

Report on Summer Activities and Plans for the Fall Semester

Chueng-Ryong Ji
North Carolina State University

Group Meeting, August 22, 2025

Outline

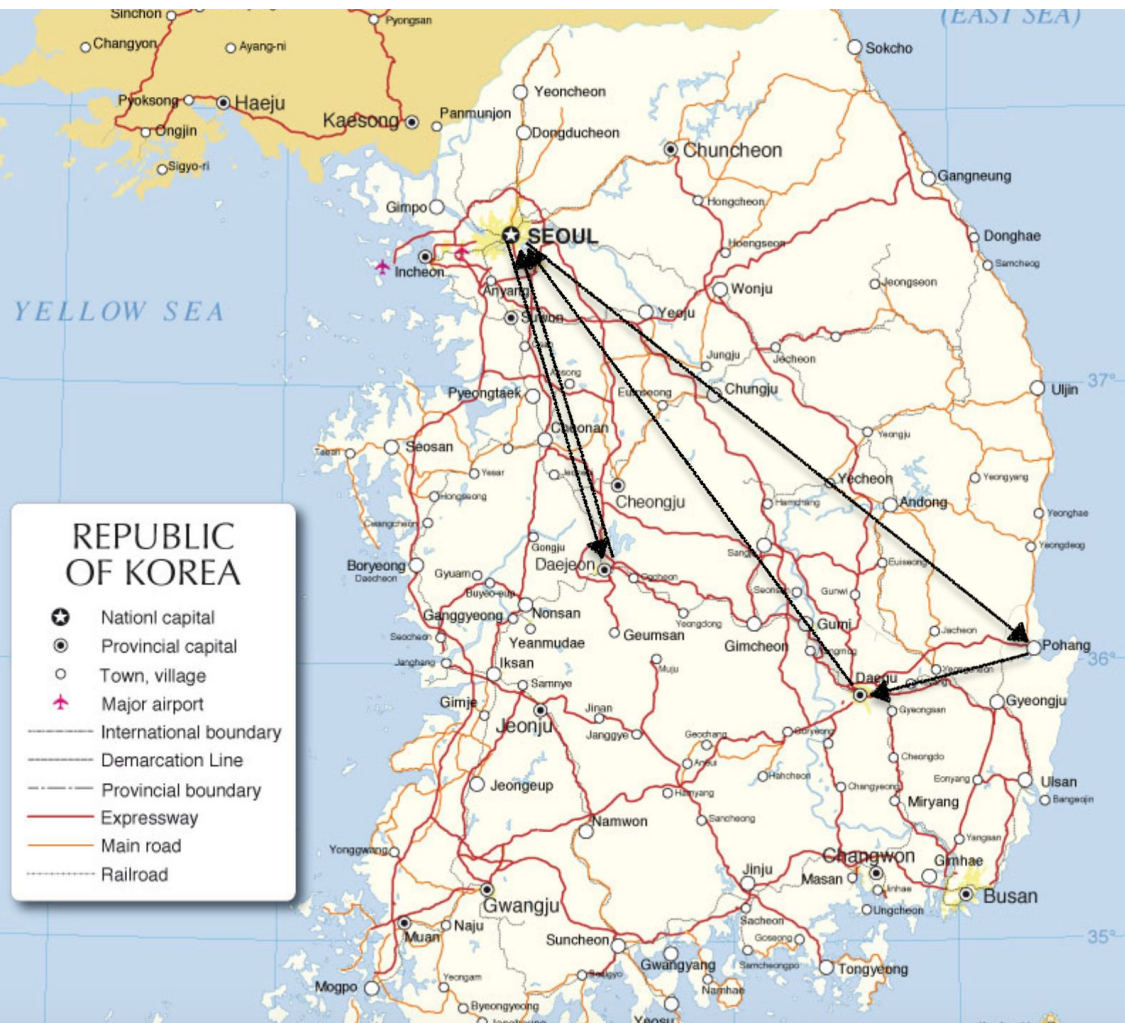
- Summer Activities for May 15 - August 15
- What did I learn from these activities?
- What do we need to work on?
- Plans for the Fall Semester

What happened during Summer

- Group meetings continued:

May 16	- C. Ji
June 6	- P. Barry
June 20	- N. Kumar
July 4	- Z. Li (4pm ET)
July 18	- S. Puhan
August 1	- B. Bakker

- Visit to Korea for May 21 - July 14
- UKC2025 at Atlanta, August 6-10
- Visit to Stony Brook, August 12-15



- May 25 - 30
INPC2025
- June 1 - 21
APCTP
- June 23 - July 4
KNU
- July 8 - 10
KOFST

The 29th International Nuclear Physics Conference

 **INPC 2025**

May 25-30, 2025
DCC, Daejeon, Korea



inpc2025.org

IBS Institute for Basic Science

한국과학기술연구원 CENS

CENTER FOR UNDERGROUND PHYSICS

CERN

NUPEP

ANPhA

DAEJEON

KPS

IRIS

중이온가속기연구소
Heavy Ion Research Institute

KoALICE

OMEG

RAON

RAON USERS ASSOCIATION

한국관광공사
Korea Science Foundation

DAEJEON
대전관광공사
Daejeon Science Foundation

- Nuclear Structure
- Nuclear Reactions
- Hot and Dense Nuclear Matter
- Fundamental Symmetries and Interactions in Nuclei
- Hadron Structure and Reactions
- Nuclear Astrophysics
- Neutrinos and Nuclei
- Hadrons in Nuclei
- Applications Based on Nuclear Physics
- New Facilities and Instrumentation
- Quantum Computing and Artificial Intelligence in Nuclear Physics
- Outreach and Science Education

The program will include oral and poster presentations of contributed papers.



Daejeon Convention Center 1

List of Plenary Speakers



INPC 2025 is proud to feature a diverse range of renowned Plenary Speakers

Abhay Deshpande (BNL)
 Alejandro Garcia (University of Washington)
 Andrea Jungclaus (CSIC Madrid)
 Bing Guo (CIAE)
 Bradley Sherrill (FRIB, MSU)
 Chihiro Sasaski (University of Wroclaw)
 Chueng-Ryong Ji (NC State University)
 Dean Lee (FRIB, MSU)
 Deuksoon Ahn (CENS, IBS)
 Hirokazu Tamura (Tohoku University)
 Hiroyoshi Sakurai (RIKEN)
 Hiroyuki Sagawa (RIKEN)
 Hyeyoung Lee (Los Alamos National Laboratory)
 Hyunchul Kim (Inha University)
 John Behr (TRIUMF)
 Kouichi Hagino (Kyoto University)
 Kouji Morimoto (RIKEN)
 Marc Vanderhaeghen (Johannes Gutenberg University Mainz)
 Maria Lugaro (Konkoly Observatory)
 Nu Xu (LBNL)
 Ren Cooper (LBNL)
 Saori Pastore (Washington University)
 Sherry Yennello (Texas A&M University)
 Su Hounng Lee (Yonsei University)
 Thomas Glasmacher (FRIB, MSU)
 Ulli Köster (ILL - Grenoble)
 Vadim Kolesnikov (CERN)
 Vandana Nanal (TIFR)
 Weiping Liu (Southern University of Sci. and Tech.)
 Wenlong Zhan (HIAF, IMP)
 Xiangdong Ji (Shanghai Jiaotong University)
 Yeongduk Kim (CUP, IBS)

	May 25, 2025 (Sun)	May 26, 2025 (Mon)	May 27, 2025 (Tue)	May 28, 2025 (Wed)	May 29, 2025 (Thu)	May 30, 2025 (Fri)
08:30 - 09:00						
09:00 - 09:30		Opening & Keynote	Parallel 3	Plenary 4	Plenary 6	Parallel 7
09:30 - 10:00						
10:00 - 10:30						
10:30 - 11:00		Break				
11:00 - 11:30						
11:30 - 12:00		Plenary 1	Parallel 4	Plenary 5	Parallel 5	Parallel 8
12:00 - 12:30						
12:30 - 13:00						
13:00 - 13:30		Lunch (Lunch box from LOC)	Lunch (Lunch box from LOC)	Lunch	Lunch	Lunch (Lunch box from LOC)
13:30 - 14:00						
14:00 - 14:30						
14:30 - 15:00		Parallel 1	Plenary 2		Plenary 7	IUPAP Award
15:00 - 15:30						
15:30 - 16:00						
16:00 - 16:30		Break			Break	Plenary 8
16:30 - 17:00						
17:00 - 17:30	Registration	Parallel 2	Plenary 3	Excursion	Parallel 6	Closing
17:30 - 18:00						
18:00 - 18:30						
18:30 - 19:00					Break	Public Lecture
19:00 - 19:30	Welcome Reception		Poster			
19:30 - 20:00						
20:00 - 20:30					Banquet	
20:30 - 21:00						
21:00 - 21:30						
21:30 - 22:00						



QCD Link to the Light-Front Quark Model

Chueng-Ryong Ji
North Carolina State University



INPC 2025

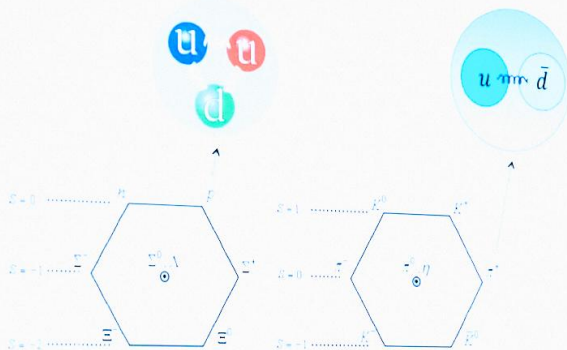
May 28, Daejeon, Korea

The 29th International Nuclear Physics Conference

 **INPC 2025**
May 25-30, 2025
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INPC 2025
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How do we understand the Quark Model in Quantum Chromodynamics?



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Large N_c QCD in 1+1 dim. ('tHooft Model)

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu}^a F^{\mu\nu a} + \bar{\psi}(i\gamma^\mu D_\mu - m)\psi$$

$$D_\mu = \partial_\mu - ig A_\mu^a t_a$$

$$F_{\mu\nu}^a = \partial_\mu A_\nu^a - \partial_\nu A_\mu^a + gf^{abc} A_\mu^b A_\nu^c$$

'tHooft Coupling $\lambda = \frac{g^2 (N_c - 1/N_c)}{4\pi}$ and mass m

$$g \rightarrow 0, N_c \rightarrow \infty; \lambda \rightarrow \text{finite}$$

The 29th International Nuclear Physics Conference

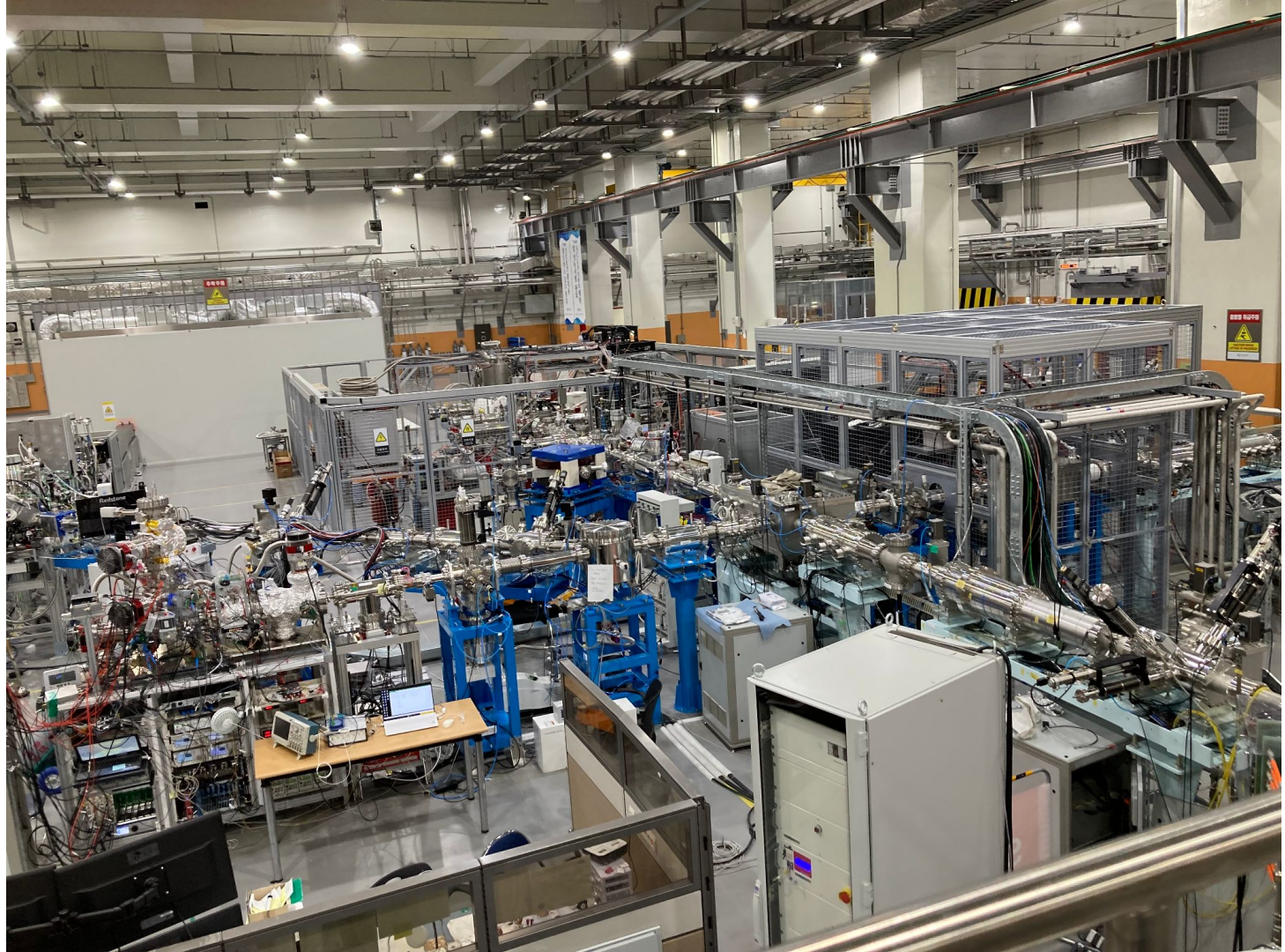
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May 25-30, 2025
DCC, Daejeon, Korea













APCTP SEMINAR

Interpolating Scattering Amplitudes between Instant and Light-Front Dynamics

Prof. Chueng-Ryong Ji

*Department of Physics
North Carolina State University*

**June 9th (Mon.) 16:00
#512, APCTP**

Relativistic quantum invariance plays prominent roles in the study of quantum field theories, typically QED and QCD. We utilize the idea of interpolating the instant form dynamics (IFD) and the light-front dynamics (LFD) to realize the relativistic quantum invariance of QED and QCD. Reviewing the connection between LFD and IFD using the idea of interpolating the two different forms of the relativistic dynamics, one can learn the distinguished features of each form and how one may utilize those distinguished features in solving the complicate relativistic quantum field theoretic problems more effectively. This presentation aims at presenting the basic first-hand knowledge of connecting the IFD and the LFD using the idea of the interpolation, and demonstrating explicit examples of its utility in QED and QCD.

■ Contact Information

- Host: Heribertus Bayu Hartanto (hayu.hartanto@apctp.org)
- Office: Research Support Team (rs@apctp.org)

The APCTP is supported by the Korean Government through the Science and Technology Promotion Fund and Lottery Fund and strives to maximize public value through its various activities.

아시아태평양이론물리센터는 정부의 과학기술진흥기금 및 복권기금 지원으로 공익적 가치 제고에 힘쓰고 있습니다.

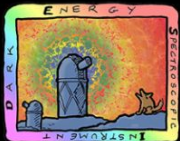


2025 APCTP-IBS Focused Research Program: The origin and evolution of the Universe

June 15(Sun.) - 21(Sat.), 2025 | APCTP, Pohang, Korea | [apctp](#) [IBS Institute for Basic Science](#)

The APCTP is supported by the Korean Government through the Science and Technology Promotion Fund and Lottery Fund and strives to maximize public value through its various activities.
기초과학연구원(기초과학진흥법)은 정부의 과학기술진흥기금 및 복원기금 지원으로 공익적 가치 제고에 힘쓰고 있습니다.





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/ EDUCATION & OUTREACH /

The Dark Energy Spectroscopic Instrument (DESI)

The Dark Energy Spectroscopic Instrument (DESI) will measure the effect of dark energy on the expansion of the universe. It will obtain optical spectra for tens of millions of galaxies and quasars, constructing a 3D map spanning the nearby universe to 11 billion light years.

The DESI Survey is being

Latest News from DESI

New results from the first 3 years of DESI data strengthen hints that dark energy is evolving, with consequences for our understanding of nature and the fate of the Universe. Read more in the [March 2025 BerkeleyLab Press Release](#). Videos discussing the results are available at the [DESI YouTube channel](#). Further details are available in our [guide to the publications](#) reporting these results. The papers themselves are available

DESI Science

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Talking:



Proton and Pion Puzzle in QCD

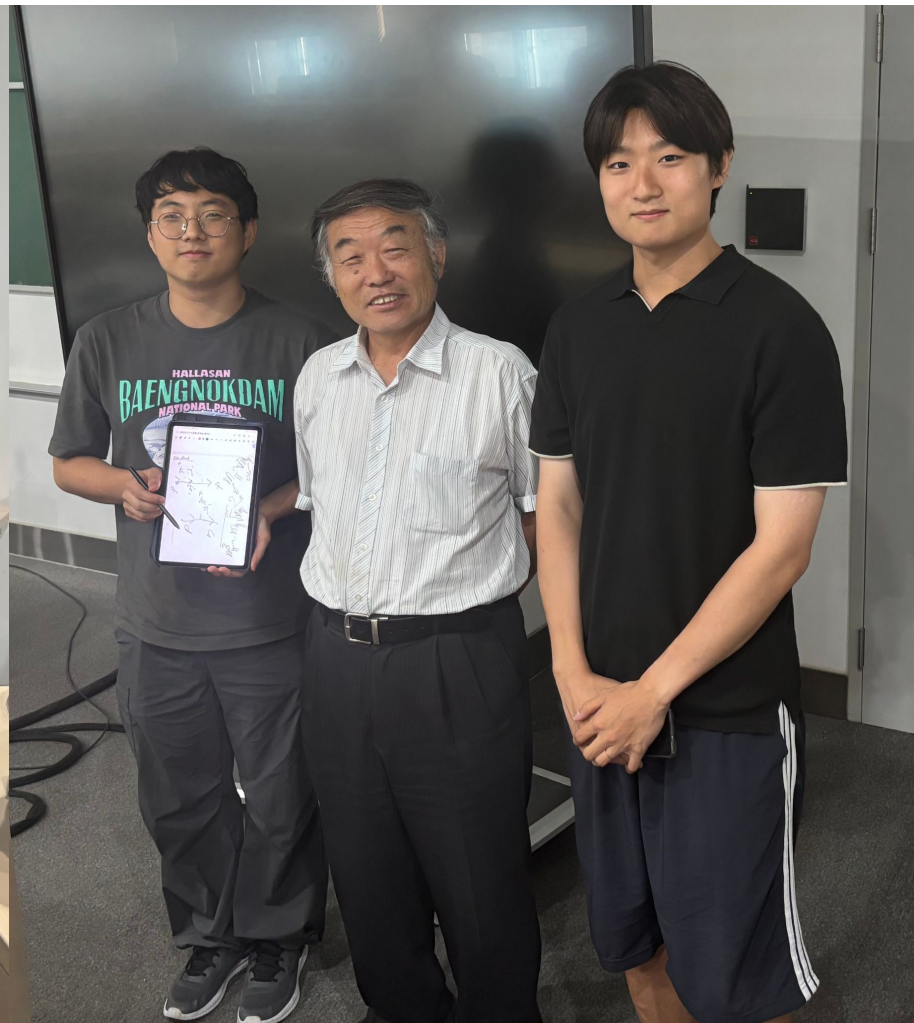
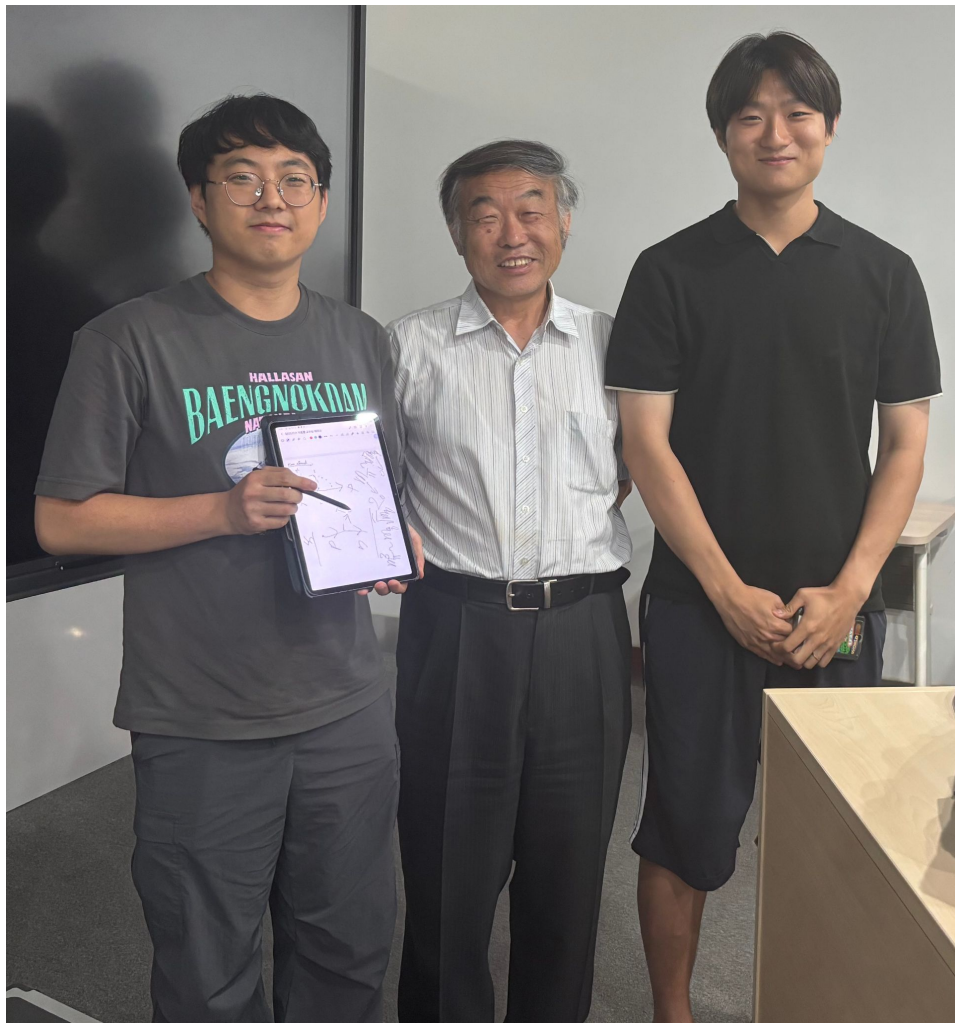
Chueng-Ryong Ji

North Carolina State University

July 1, 2025





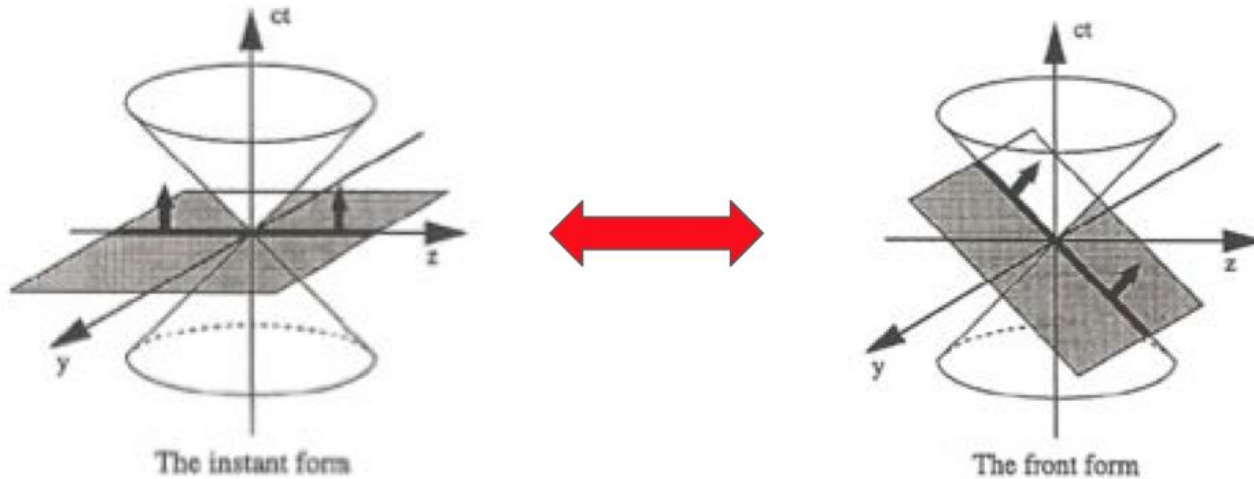




Interpolating instant and light-front dynamics

Chueng-Ryong Ji

North Carolina State University



**Center for Theoretical Physics of the Universe
Institute for Basic Science**

July 3, 2025



제3회 세계한인 과학기술인대회

The 3rd World Congress of Korean Scientists & Engineers

2025년 7월 8일(화) ~ 10일(목) | 한국과학기술회관

하나된 과학기술인,
함께 만드는 미래 대한민국



과학기술정보통신부

주관

KOFST
한국과학기술단체총연합회

19개 재외한인과학기술자협회





광복 80주년 기념
독립운동가 후손
과학기술인과의 만남



주최 과학기술정보통신부 주관 **KC ST** 한국과학기술인추진위원회 19개 재외한인과학기술자협회



2025 세계 한
과학기술인
2025 World Korean Scientists

2025 세계 한인 과학기술인대회
2025 World Congress of Korean Scientists & Engineers

만족도 QR코드

2025
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과학기술인대회

주최 과학기술정보통신부

주관 KCEST
한국과학기술인재연구원
19개 재외한인과학기술자협회



Interpolation of Instant Form Dynamics and Light-Front Dynamics

Chueng-Ryong Ji

North Carolina State University



August 8, 2025



QCD, 'tHooft Model and the Light-Front Quark Model

Chuang-Ryong Ji
North Carolina State University



Stony Brook
August 13, 2025

AI overviews of QCD

Quantum Chromodynamics (QCD) is interesting because it describes the strong nuclear force, one of the fundamental forces of nature and explains how quarks and gluons interact to form hadrons like protons and neutrons. Its study reveals the inner workings of matter and the forces that govern the universe at its most basic level.

Key Words:

Strong Interaction, Quarks and gluons, Color Confinement, Asymptotic Freedom, Analog to Quantum Electrodynamics, Chiral symmetry breaking, Quark-gluon plasma, ...

Some studies have linked confinement and chiral symmetry breaking to QCD monopoles which are topological objects that can emerge in certain gauge conditions. These monopoles may play a role in both confinement and chiral symmetry breaking.

In Quantum Chromodynamics (QCD), the theory describing the strong force, magnetic monopoles are theorized to play a role, particularly in the context of quark-gluon plasma and confinement. While not directly observed as fundamental particles, QCD monopoles are often treated as quasiparticles or emergent phenomena within the theory, especially in extreme conditions like high temperatures. ↗

In summary: While magnetic monopoles are not fundamental particles in QCD, they are proposed as quasiparticles or emergent phenomena that play a significant role in phenomena like quark confinement, quark-gluon plasma properties, and jet quenching in heavy-ion collisions. [Research from Stony Brook University shows](#) that studies of monopoles in lattice QCD and heavy-ion experiments have provided insights into their behavior and influence on QCD. ↗

Recent Progress in Understanding the Role of Monopoles in QCD

A Dissertation presented

by

Adith Ramamurti

Edward Shuryak - Dissertation Advisor

Distinguished Professor, Department of Physics & Astronomy

Derek Teaney - Chairperson of Defense

Associate Professor, Department of Physics & Astronomy

Matthew Dawber

Associate Professor, Department of Physics & Astronomy

Jinfeng Liao

Associate Professor, Department of Physics, Indiana University

December 2018

Hadronic structure on the light-front I

Instanton effects and quark-antiquark effective potentials

Edward Shuryak^{*} and Ismail Zahed[†]

*Center for Nuclear Theory, Department of Physics and Astronomy,
Stony Brook University, Stony Brook, New York 11794-3800, USA*

Phys.Rev.D 107 (2023) 3, 034023 • e-Print: [2110.15927](https://arxiv.org/abs/2110.15927) [hep-ph]

.....

Hadronic structure on the light-front IX .

Orbital-spin-isospin wave functions of baryons

Nicholas Miesch,^{*} Edward Shuryak,[†] and Ismail Zahed[‡]

*Center for Nuclear Theory, Department of Physics and Astronomy,
Stony Brook University, Stony Brook, New York 11794-3800, USA*

Phys.Rev.D 108 (2023) 9, 094033 • e-Print: [2308.14694](https://arxiv.org/abs/2308.14694) [hep-ph]

.....

Conclusions and Outlook

- Link between QCD and LFQM may be feasible as exemplified by the mass gap solution in the 't Hooft model interpolation between IFD and LFD.
- LF ZMs appear essential in understanding the constituent mass in LFQM.
- BT construction provides the self-consistency of LFQM which assures the component and frame independence of the physical observables.
- Looking forward to studying monopoles in QCD with the interpolation between IFD and LFD.



2024 CFNS Summer School

The discriminant formula

$$ax^2 + bx + c = 0$$

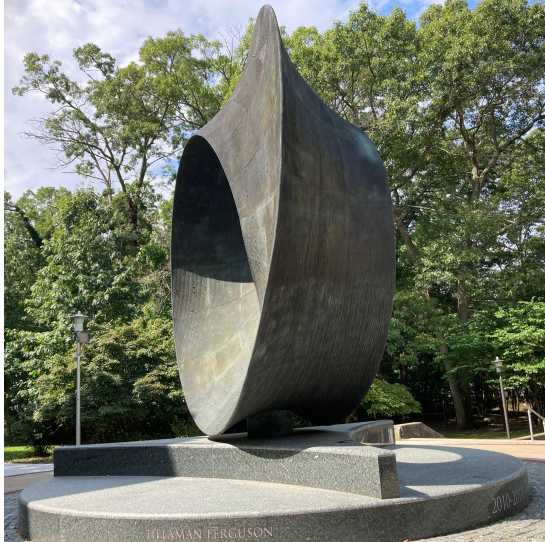
$$D = b^2 - 4ac$$

$$ax^3 + bx^2 + cx + d = 0$$

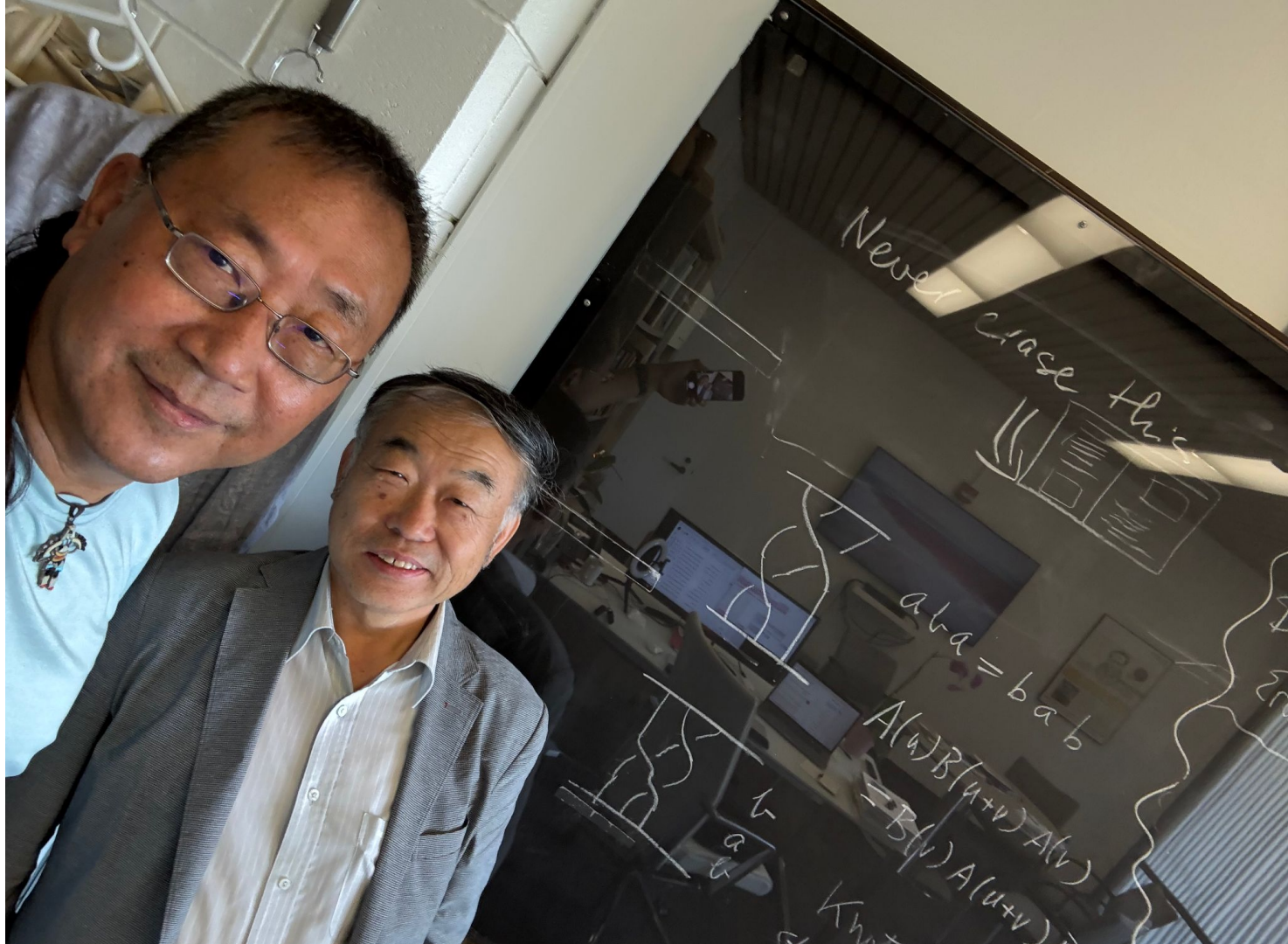
$$D = b^2c^2 - 4ac^3 - 4b^3d - 27a^2d^2 + 18abcd$$

If $D > 0$,

all the three roots are real and distinct.







What did I learn from these activities?

- **AI appears powerful tool in most areas of science.**
- **Data analyses and Impact studies are more extensively called for.**
- **LFD may fit well with the Quantum Computing with less Qubits.**
- **QCD vacuum approach and parton approach need to linked together.**
- **EIC physics intermediates between Hot and Cold QCD**
- **Timelike region of mass gap should be explored**
- **Hadron structure studies via SIDIS (TMDs,GPDs,TDAs)**
- **Theoretical Simulation vs. Experiments, Lattice, etc.**

What do we need to work on?

- **LFQM of Baryons: quark-diquark vs. 3 quarks**
- **Convolution of the nucleon-meson splitting functions in the chiral effective theory with the LFQM of mesons**
- **Theoretical simulations: CFFs, GPDs, gravitational FFs**
- **Timelike region study with transition form factor**
- **Impact studies for JLab-TDIS, EIC and Amber**
- **Lattice computation of interpolating quasi-PDFs**
- **Scaled interpolating variables and covariance**
- **Orientation entanglement in Quantum Computing**
- **Isometry of $SO(4,2)$ and conformal symmetry**
- **Energy-Momentum Tensor in LFD**

Plans for the Fall Semester

- **Electroproduction of scalar meson off scalar target in 3+1D**
- **Wigner Function in QCD**
- **Linear potential and Airy function**
- **Orientation entanglement in LFD**
- **Conformal Symmetry in 1+1D and 3+1D**
- **Axial anomaly in 1+1D vs. 3+1D**
- **Data analyses for Kaon and pion PDFs**
- **Nucleon Structures in Nonlocal chiral effective theory**

- **DOE Renewal Proposal**
- **NERSC Proposal**

Aug. 29: Kirill Semenov

Sep. 5: Jaeweon Lee

Sep. 12: Ping Wang

Sep. 19: Daniel

Sep. 26: Paul+Connor

Oct. 3: Deepasika

Oct. 10: Sangwoo Ha

Oct. 17: Hari

Oct. 24: Bailing

Oct. 31: Keanan

Nov. 21: Thomas

Nov. 28: Marston

Dec. 5: Fengchang