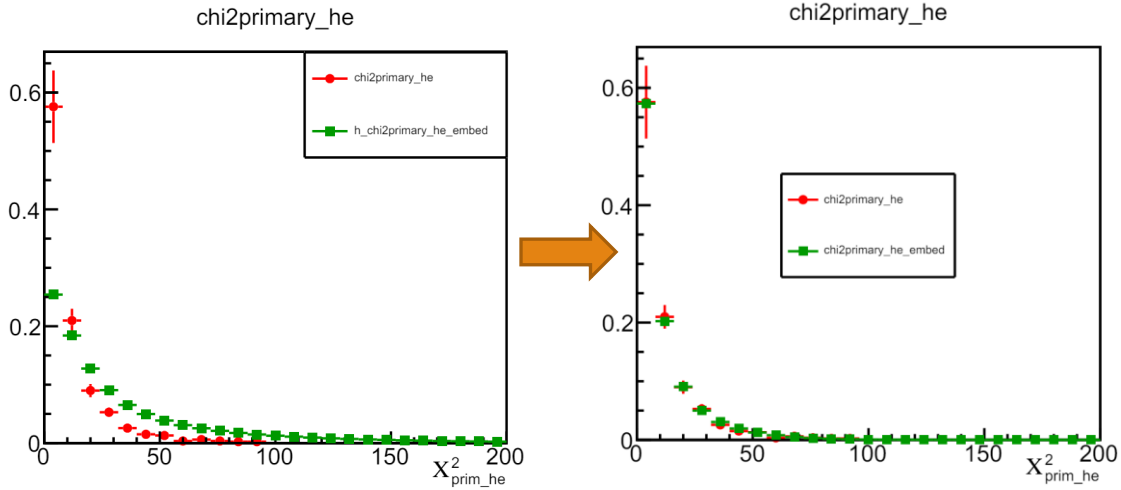
- $^3_\Lambda$H and hyperon(Λ,Ξ) yield measurement in Ru+Ru/Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR
- Complementary to the ALICE measurements
- Consistent with the 2-body coalescence prediction
- The results will be shown at SQM2024 (accepted as a talk)

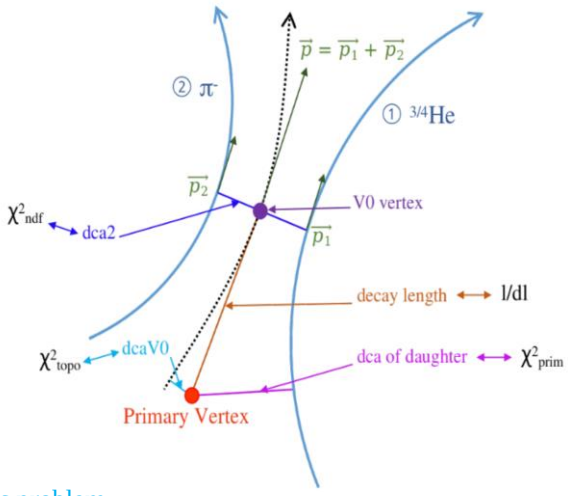
Research B：Hypernuclei at STAR

- **Observation of the Antimatter Hypernucleus $^{4}_{\Lambda}\overline{\mathrm{H}}$**
- Measurement on yield, lifetime, etc…
- Main work done by the group at IMP, CAS
- I found and solved a problem in their MC sample
  - The Data-MC discrepancies used to be ignored
  - Lead to 10-20% efficiency difference



arXiv:2310.12674
(STAR Collaboration) Observation of the Antimatter Hypernucleus $^{4}_{\Lambda}\overline{\mathrm{H}}$





The vertex resolution was not set in the MC sample
The Kalman filter algorithm is applied in the calculation. Many topological variables were affected by this problem
I reported the problem before the release of this paper

Summary

- Academic Performance
  - Qualified for application

- Scientific Research
  - Beauty decay electron at LHC (published)
  - Hypernuclei measurement at STAR
    - Production mechanism (preliminary)
    - Observation of novel anti-matter hypernucleus (under journal review)

Publication	First Co-author	Physics Letters B 832, 137249 (2022)
	Principal Author	arXiv:2310.12674
Conference	Online	the 7th China LHC Physics (CLHCP 2021), Nov. 25-28, 2021
		STAR Collaboration Meeting, Feb. 27 - Mar. 3, 2023

Thank you!