Introduction to ExHIC-p workshop on polarization phenomena in nuclear collisions

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Organizers :

Philipp Gubler (JAEA)
Koichi Hattori (Zhejiang Univ.)
Xu-Guang Huang (Fudan Univ.)
Su Houng Lee (Yonsei Univ.)
Di-Lun Yang (Academia Sinica)

The Institute of Physics, Academia Sinica

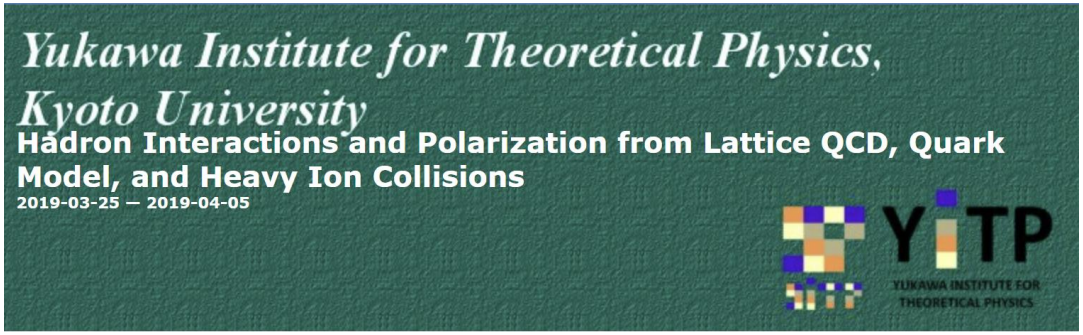
- Academia Sinica (AS, Latin: Academia Sinica, lit. 'Chinese Academy'; Chinese: 中央研究院; lit. 'Central Research Academy')
- It is a government founded research institute analogous to Chinese Academy of Science, Max Plank Institute, and RIKEN.

- The Institute of Physics (IoP) was founded in Shanghai in 1928 and was reestablished in Taiwan in 1962, with Dr. Ta-You Wu (吳大猷) as its first Director.

- Current research areas of IoP can be grouped into three main categories: Quantum Materials Physics, Physics of Active and Biological Systems, Medium and High Energy Physics.

ExHIC-p?

- What does ExHIC-p mean? Exotic Phenomena in heavy ion collision
- The ExHIC-p collaboration was formed by the present organizers at the molecular workshop held in YITP at 2019.

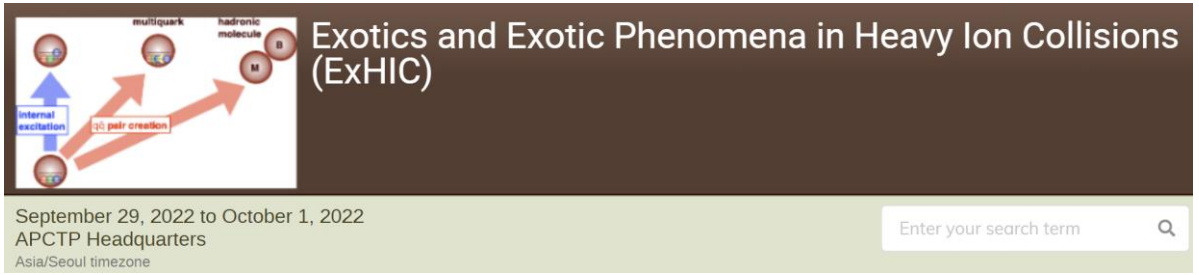


❑ One paper published by ExHIC-p collaboration in 2020:

Legacy of Prof. Akira Ohnishi (大西 明)

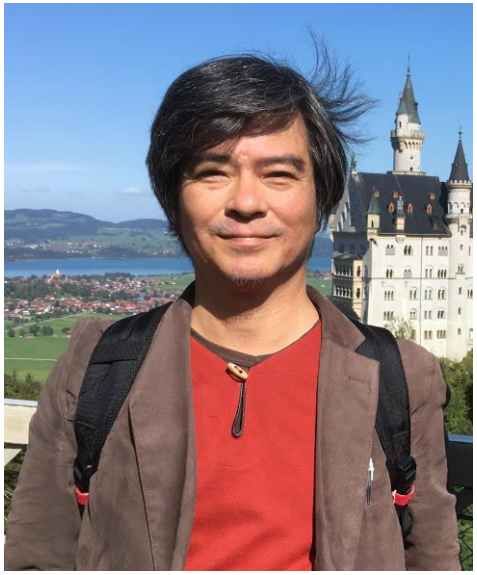
- Follow-up workshop :

  combination with the ExHIC (Exotics from Heavy Ion Collision) collaboration



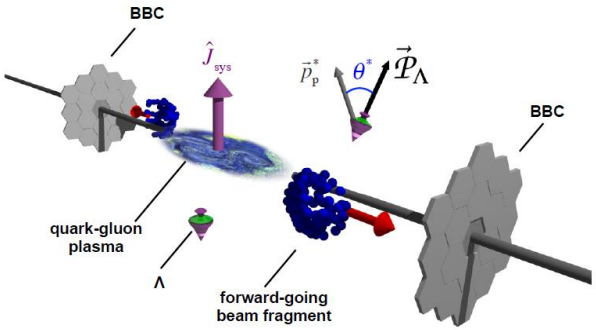
- Akira Ohnishi plays a pivotal role in both collaborations. He was a theoretical nuclear physicist and professor at Yukawa Institute for theoretical physics of Kyoto Univ. He worked on various topics including heavy ion collisions, nuclear interaction, and neutron stars.

- He passed away by the pancreatic cancer in 2023.

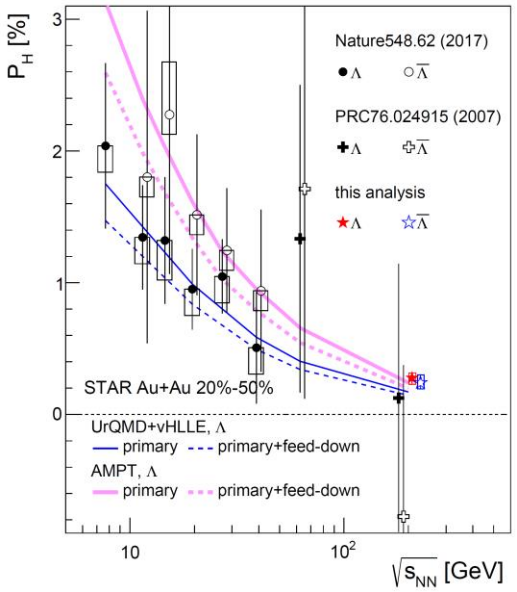


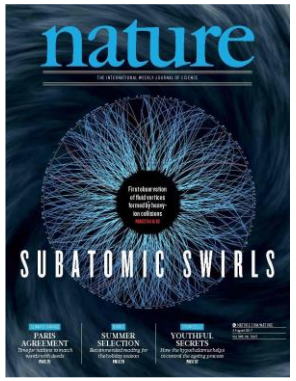
Spin polarization of Λ hyperons in HIC

- Global polarization of Λ hyperons :



strong vorticity in HIC : $\omega \sim 10^{22}\ \mathrm{s}^{-1}$

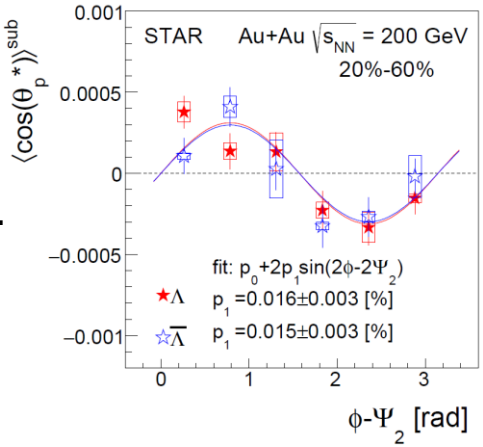




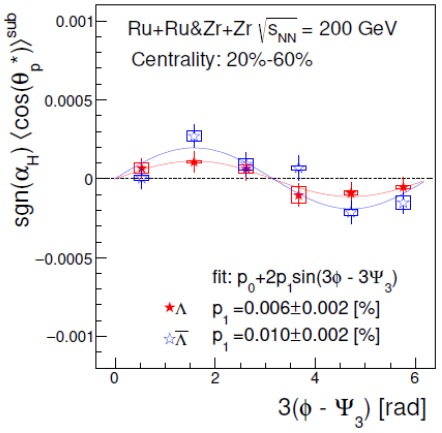
L. Adamczyk et al. (STAR), Nature 548, 62 (2017)

- Local spin polarization :

  spin polarization led by thermal-shear correction etc.



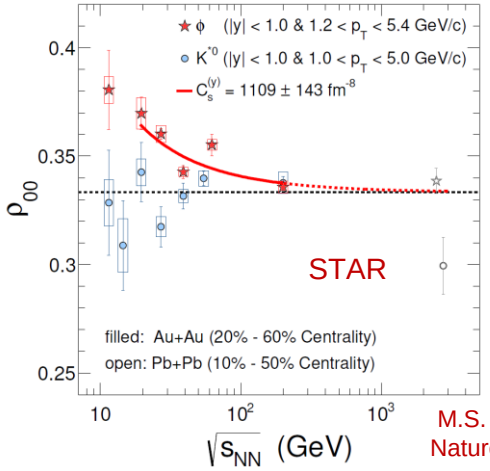
J. Adam et al. (STAR), PRL. 123, 132301 (2019)



M. Abdulhamid et al. (STAR), PRL 131, no.20, 202301 (2023)

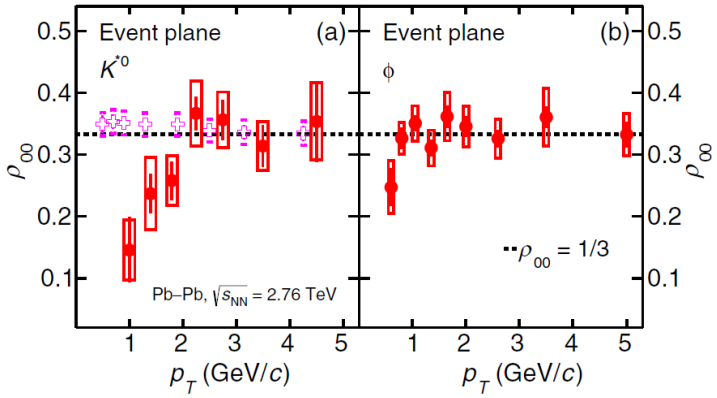
Spin alignment of vector mesons

- Spin alignment of vector mesons : $\rho_{00} \neq 1/3$
- Flavor & collision-energy dependence :



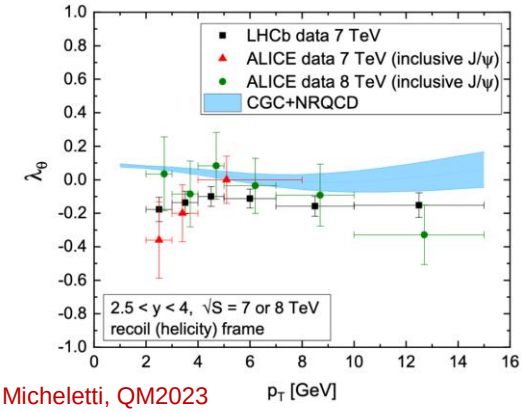
M.S. Abdallah et al. (STAR), Nature 614 (2023) 7947, 244-248

ALICE:

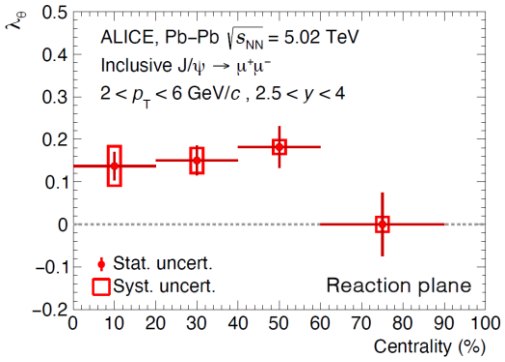


S. Acharya et al. (ALICE), PRL.125, 012301 (2020)

- Spin alignment for quarkonium : $\lambda_\theta \neq 0$



L. Micheletti, QM2023



ALICE Collaboration, PRL 131 (2023) 042303

Scientific purposes

- Various polarization phenomena in HIC or small collision systems lead to new challenges and also opportunities for theorists.

- Theoretical developments to understand dynamical spin polarization : quantum kinetic theory, spin hydrodynamics, quantum statistical field theory, etc.

- Polarization phenomena may be utilized to probe strong vortical fields, (chromo-) electromagnetic fields, and spin-orbit interaction in relativistic QCD and hadronic matter.

  ⟹ We need the input from experts both inside and outside this field and the cross talks between experimentalists and theorists.

❑ The workshop is comprised by 6 overview talks and 14 research talks and 4 discussion sessions.

Polarization phenomena in HIC

- Spin polarization and alignment phenomena in HIC :
  - Experimental status :
    - **STAR overview** by Aihong Tang
    - **Recent experimental results at the LHC on polarization and spin alignment** by Sanghoon Lim
  - Theoretical tools :
    - **Overview on spin transport theories in HIC** by Qun Wang
    - **Overview on transport simulations of vector mesons** by Lucia Oliva
  - Phenomenological studies on spin alignment :
    - **Global spin alignment of vector mesons in heavy ion collisions** by Xin-Li Sheng
    - **Spin alignment of vector mesons by the color fields in the glasma** by Avdhesh Kumar
    - **Spin 1 mesons as a probe of spin-vorticity non-equilibrium** by Giorgio Torrieri

Spin polarization & quantum transport

- Spin polarization in HIC :

❖ **Spin polarization within perturbative calculations** by Shashan Cao

❖ **Hadronic effects on Lambda polarization in relativistic heavy ion collisions** by Che-Ming Ko

❖ **Dynamical Core-Corona Initialization Model for High Energy Nuclear Collisions** by Yasuki Tachibana

- Developments on quantum transport theories for polarization :

❖ **Problems in causality and stability analysis for spin hydrodynamics and the new stability and causality criteria** by Shi Pu

❖ **Timescales of spin transport** by David Wagner

❖ **The effects of self-energies in spin polarization and spin alignment** by Shuo Fang

- Spin transport in condense matter systems :

❖ **Gyromagnetic spin transport in micro/nanomechanical systems** by Mamoru Matsuo (canceled)

Heavy flavor & small collision systems

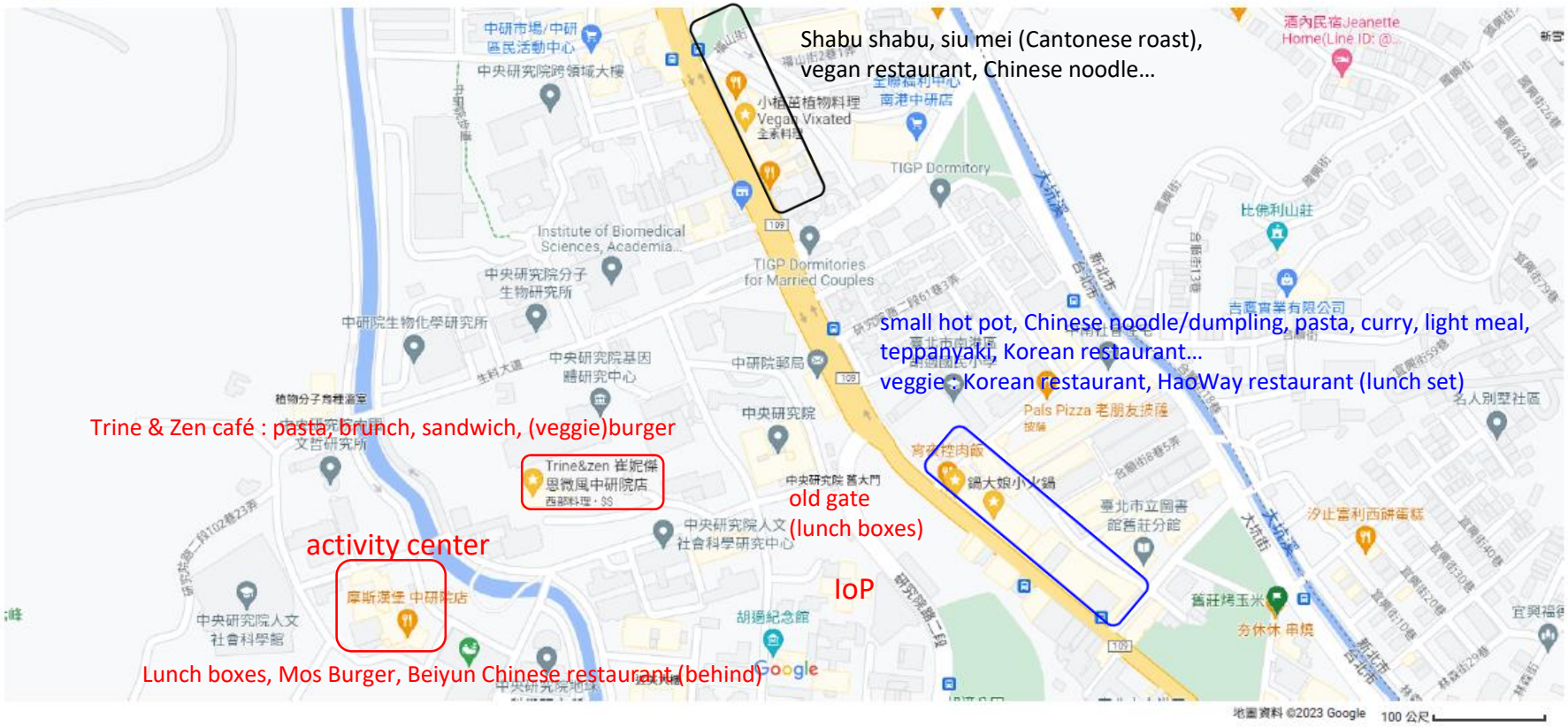
- Polarization and transport phenomena for heavy quarks :
  - **Quantum mechanical description of heavy quark transport** by Yukinao Akamatsu
  - **Jpsi polarization in nuclear collisions from CGC perspective** by Hirotsugu Fujii
  - **Spin-1 quarkonia in a rotating frame and their spin contents** by HyungJoo Kim
  - **J/psi spin alignment from polarized damping rate** by Shu Lin
- Polarization and transport phenomena in small collision systems :
  - **Heavy quarkonium production and polarization in small collision systems** by Kazuhiro Watanabe
  - **Experimental study of in-medium spectral change of vector mesons and its polarization dependence at J-PARC** by Kazuya Aoki
  - **Spin dynamics of the phi meson in pA reactions probed at KEK and J-PARC** by Philipp Gubler

Workshop guidelines

- Please turn on the microphone on the desk when asking questions.
- Please send me the slides before your talks and we will upload them to the workshop website.
- 50 min presentation + 10 min Q&A for the 1-hour overview talk and 25 min presentation + 5 min Q&A for the 30-minute research talk. (5-10 min extension is possible)
- One may ask questions during the presentation.
- In the discussion session, the host will raise some relevant issues for discussions and one may also continue the discussions with the speakers.
- Following the spirit of Akira, we look forward to fruitful discussions, cross-field exchanges, and potential collaborations.

Where to eat?

(more options)



veggie options : Trine & Zen café (on campus), Vegan Vixated, HaoWay restaurant, Korean restaurant