

Report on Summer Activities

May 27 - August 19

Chueng-Ryong Ji

North Carolina State University



Group Meeting, August 25, 2023


Outline


- Inha HTG Seminar (May 30)
- KNU Visit (June 1-30)
- KNU Theory Seminar (June 14)
- Yonseok Oh Memorial Symposium (June 21)
- KNUT Miniworkshop (June 27)
- Soongsil OMEG Seminar (July 1)
- KAST Symposium/1st World Congress (July 3-7)
- APCTP Focus Program (July 8)
- 14th APCTP-BLTP JINR Joint Workshop (July 10-15)
- Deepasika's Prelim (July 19)
- UKC2023 (August 2-6)
- Entrance Exam (August 9)
- JLab Visit (August 13-19)
- What did I learn?
- What do we need to work on?


Inha HTG Workshop: Modern issues in Hadronic Physics


• 일정 : 2022년 7월 7일(목) ~ 8일(금)

• 장소 : 인하대학교 60주년 기념관

주최 |  인하대학교 물리학과

후원 |  인하대학교

 한국연구재단

 극한핵물질연구센터



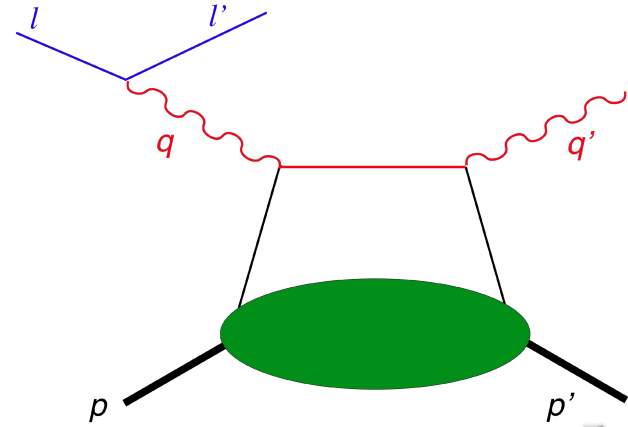
Theoretical Simulation of the Virtual Meson Production in the Forward Direction

Chueng-Ryong Ji
North Carolina State University

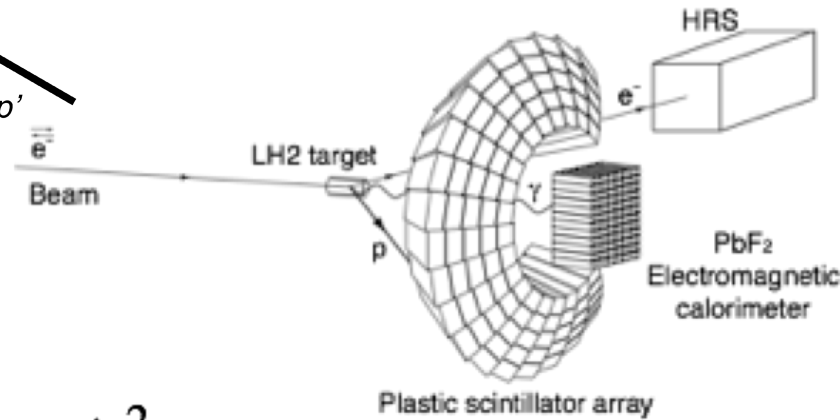


May 30, 2023

Better Work in Forward Direction



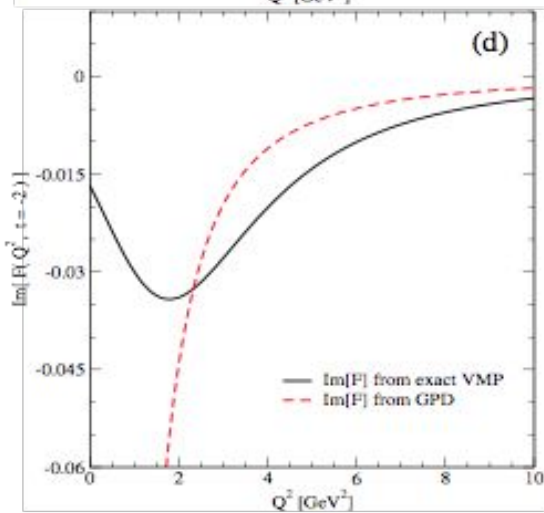
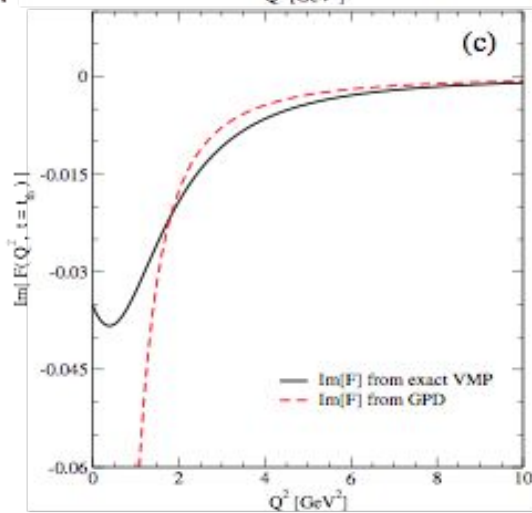
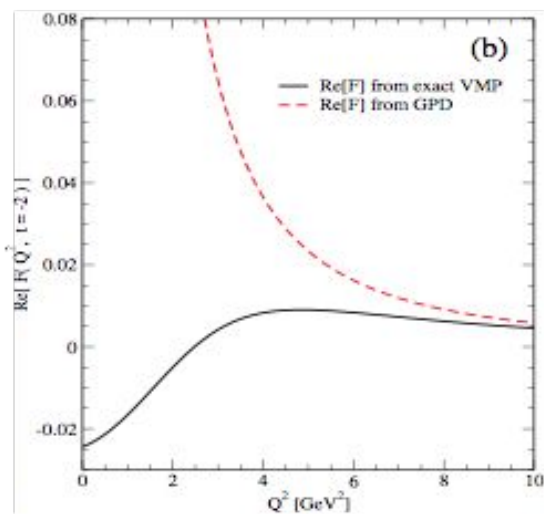
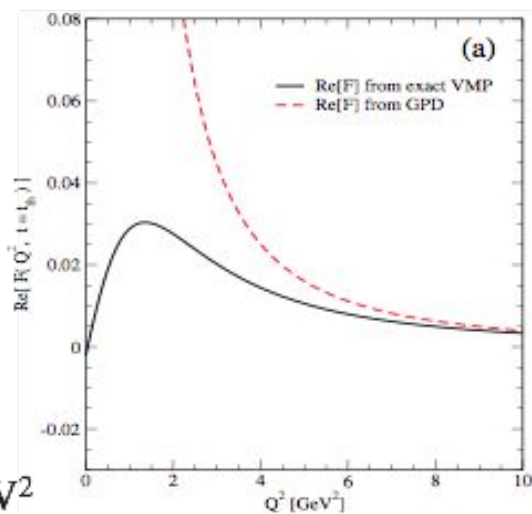
GPD



LFD



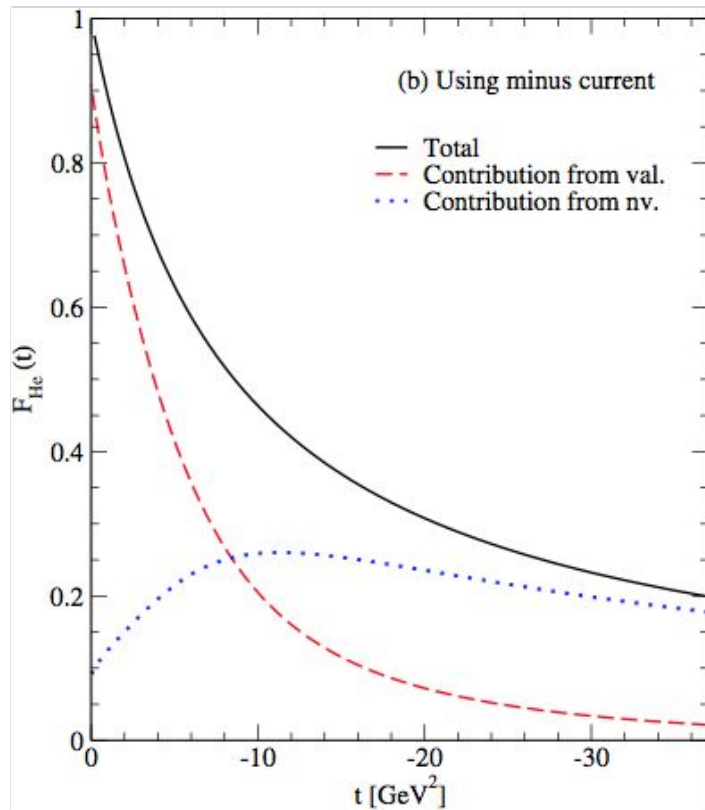
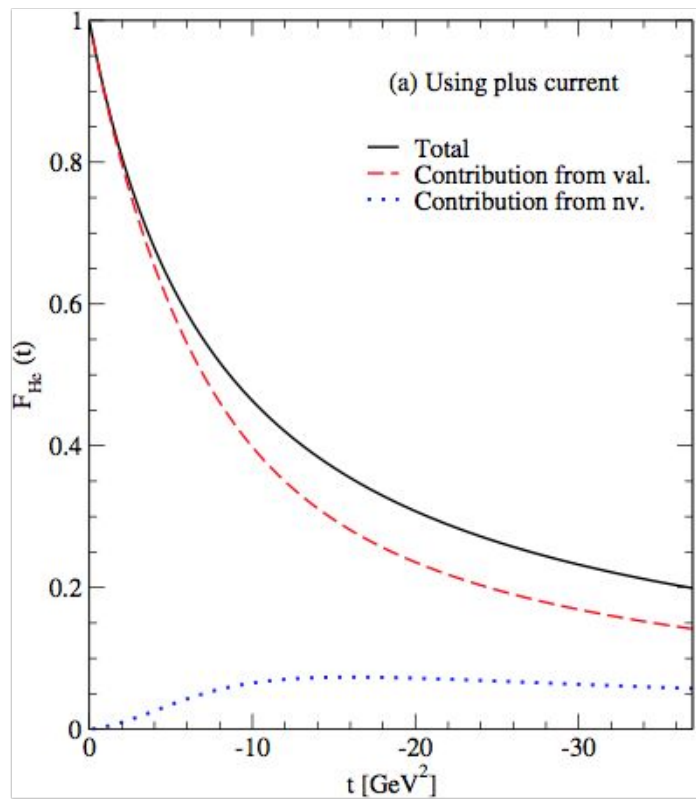
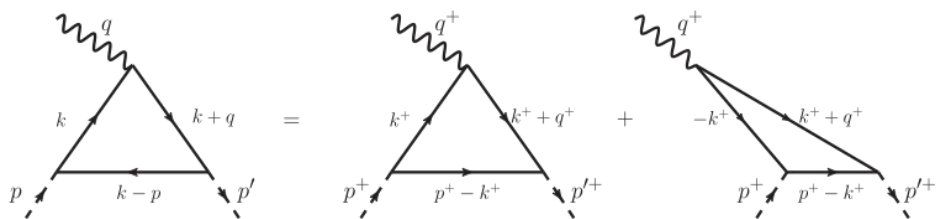
$$t = \Delta^2 = -\frac{\xi^2 M^2 + \Delta_{\perp}^2}{1 - \xi}; \Delta^+ (\equiv \Delta^0 + \Delta^3) = \xi P^+; \Delta_{\perp}^2 > \Delta_{\perp \min}^2 \neq 0$$



$$t = t_{\text{th}} \simeq -0.7593 \text{ GeV}^2$$

$$t = -2 \text{ GeV}^2$$

$$-t/Q^2 \lesssim 0.1$$

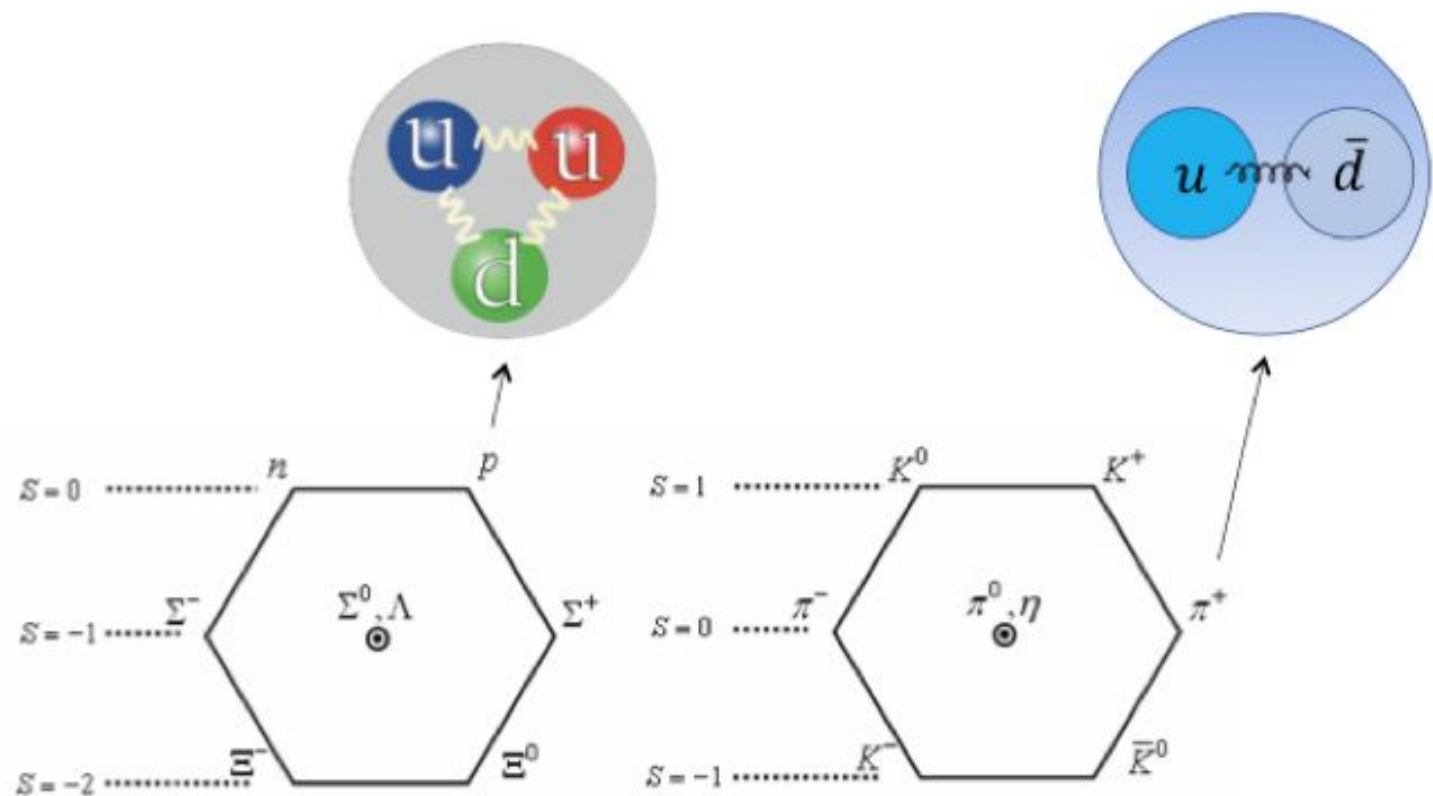


1+1 Dimensional Bridge between QCD and LFQM

**Chueng-Ryong Ji
North Carolina State University**

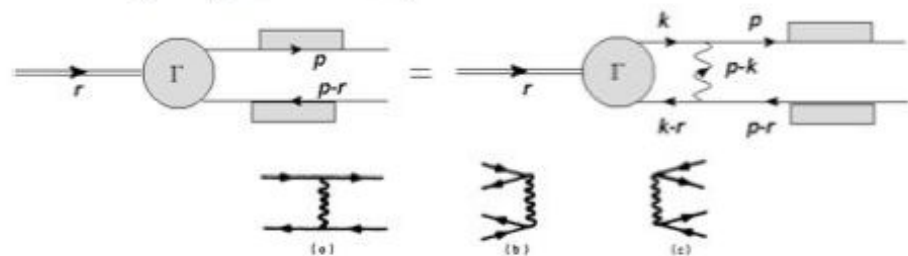
June 14, 2023, KNU

How do we understand the Quark Model in Quantum Chromodynamics?

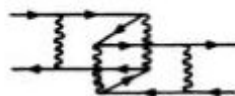


BOUND-STATE EQUATION

$$\Gamma(r, p) = \frac{i\lambda}{2\pi} \int \frac{dk_{\perp} dk_{\parallel}}{(p_{\perp} - k_{\perp})^2} S(p) \gamma^{\dagger} \Gamma(r, k) \gamma^{\dagger} S(p - r)$$



$$\begin{aligned} & \left[-r_{\parallel} + \frac{-S p_{\parallel} + E(p_{\parallel})}{C} + \frac{S(p_{\parallel} - r_{\parallel}) + E(p_{\parallel} - r_{\parallel})}{C} \right] \hat{\phi}_{+}(r_{\perp}, p_{\perp}) \\ &= \lambda \int \frac{dk_{\perp}}{(p_{\perp} - k_{\perp})^2} \left[C(p_{\perp}, k_{\perp}, r_{\perp}) \hat{\phi}_{+}(r_{\perp}, k_{\perp}) - S(p_{\perp}, k_{\perp}, r_{\perp}) \hat{\phi}_{-}(r_{\perp}, k_{\perp}) \right], \\ & \left[r_{\parallel} + \frac{-S(p_{\parallel} - r_{\parallel}) + E(p_{\parallel} - r_{\parallel})}{C} + \frac{S p_{\parallel} + E(p_{\parallel})}{C} \right] \hat{\phi}_{-}(r_{\perp}, p_{\perp}) \\ &= \lambda \int \frac{dk_{\perp}}{(p_{\perp} - k_{\perp})^2} \left[C(p_{\perp}, k_{\perp}, r_{\perp}) \hat{\phi}_{-}(r_{\perp}, k_{\perp}) - S(p_{\perp}, k_{\perp}, r_{\perp}) \hat{\phi}_{+}(r_{\perp}, k_{\perp}) \right]. \end{aligned}$$



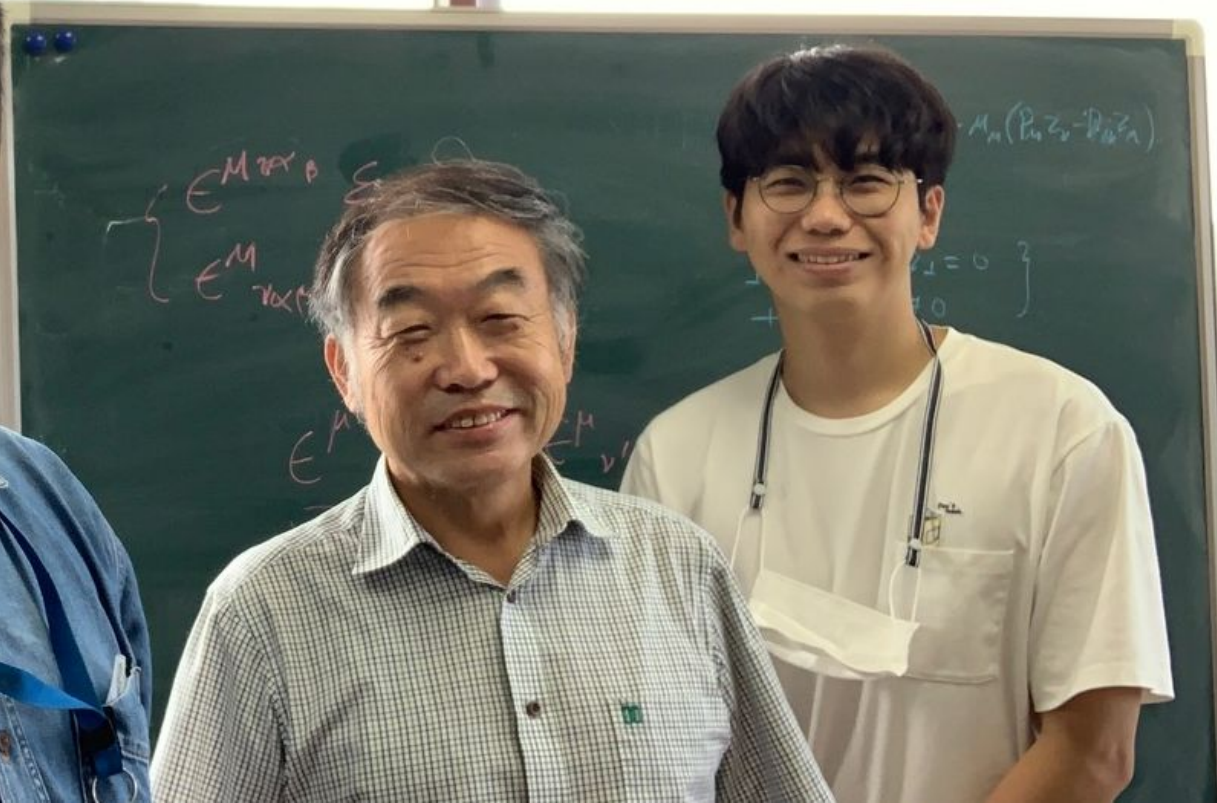
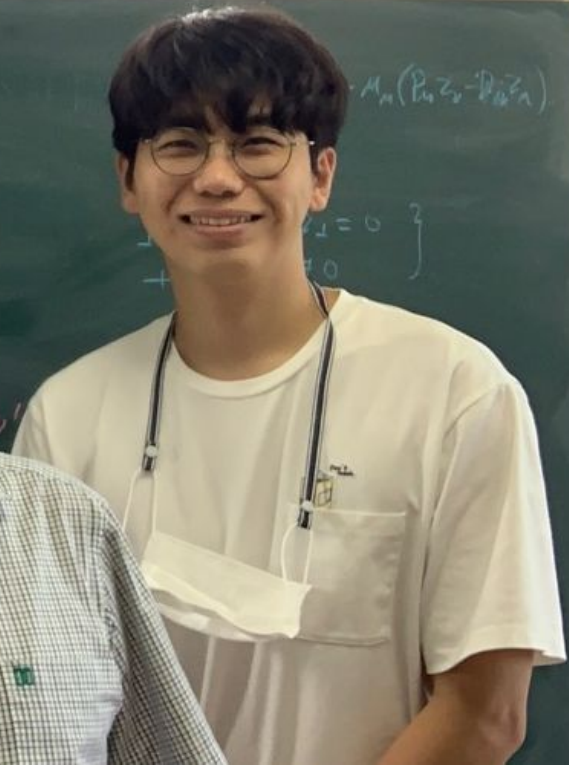
LFD

$$\left[\mathcal{M}^2 - \frac{m^2 - 2\lambda}{x} - \frac{m^2 - 2\lambda}{1-x} \right] \phi(x) = -2\lambda \int_0^1 \frac{dy}{(x-y)^2} \phi(y)$$

Hadron Physics Research Journey with the Late Professor Yongseok Oh



Chueng-Ryong Ji, North Carolina State University
Memorial Symposium & 7th CHEP Workshop
June 21, 2023





CHARLES B. WANG CENTER

Welcome to the
Electron-Ion Collider
Resource Review Board
Meeting

April 3-4, 2023



Peace be with you all...



바위 앞에 석녀가 아이를 안고 재우고 있구나

도림 법전 스님 임종계

山色水聲演實相(산색수성연실상)

曼求東西西來意(만구동서서래의)

若人問我西來意(약인문아서래의)

巖前石女抱兒眠(암전석녀포아면)

산빛과 물소리가 그대로 실상을 펼친 것인데
부질없이 사방으로 서래의를 구하려 하는구나
만약 어떤 사람이 나에게 서래의를 묻는다면
바위 앞에 석녀가 아이를 안고 재우고 있구나

Stone Woman

Light of mountain and sound of water provide the reality
as they are, (nevertheless)

People are trying to seek the truth everywhere in vain,

If someone asks me the truth, (I will answer)

Stone woman in front of the rock is holding her child to
sleep....

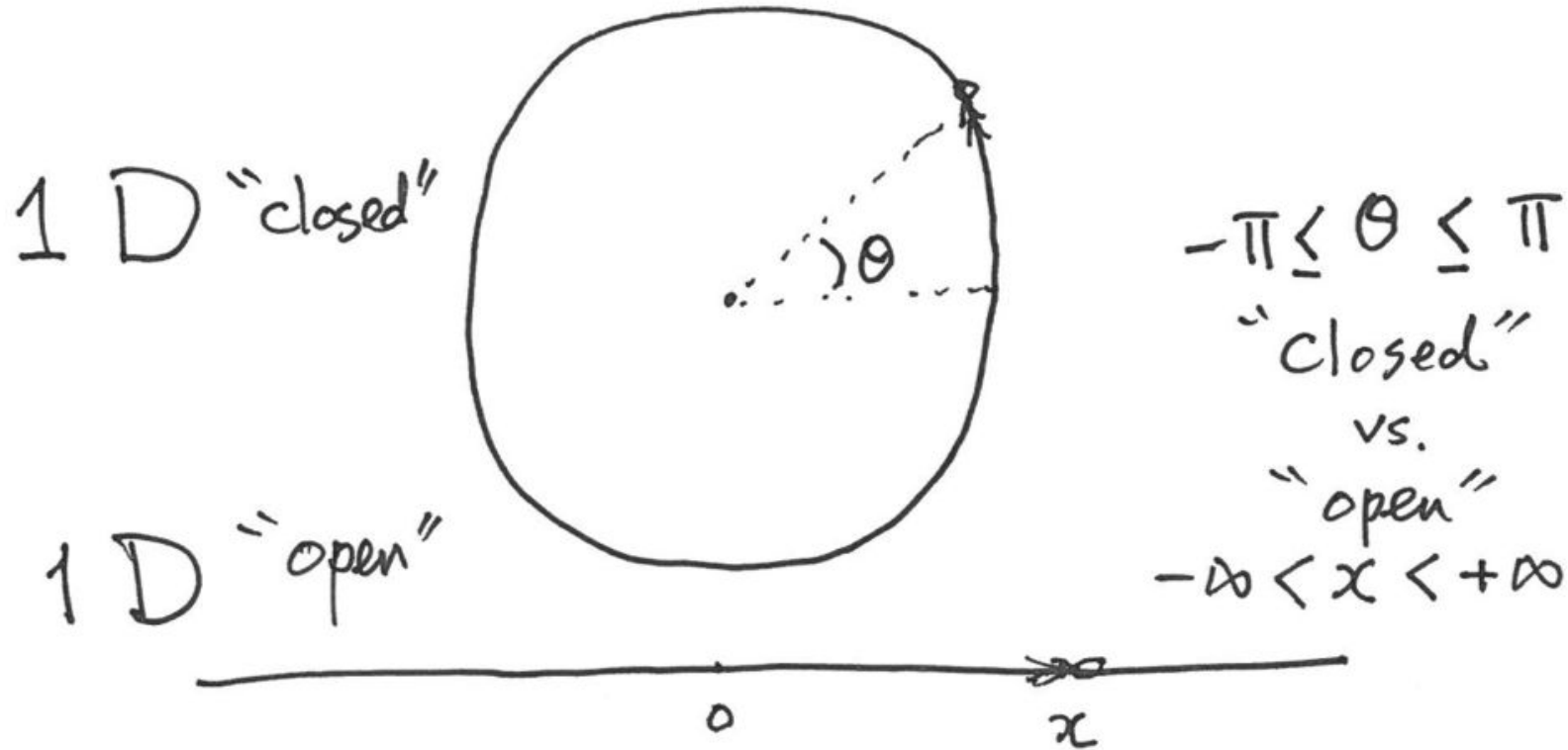
Closed vs. Open Spacetime

Homogeneous vs. Inhomogeneous Spacetime Transformation

Chueng-Ryong Ji
North Carolina State University

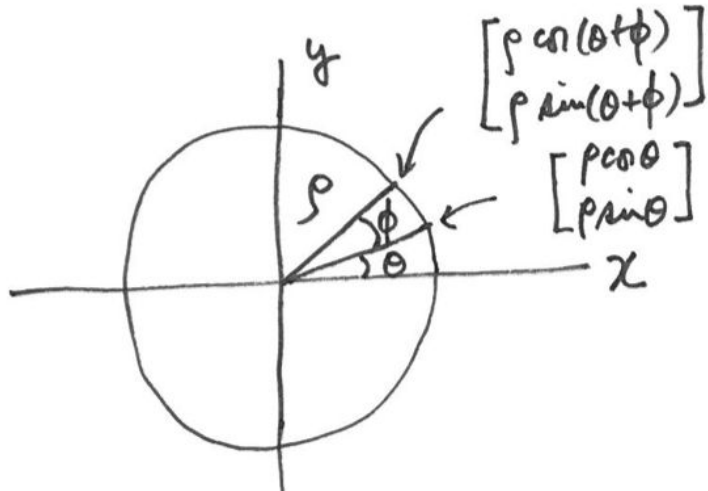
KNUT Miniworkshop, June 27, 2023

One dimensional "closed" vs. "open" space



Inhomogeneous transformations in the lower dimensions can be derived from the homogeneous transformations in the higher dimensions with an appropriate scaling.

e.g. Rotation in 2D \rightarrow Translation in 1D.



$$\begin{bmatrix} \rho \cos(\theta+\phi) \\ \rho \sin(\theta+\phi) \end{bmatrix} = \begin{bmatrix} \cos \phi & -\sin \phi \\ \sin \phi & \cos \phi \end{bmatrix} \begin{bmatrix} \rho \cos \theta \\ \rho \sin \theta \end{bmatrix}$$

Relativistic Quantum Invariance

Chueng-Ryong Ji

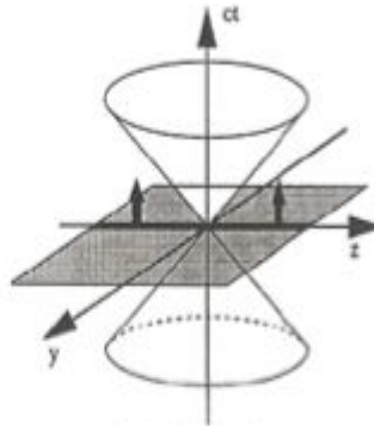
North Carolina State University

July 1, 2023

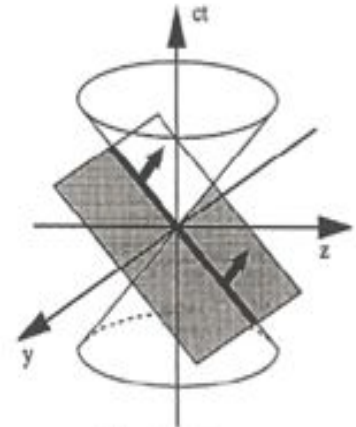


Relativistic Quantum Invariance

Interpolating instant form dynamics and light-front dynamics



The instant form



The front form

What did we learn from KSEA 50+ years history?

Chueng-Ryong Ji
North Carolina State University

HISTORY COMMITTEE Chair

**Roadmap of our journey for the publication of
“KSEA 50 Years”**

For the KAST Meeting discussions

July 3, 2023

KSEA 50 Years

50년의 땀 100년의 꿈



Korean-American Scientists and Engineers
Association





제54회 한림국제심포지엄
재미완연과학기술자협회 회장단 초청

한국 과학기술의 미래

일시
2023. 7. 3.(화) 15:30
장소
한림원회관 성명철홀(1층)

한림원
한림원



The Link between the QCD and the Light-Front Quark Model

Chueng-Ryong Ji
North Carolina State University

APCTP Focus Program
July 8, 2023

Hadron Physics in Light-Front Dynamics

Chueng-Ryong Ji

North Carolina State University



14th APCTP-BLTP JINR Joint Workshop

July 10, 2023

14th APCTP-BLTP JINR Joint Workshop - Memorial Workshop in Honor of Prof. Yongseok Oh

July 9(Sun) - July 14(Fri), 2023 | Posco International Center(PIC) Auditorium | apctp

14th APCTP-BLTP JINR Joint Workshop
- Memorial Workshop in Honor of Prof. Yongseok Oh
From July 9 to July 14, 2023
Posco International Center, Pohang, Korea

Invited Speakers

Yongseok Oh (JINR)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)

Organizers

Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)
Yongsoo Kim (APCTP)	Yongsoo Kim (APCTP)

Sponsors

APCTP	BLTP	JINR
Posco	Posco	Posco
Posco	Posco	Posco
Posco	Posco	Posco
Posco	Posco	Posco





Interpolating Relativistic Spacetimes and Quantum Fields between Instant Form Dynamics and Light-Front Dynamics.

Deepasika Dayananda

Department of Physics
North Carolina State University

Spin Correlations and Bell's Inequality

Chueng-Ryong Ji

North Carolina State University



Technical Group: A-1, Physics (PHY)



August 3, 2023



Non-diagonal pion-to-rho DVCS at JLab

Chuang Ji <crji@ncsu.edu>

Thu, Aug 17, 2023 at 2:18 PM

To: "Cynthia (Thia) Keppel" <keppel@jlab.org>

Cc: Eric Christy <christy@jlab.org>, Dipangkar Dutta <ddutta@jlab.org>, Rachel Montgomery <Rachel.Montgomery@glasgow.ac.uk>, Bogdan Wojtsekhowski <bogdanw@jlab.org>, "hornt@cua.edu" <hornt@cua.edu>, Paul King <pkking@jlab.org>, "Liyanage, Nilanga K (nl8n)" <nl8n@virginia.edu>

Bcc: Patrick Barry <barryp@jlab.org>, cyrstsh <cyrstsh@gmail.com>, Hyeondong Son <hdson21@gmail.com>, Nobuo Sato <nsato@jlab.org>, Wally Melnitchouk <wmelnitc@jlab.org>

Hi Thia,

Sorry that we can't meet to discuss in person, but I talked with Dipangkar this morning over the zoom. It seems that it would be too difficult for TDIS to measure the exclusive processes shown in Fig.1 of the paper by D. Amrath, M. Diehl, J.P.Lansberg, EPJC 58, 179-192 (2008).

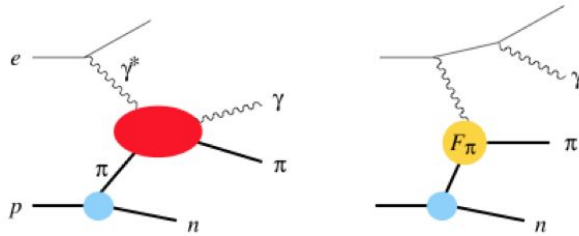


Fig. 1 Graphs for $ep \rightarrow e\gamma\pi^+n$ in the one-pion exchange approximation. Contributing subprocesses are virtual Compton scattering on a pion (*left*) and the Bethe-Heitler process (*right*). The crossed Bethe-Heitler graph (not shown) has the photons attached to the lepton line in opposite order. The blob marked with F_π represents the electromagnetic pion form factor

If it can be measured, then of course one may go over the typical discussion about the extraction of the pion GPD from DVCS and the BSA from the interference between DVCS and BH, etc. for the virtual pion target. Motivated by the recent discussion about the proton-to-Delta transition GPD in PRL 131, 021901 (2023), Kirill previously inquired about the feasibility of measuring the non-diagonal pi-to-rho DVCS. However, it seems too difficult to measure these exclusive processes in the current TDIS experimental setup as far as I understand from the discussion with Dipangkar.

Nevertheless, Patrick joined this morning as well to discuss about the L-T separation of the pion structure functions, i.e. F_L vs. F_T , in TDIS, which seems of course feasible by measuring different beam energies, e.g. 6.6 GeV, 8.8 GeV and 10.8 GeV. We could have discussed more about the impact study of JLab 22 GeV upgrade in this occasion, but it would be fine to look forward to discussing more in any future opportunity.



What did I learn from these meetings?

- Degrees of freedom matter in physics of excited hadrons: nucleus, nucleon, quarks and gluons...
Lagrangian vs. Hamiltonian and IFD vs. LFD
Energy scales for NJL, CQS, LFQM and PQCD
- Roper resonance and radial excitations:
QCD confining potential provides 500~600 MeV difference
- Three-body extension of LFQM is necessary
- Timelike region vs. dynamical mass generation
- SIDIS (TMDs, GPDs, TDAs) focused 20+ GeV Upgrade
- Experiments, Lattice, PARTON vs. Theoretical Simulation
- Data analyses and Impact studies called more extensively

What do we need to work on?

- Timelike region study with transition form factor
- Three-body extension and higher Fock-states in LFQM
- 3+1D electroproduction of mesons
- Theoretical simulations of GPDs vs. TDAs
- Impact studies for JLab 20+ GeV upgrade and EIC
- Scaled interpolating variables and covariance
- Isometry of $SO(4,2)$ and conformal symmetry
- Energy-Momentum Tensor in LFD
- Physical observable universality and decomposition issue

