The future is illuminating

An NCTS TG2.1 Hsinchu Hub Workshop
on trends in
high energy and astrophysics

We're happy to have welcomed you, it's great to see you!

Timeline of this workshop:

- Continuation of the new "The future is …"-series of yearly events

Previous "installments"

- "The future is dark" [workshop website]

Organisational

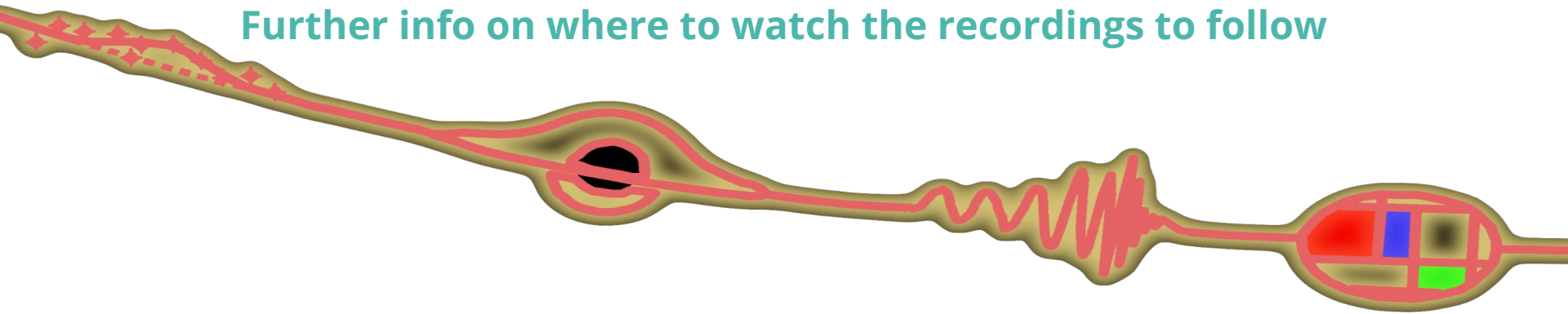
Website:

- Workshop website:
  [website link]

Virtual link and password:

- [cern.zoom.us] (Meeting-ID: 654 5476 8791, Passcode: 501688)

Further info on where to watch the recordings to follow



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National Center for Theoretical Sciences

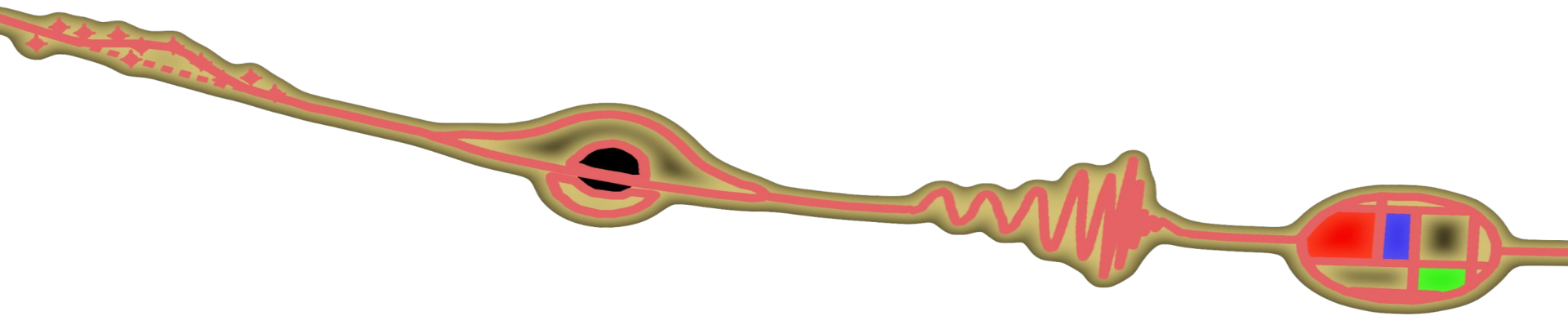
Physics Division 國家理論科學研究中心 物理組

Scope & Challenge

Foster exchange and collaboration between fields and topics

- From high-energy BSM and gravitational waves to nuclear- and astrophysics

Elucidate the range of phenomena & their interplay that are relevant & challenging to describe & reveal new physics



Scope & Challenge

Foster exchange and collaboration between fields and topics

This installment of the series:

1. Dark Matter and Physics Beyond the Standard Model
2. Primordial Black Holes
3. Gravitational Waves and their Detectors
4. Lattice Quantum Chromodynamics

Scientific Themes: bridging the gap

Probing for new physics

Talks and interdisciplinary dialogue to address:

- Advances in extraction of signals in cosmic and particle physics contexts.
- New observables for dark matter detection and neutrino physics.
- Impact of precision measurements in nuclear- and astrophysics.
- Connecting different approaches and fields for new constraints.
- The systematics and complementarities of methods.

Solving the problem: community overview

An Open Question: a matter that is *not yet* decided or is *unable* to be decided

[Oxford English dictionaries]

Observation 1: common themes and questions have emerged - uncertainty quantification, robustness, global fits, interdisciplinary connections.

Observation 2: we are in an approach-rich but data-scarce environment (although some high precision data is available). This makes it hard to find robust constraints as the precision for those data we do have needs to be extremely high.

Solving the problem: domain knowledge

Giving robust constraints requires extra information

- On the level of data: identify complementary observables to constrain target quantities
- On the level of methods: identify complementary interdisciplinary methods and understand how this knowledge can be used to constrain specific scenarios

Observation 3: Some communities have made progress but concerted efforts prove difficult. This is partly due to the vast difference in methods and energy scales at play.

Challenges

- Can the relevant systematics in methods be articulated a priori?
- Is there a hierarchy of systematics?
- At what level do the different disciplines interact and require the mutual inclusion of their effects? (E.g. how much of the microscopic details of QCD or BSM-QFT models need to be included?)
- How to compare results from different methods in a meaningful way?
- Prospects and priorities for averages that combine all knowledge from different fields?

We hope you had a great and fruitful few days!

- 95 registered participants in total, including:
  - 3 participant institutes in America,
  - 3 in Europe,
  - 3 in India,
  - 3 in Indonesia
  - 12 in Japan,
  - 6 in South Korea

Thank you for joining us from around the world!

An artistic rendition of the physics building at NTHU housing the NCTS node

After the game
Is before the game

The future is ...

Towards the next workshop

The future is ... non-perturbative

- **Branch out towards new fields:**
  - Lattice quantum field theory in particle physics
  - Tensor networks in condensed matter physics
  - Quantum computing and the foundations of quantum mechanics
  - ...
- **Addressing the challenges from another perspective**
  - Avenues for real-time and out-of-equilibrium physics inputs
  - Future impact on new physics searches and high precision calculations
- **Beyond BSM**
  - Non-perturbative approaches and methods of (quantum) computation stand to impact our approach to physics with applications from BSM to materials science.
- **Continue and extend the dialogue**

Thank you!

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- Thanks to Po-Yen Tseng and Martin Spinrath for leading the organisation of this workshop.
- Thanks to our invited speakers for excellent talks.
- Thanks to all participants for a stimulating and fruitful time!

We hope we can meet in person next time!