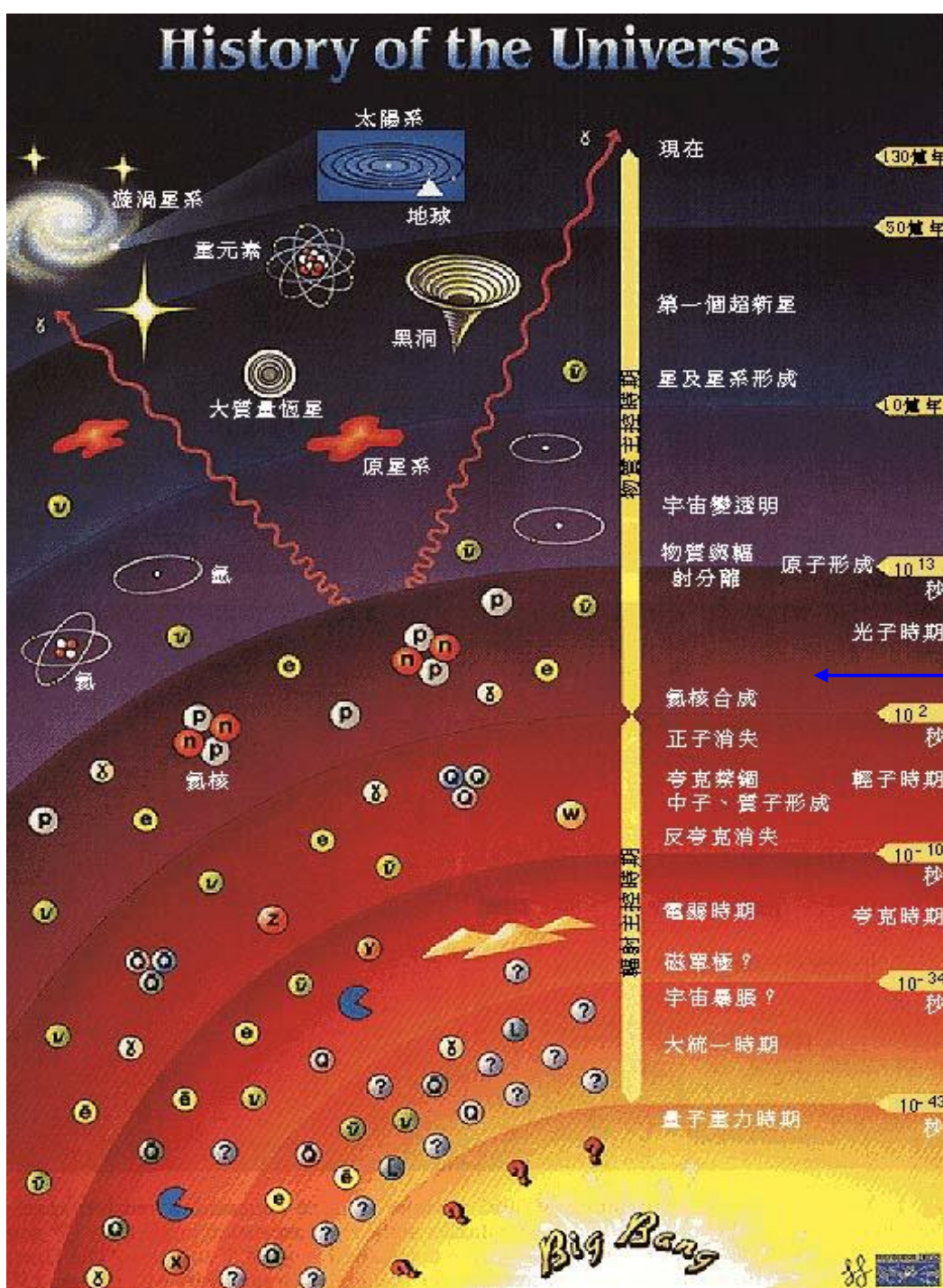




- 中央研究院 物理研究所
- 中高能物理組研究簡介
- Di-Lun Yang (楊迪倫), on behalf of the MHEP group
- July 06, 2022

History of the Universe

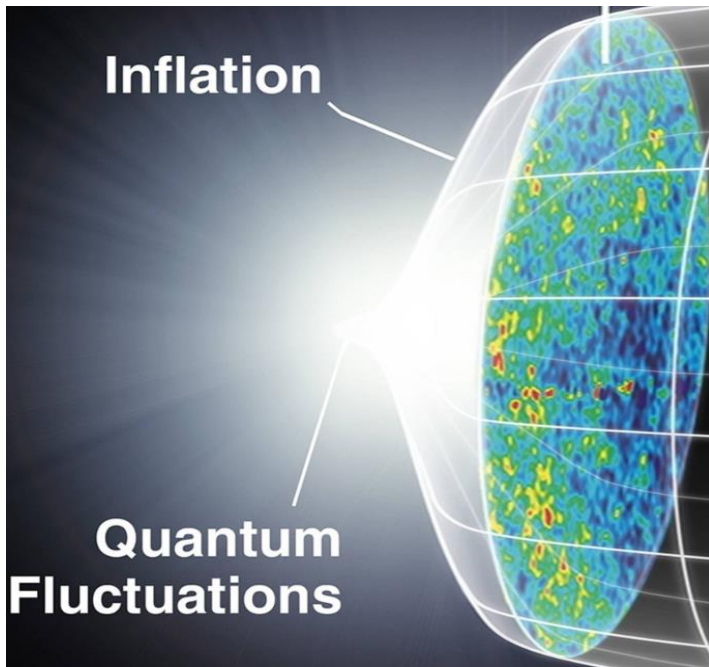


- The evolution of the Universe is governed by the microscopic nature of fundamental physics

Standard Model of Elementary Particles

	three generations of matter (fermions)			interactions / force carriers (bosons)	
	I	II	III		
QUARKS	mass $\approx 2.2 \text{ MeV}/c^2$ charge $\frac{2}{3}$ spin $\frac{1}{2}$ u up	mass $\approx 1.28 \text{ GeV}/c^2$ charge $\frac{2}{3}$ spin $\frac{1}{2}$ c charm	mass $\approx 173.1 \text{ GeV}/c^2$ charge $\frac{2}{3}$ spin $\frac{1}{2}$ t top	mass 0 charge 0 spin 1 g gluon	mass $\approx 124.97 \text{ GeV}/c^2$ charge 0 spin 0 H higgs
	mass $\approx 4.7 \text{ MeV}/c^2$ charge $-\frac{1}{3}$ spin $\frac{1}{2}$ d down	mass $\approx 96 \text{ MeV}/c^2$ charge $-\frac{1}{3}$ spin $\frac{1}{2}$ s strange	mass $\approx 4.18 \text{ GeV}/c^2$ charge $-\frac{1}{3}$ spin $\frac{1}{2}$ b bottom	mass 0 charge 0 spin 1 γ photon	
	mass $\approx 0.511 \text{ MeV}/c^2$ charge -1 spin $\frac{1}{2}$ e electron	mass $\approx 105.66 \text{ MeV}/c^2$ charge -1 spin $\frac{1}{2}$ μ muon	mass $\approx 1.7768 \text{ GeV}/c^2$ charge -1 spin $\frac{1}{2}$ τ tau	mass $\approx 91.19 \text{ GeV}/c^2$ charge 0 spin 1 Z Z boson	
LEPTONS	mass $< 2.2 \text{ eV}/c^2$ charge 0 spin $\frac{1}{2}$ ν_e electron neutrino	mass $< 0.17 \text{ MeV}/c^2$ charge 0 spin $\frac{1}{2}$ ν_μ muon neutrino	mass $< 18.2 \text{ MeV}/c^2$ charge 0 spin $\frac{1}{2}$ ν_τ tau neutrino	mass $\approx 80.39 \text{ GeV}/c^2$ charge ± 1 spin 1 W W boson	GAUGE BOSONS VECTOR BOSONS

• Unsolved Mysteries in Fundamental Physics?

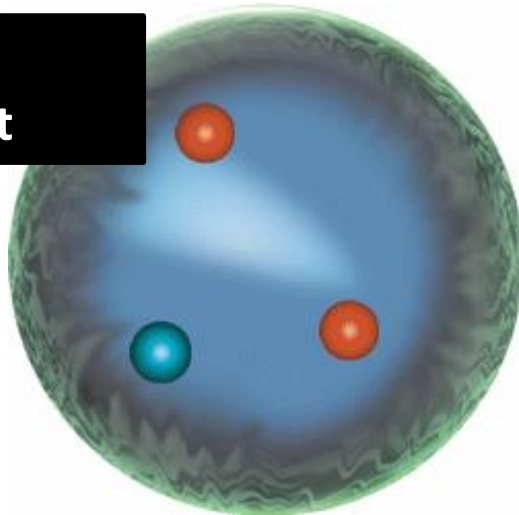


Why No Antimatter?

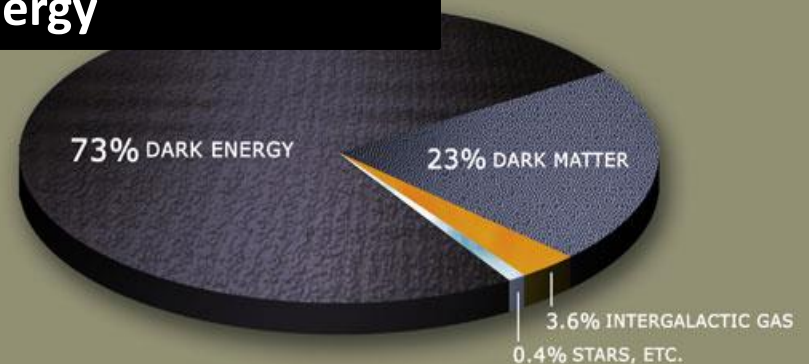
Matter and antimatter were created in the Big Bang. Why do we now see only matter except for the tiny amounts of antimatter that we make in the lab and observe in cosmic rays?

The illustration shows two human figures, one blue and one orange, standing on either side of a central point of annihilation. The blue figure has three red spheres (representing protons) and the orange figure has three green spheres (representing neutrons). A bright, glowing red and orange sphere is shown between them, representing the annihilation of matter and antimatter.

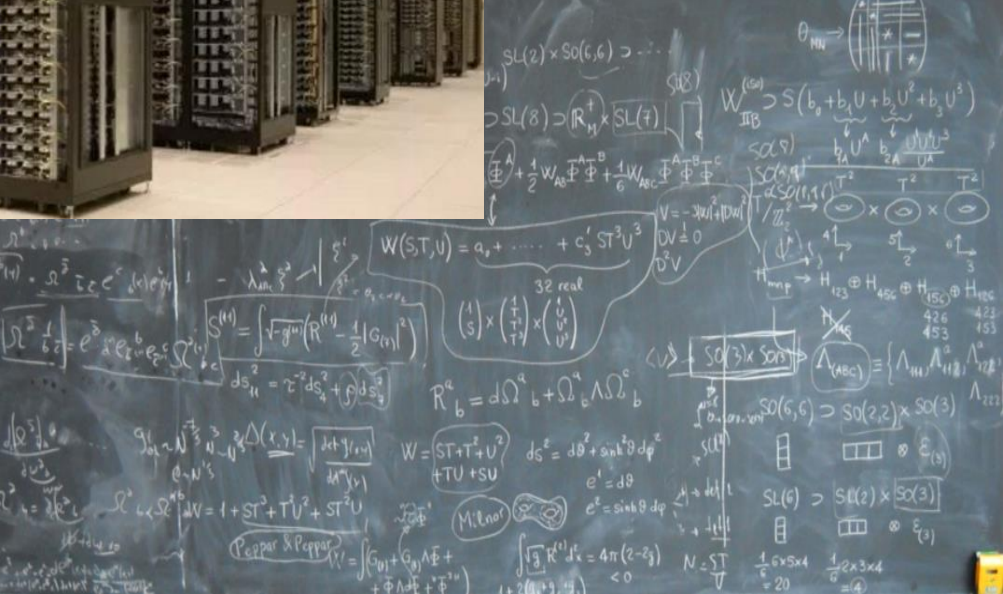
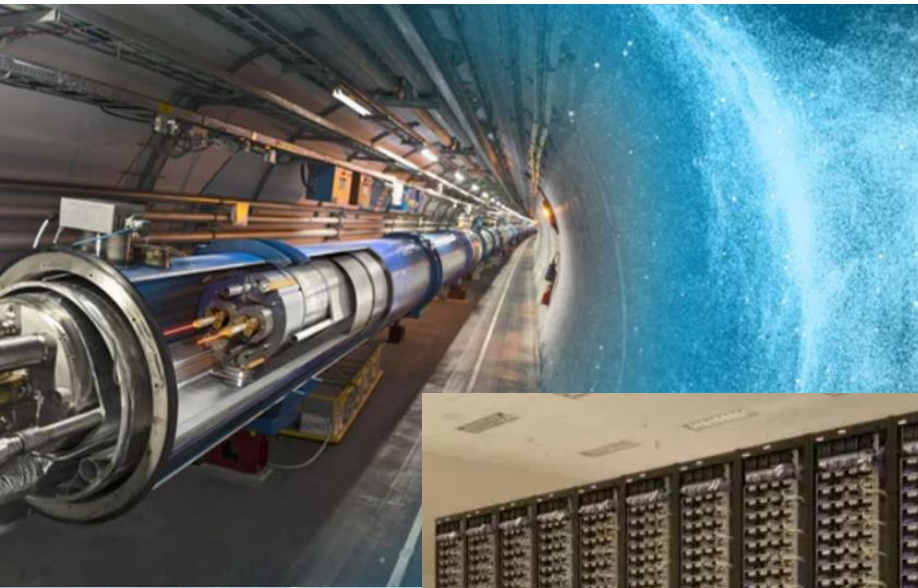
• Quark Confinement



• Dark Matter & Dark Energy



- Tools to explore these questions



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MHEP(Expt) – 10 Faculty Members on 9 Programs

Collider Physics
Search for new particles and new physics



ATLAS
 1999 ~

*S.M.Wang/ S. Hou/
 R. Mazini*

Astroparticle Physics
Study cosmic-rays, search for anti-matter, dark matter



AMS
 1995 ~

Y.H. Chang/S. Haino

Gravitational Wave
New tool to study our universe



1997 ~

S. Haino/H.T. Wong



CEPC – Higgs factory

S. Hou

Neutrino & Dark Matter Physics
With low energy detectors



TEXONO
 1996 ~

H.T. Wong

Experimental support; novel detectors & applications

Instrumentation

M.L. Chu/C.H.Lin

Hadron Physics
probing nucleons by GeV photons and hadrons



LEPS, SeaQuest, COMPASS

1999 ~

W.C. Chang



TASEH
 2020 ~

Y.H. Chang

Asian Grid Center
For HEP to other Sciences




Computing

Y.H.Chang/E.Yen


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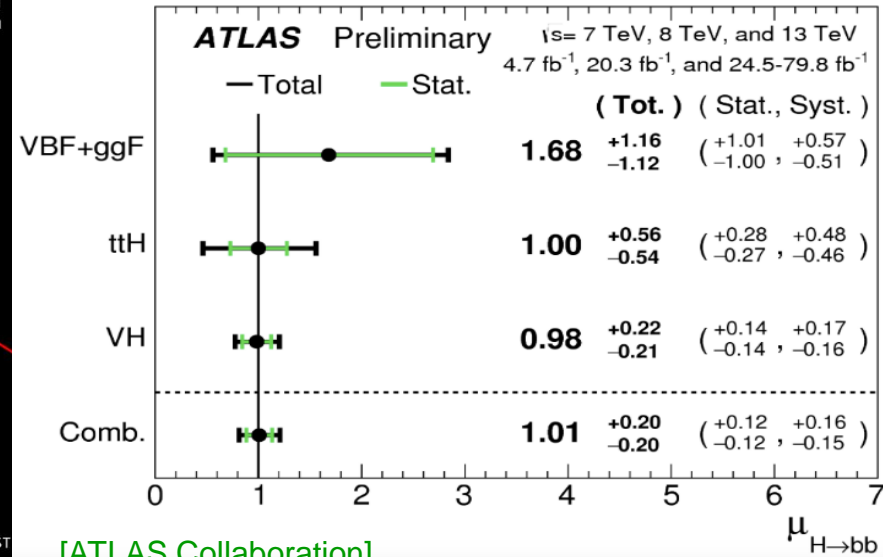
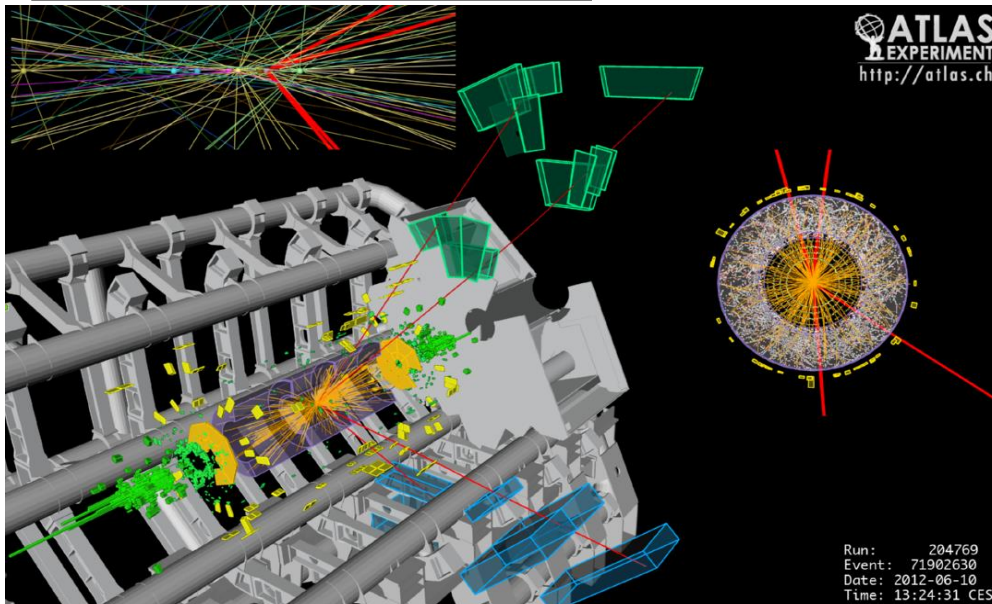
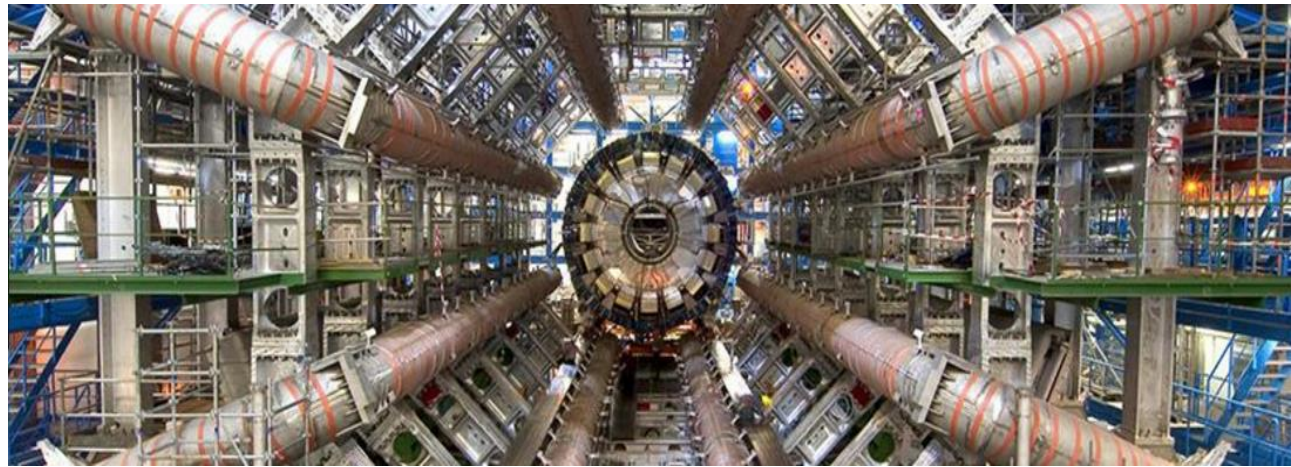
Collider Physics
Search for new particles
and new physics



ATLAS
 1999 ~
*S.M.Wang/ S. Hou/
 R. Mazini*



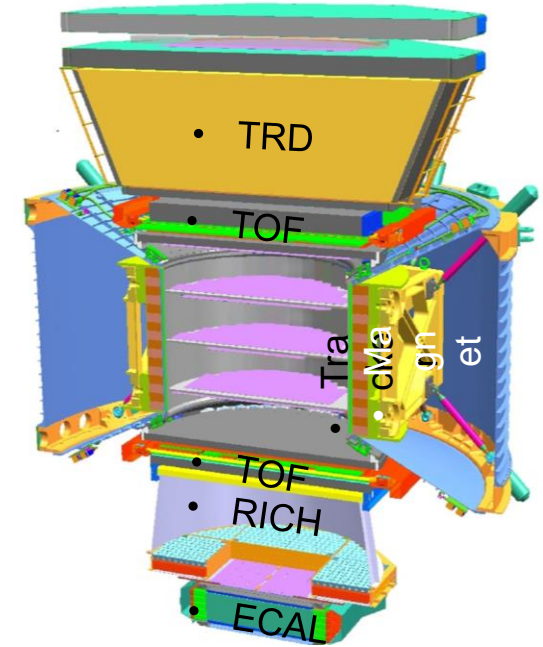
CEPC – Higgs factory
S. Hou




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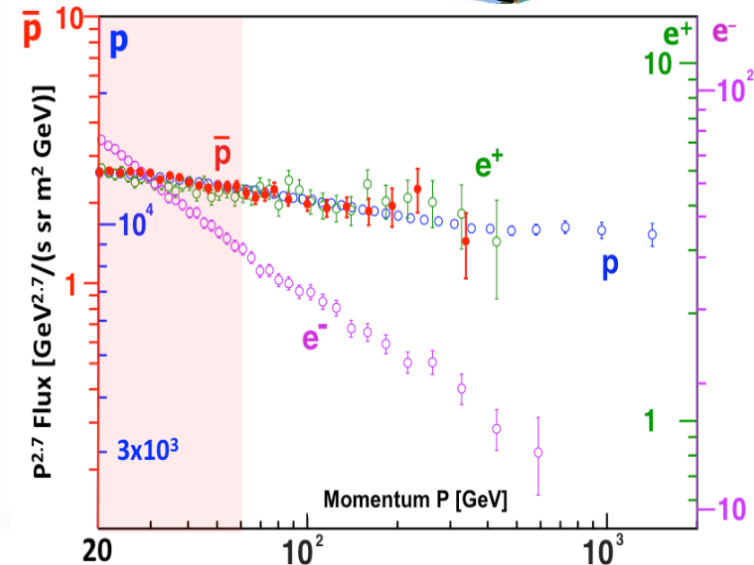
Astroparticle Physics
Study cosmic-rays, search for anti-matter, dark matter





AMS
1995 ~
Y.H.Chang/S. Haino


	e^-	P	Fe	e^+	\bar{P}	\bar{He}
TRD						
TOF						
Tracker + Magnet						
RICH						
ECAL						
Physics example	Cosmic Ray Physics Strangelets			Dark matter		Antimatter



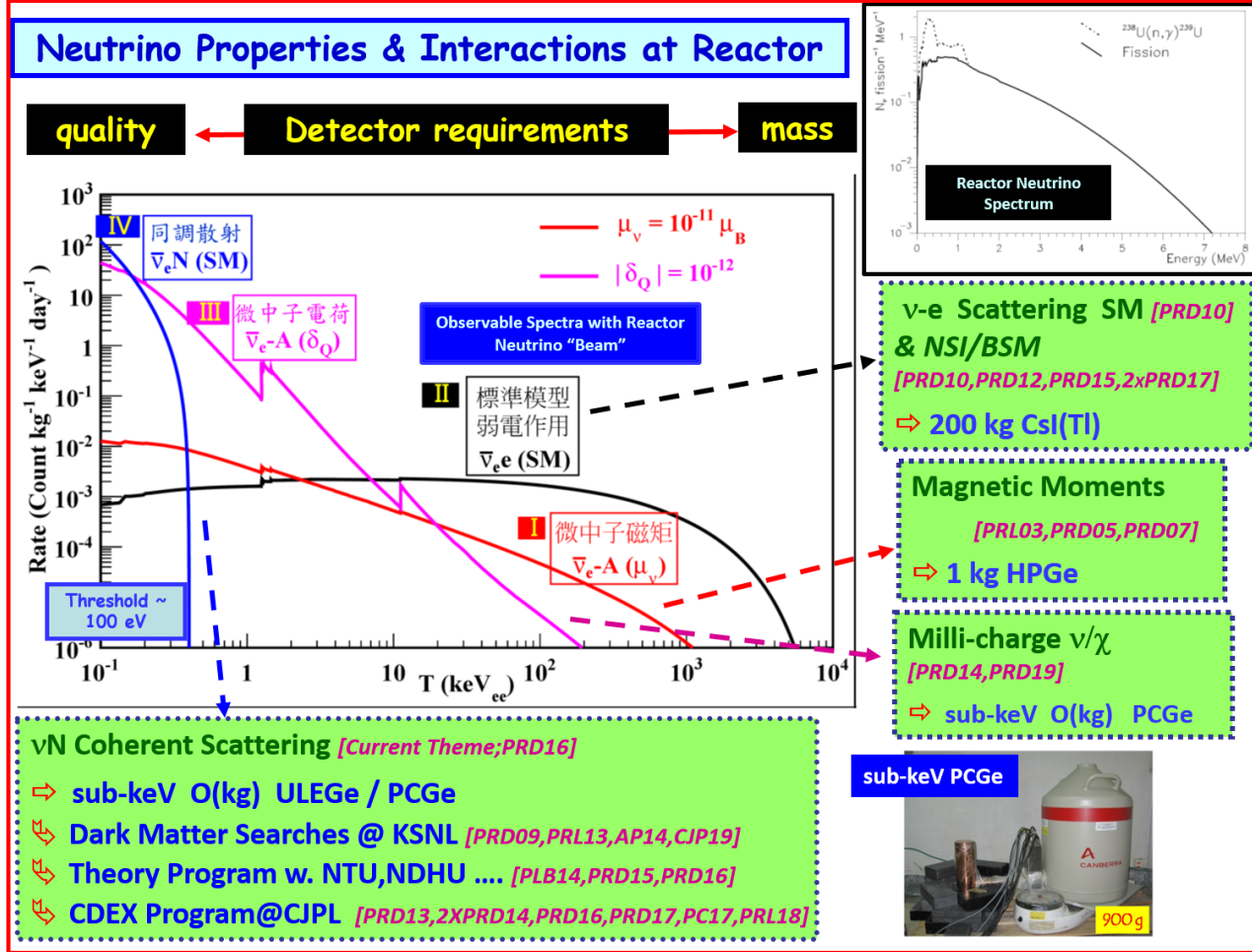
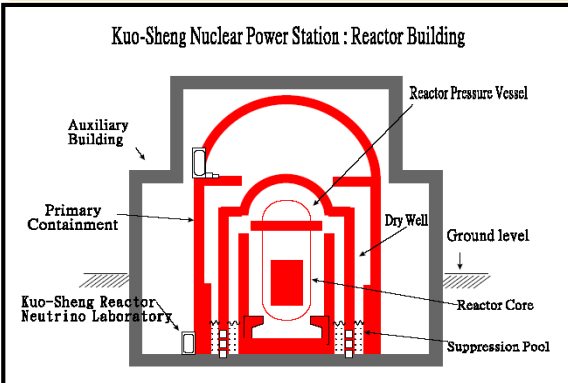
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Neutrino & Dark Matter
Physics
With low energy detectors




TEXONO
1996 ~
H.T. Wong



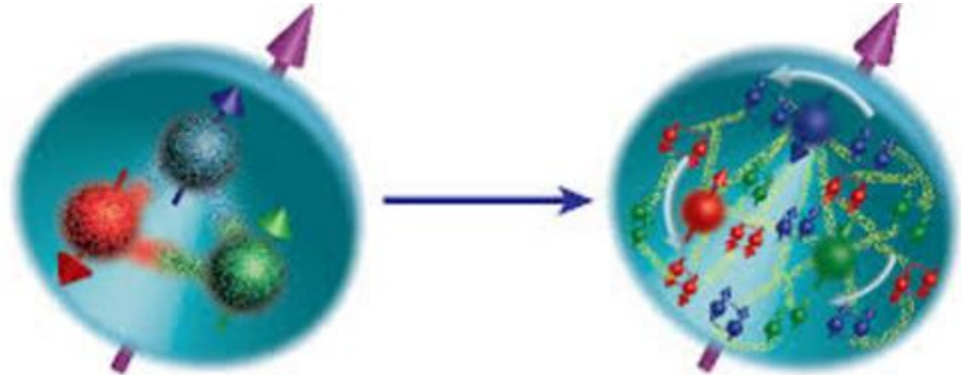
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MHEP(Expt) – 10 Faculty Members on 9 Programs

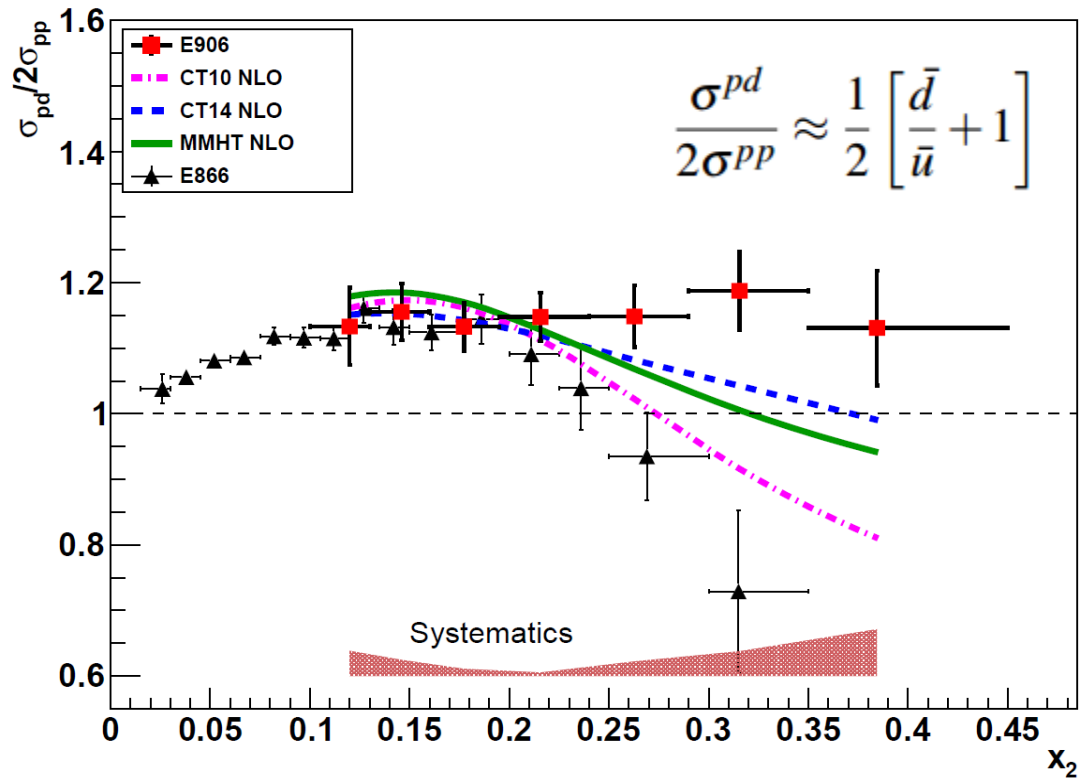
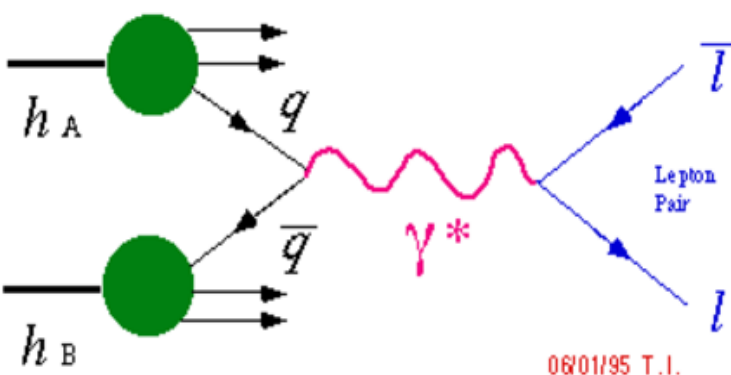
Hadron Physics
 probing nucleons by GeV
 photons and hadrons



LEPS, SeaQuest, COMPASS
 1999 ~
 W.C. Chang



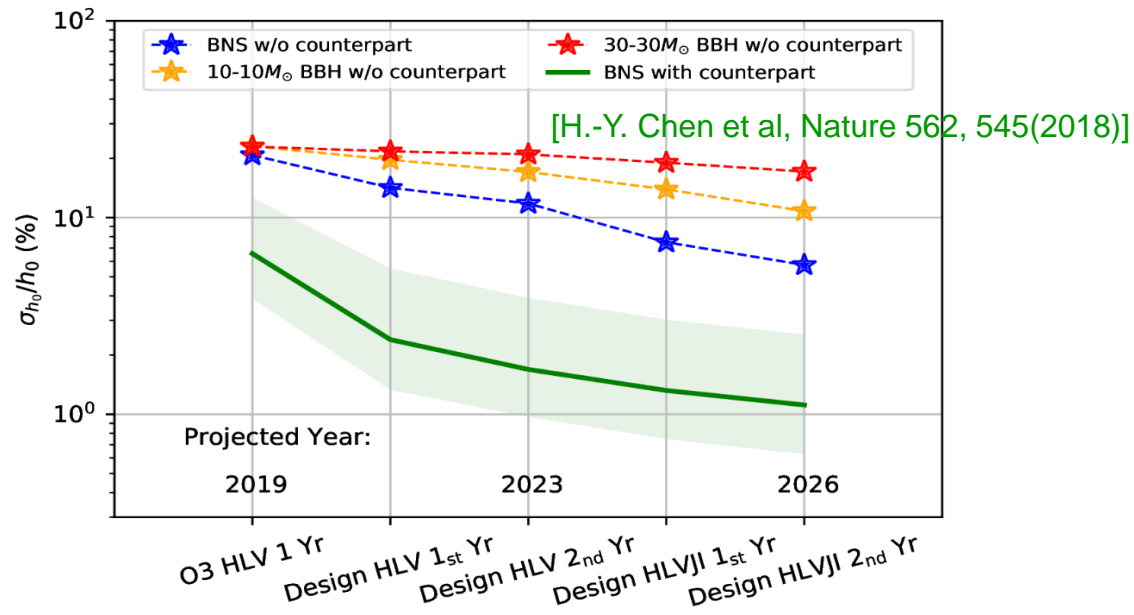
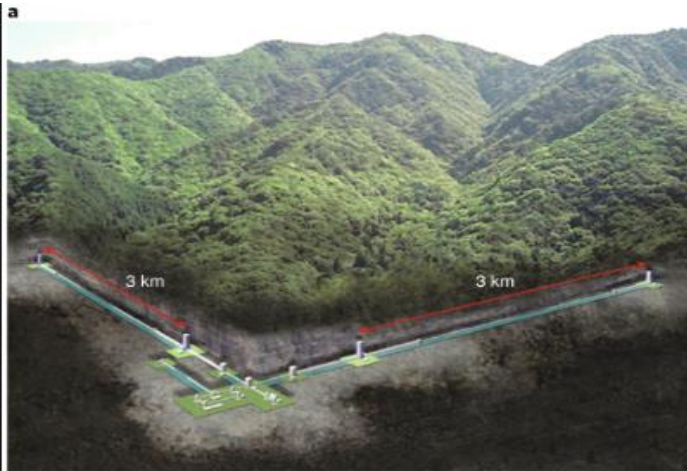
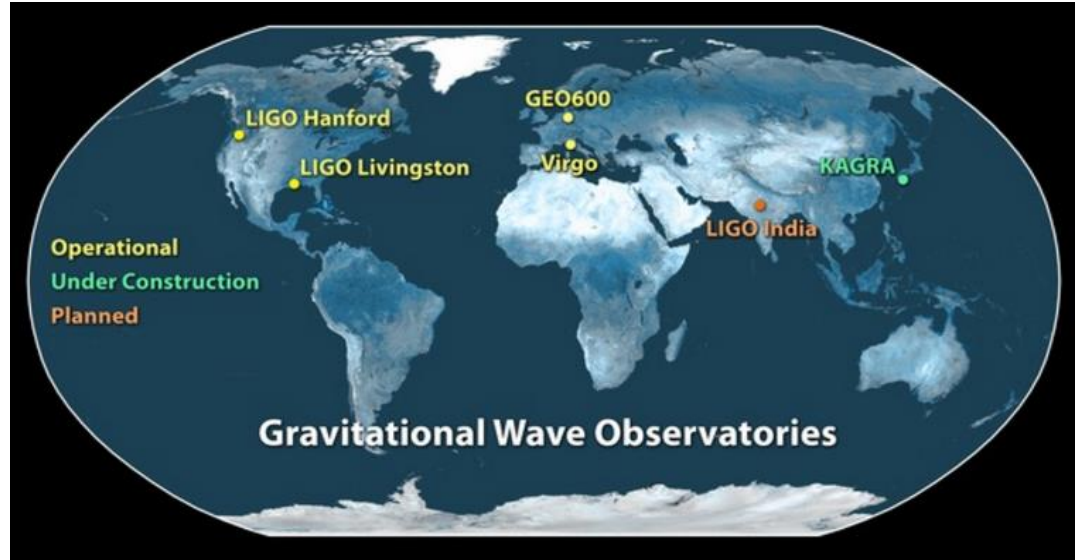
The Drell-Yan Process



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Gravitational Wave
New tool to study our
universe



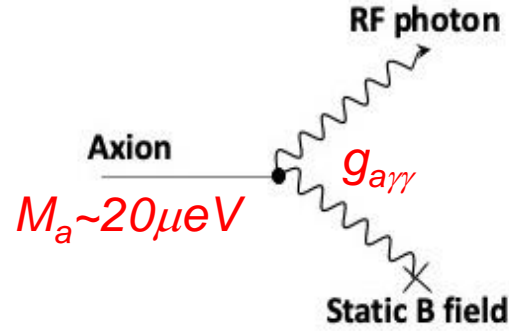
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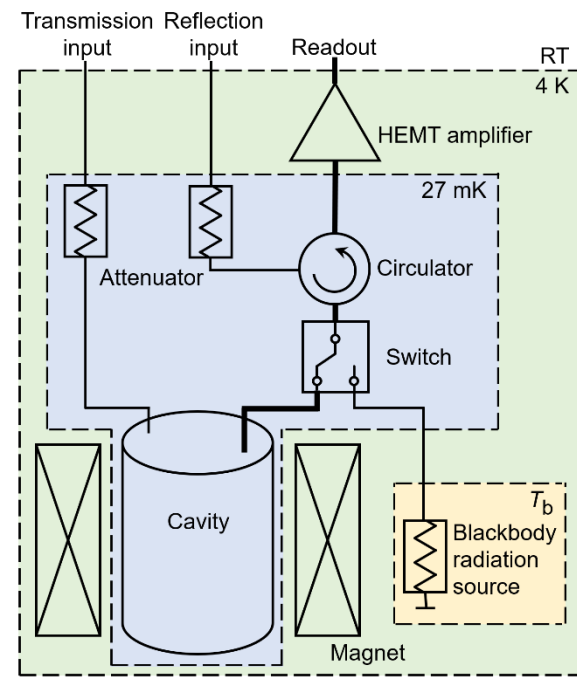
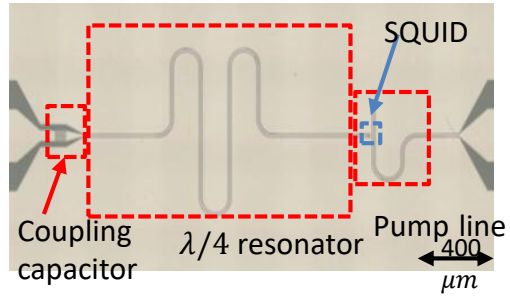
Axion Dark Matter
Search for Axion Dark
matter with μeV mass



TASEH
2020 ~
Y.H. Chang



Josephson
Parametric Amplifier:
With Quantum limited
added noise



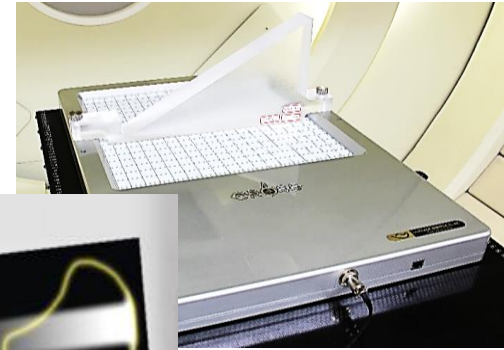
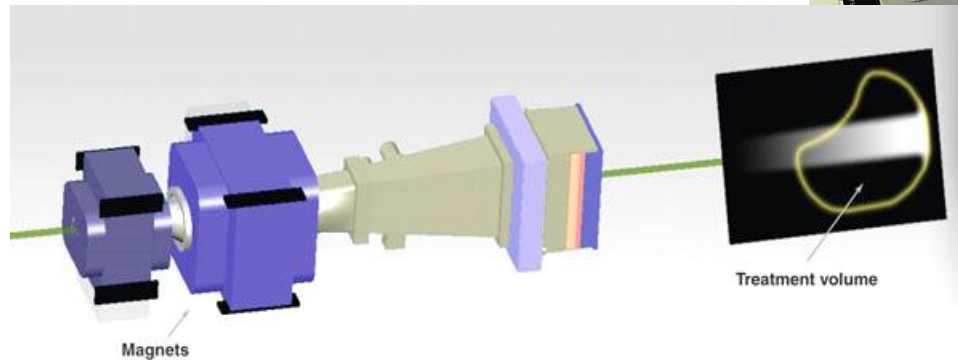
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**Experimental support;
novel detectors &
applications**

Instrumentation
M.L. Chu/C.H.Lin

- **Proton Therapy Detector**



**Asian Grid Center
For HEP to other Sciences**



Computing
Y.H.Chang/E.Yen

DiCOS Web Services

CPU Cluster (single/multiple cores, MPI) by VM/Container

CryoEM, Photon, HPC, HEP

GPU Cluster (GTX-1080ti)

CryoEM, Gravitational Wave

GPU Cluster (P100)

HPC, HEP, DL

GPU Cluster (V100)

QCD, HPC, DL

DiCOS Storage Services (DiCOSBox, Ceph, Distributed Storage)

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MHEP(Theory) – 7 Faculty Members

- The Early Universe
- Inflation, primordial black holes and CMB



• *K.-W. Ng*

- Hadron Physics
- QCD, meson decays, and CP violation, heavy ion collisions



• *H.-N. Li*



• *D.-L. Yang*

- Collider Phenomology
- Signature of New Physics in Collider



• *H.-N. Li*



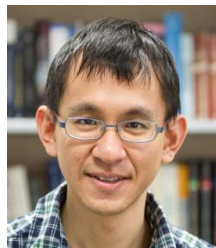
• *T.-C. Yuen*

- Dark Matter & Cosmic Structure
- Imprint of Dark Matter on the cosmic structure



• *K.-W. Ng*

- Astrophysics
- Exploring particle & nuclear physics nature in astrophysics



• *M.-R. Wu*



• *K.-W. Ng*



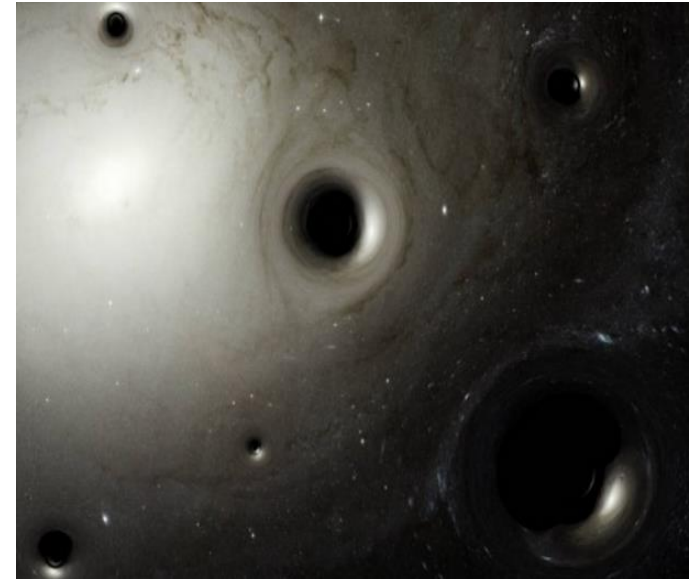
• *A. Fedynitch*



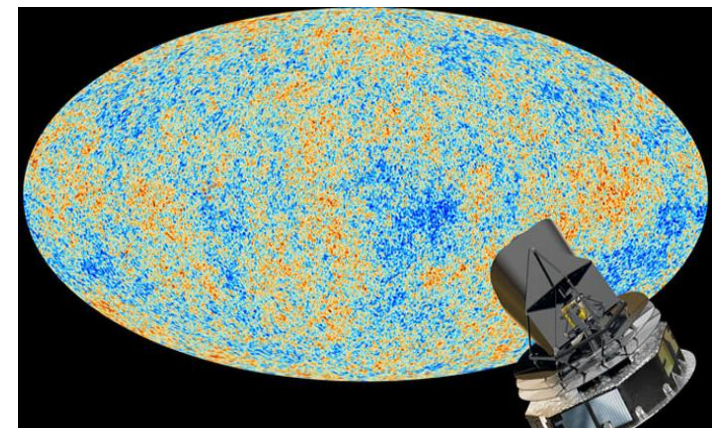
• *D.-L. Yang*

•The Early Universe

- Cosmic Inflation Models and imprints on CMB
- Formation of the primordial black holes
- Gravitational waves from the early Universe



• 吳建宏



• CMB

• Hadron Physics

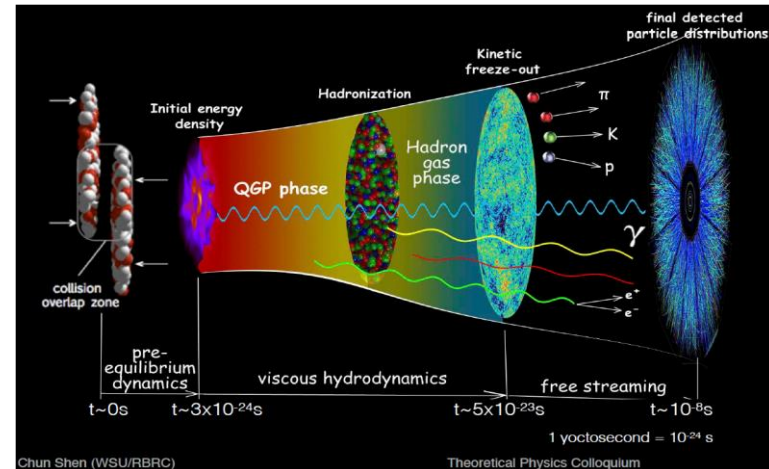
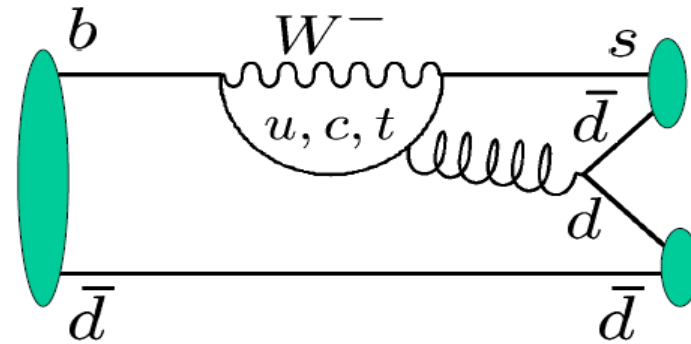
- CP Violation \leftrightarrow The baryon asymmetry
- CP violation in B & D meson decay
- Developing theory for heavy quark physics
- Relativistic heavy ion collisions and quark gluon plasmas
- QFT in strong fields



• 李湘楠

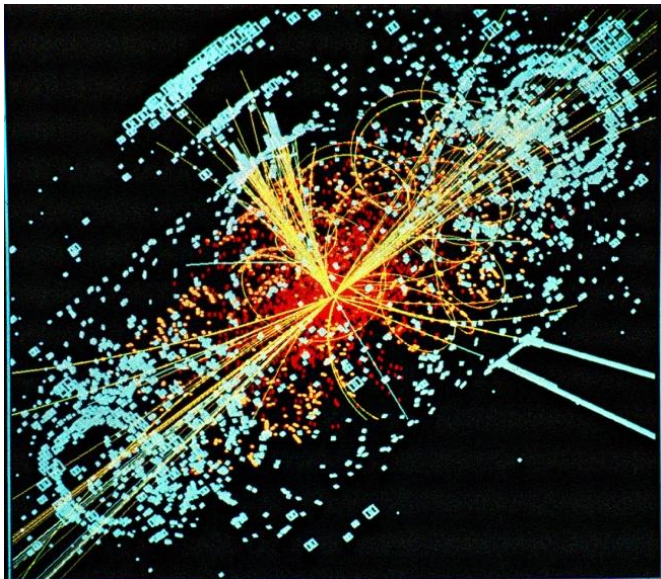


• 楊迪倫

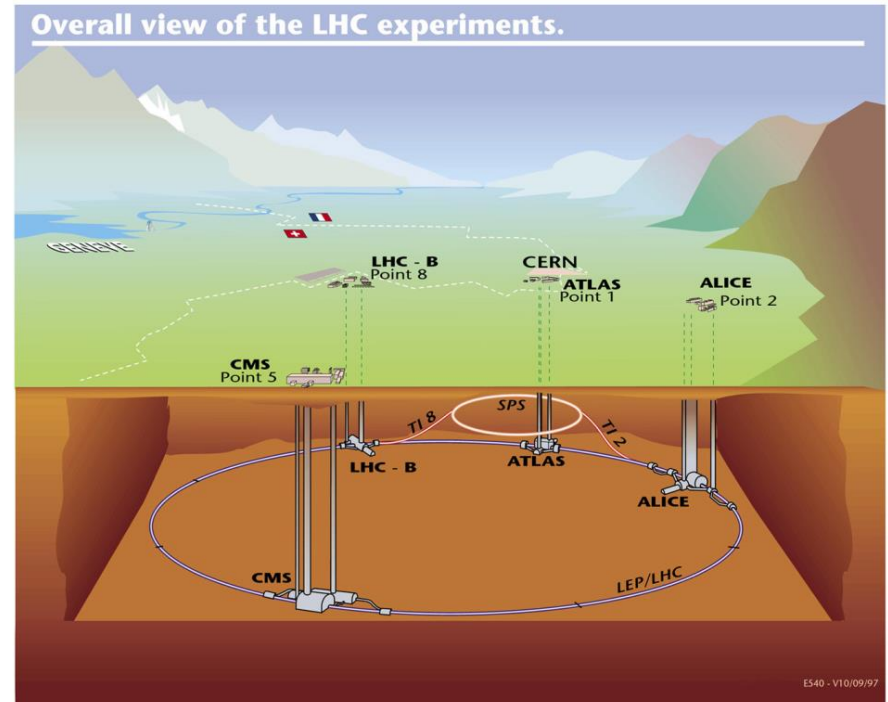


• Collider Phenomenology

- Top quark, Higgs physics
- Electro-weak symmetry breaking
- Jet physics
- New Physics



• $H \rightarrow b \bar{b}$ 事例



• 李湘楠



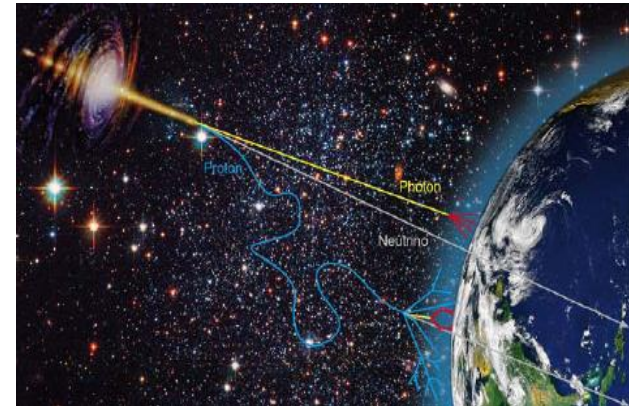
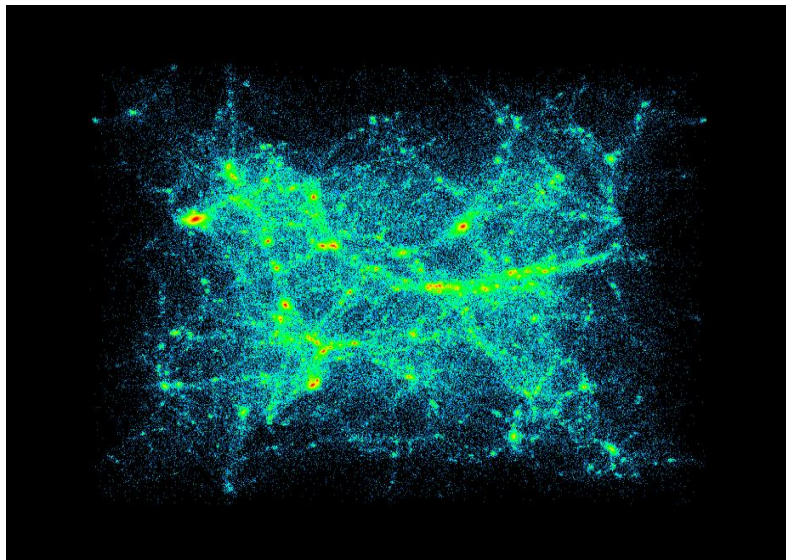
• 阮自強

• Dark Matter & Cosmic Structure

- Formation of the large scale Cosmic structure
- 21 cm line
- Cosmic Rays & DM
- Dark Sector Physics



• 吳建宏



• Particle and Nuclear Astrophysics

- Neutrino physics in stars and stellar explosions
- Binary neutron star mergers and their multimessenger signals
- Neutron star structure and composition
- New Physics imprints in astrophysics
- Ultra-high energy cosmic rays and hadronic interactions



• 吳孟儒



• 吳建宏



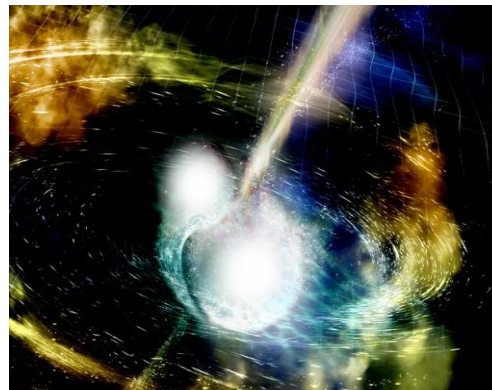
• 安納托里



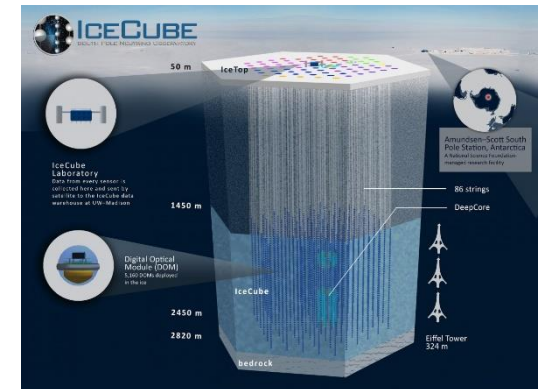
• 楊迪倫



• Supernova explosion



• Neutron star merger



• High-energy neutrinos

• You are welcome to join the quest to
“BOLDLY GO WHERE NO MAN HAS GONE BEFORE”

