

THE OUTLOOK FOR FUNDAMENTAL PHYSICS

WINDOWS ON THE UNIVERSE

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for
Theoretical
Physics



Inaugural Conference

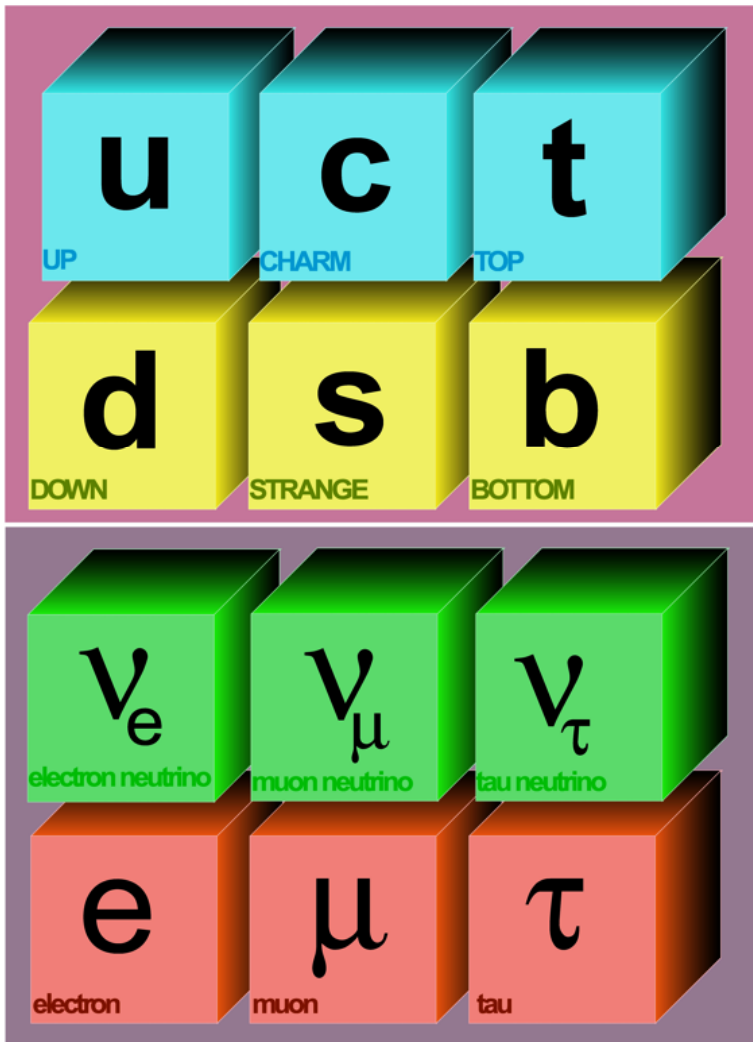
2013

QUY NHON

INTERNATIONAL CENTER FOR INTERDISCIPLINARY SCIENCE EDUCATION

The Standard THEORY Elementary Particles

leptons
quarks



force carriers

- 1 E & M
- 2 WEAK
- 3 STRONG

HIGGS



THE STANDARD THEORY

$$\begin{aligned}\mathcal{L} = & -\frac{1}{4g'^4} B_{\mu\nu} B^{\mu\nu} - \frac{1}{4g^2} W_{\mu\nu}^a W^{\mu\nu a} - \frac{1}{4g_s^2} G_{\mu\nu}^a G^{\mu\nu a} \\ & + \bar{Q}_i i \not{D} Q_i + \bar{u}_i i \not{D} u_i + \bar{d}_i i \not{D} d_i + \bar{L}_i i \not{D} L_i + \bar{e}_i i \not{D} e_i \\ & + (Y_u^{ij} \bar{Q}_i u_j \tilde{H} + Y_d^{ij} \bar{Q}_i d_j H + Y_l^{ij} \bar{L}_i e_j H + c.c.) \\ & - \lambda (H^\dagger H)^2 + \lambda v^2 H^\dagger H + \frac{\theta}{64\pi^2} \epsilon^{\mu\nu\rho\sigma} G_{\mu\nu}^a G_{\rho\sigma}^a\end{aligned}$$

UNBELIEVABLY
SUCCESSFUL

BEYOND THE ST

- Dark Matter ✓
- Neutrino Masses
- Baryon Asymmetry
- Cosmic Acceleration

Exp

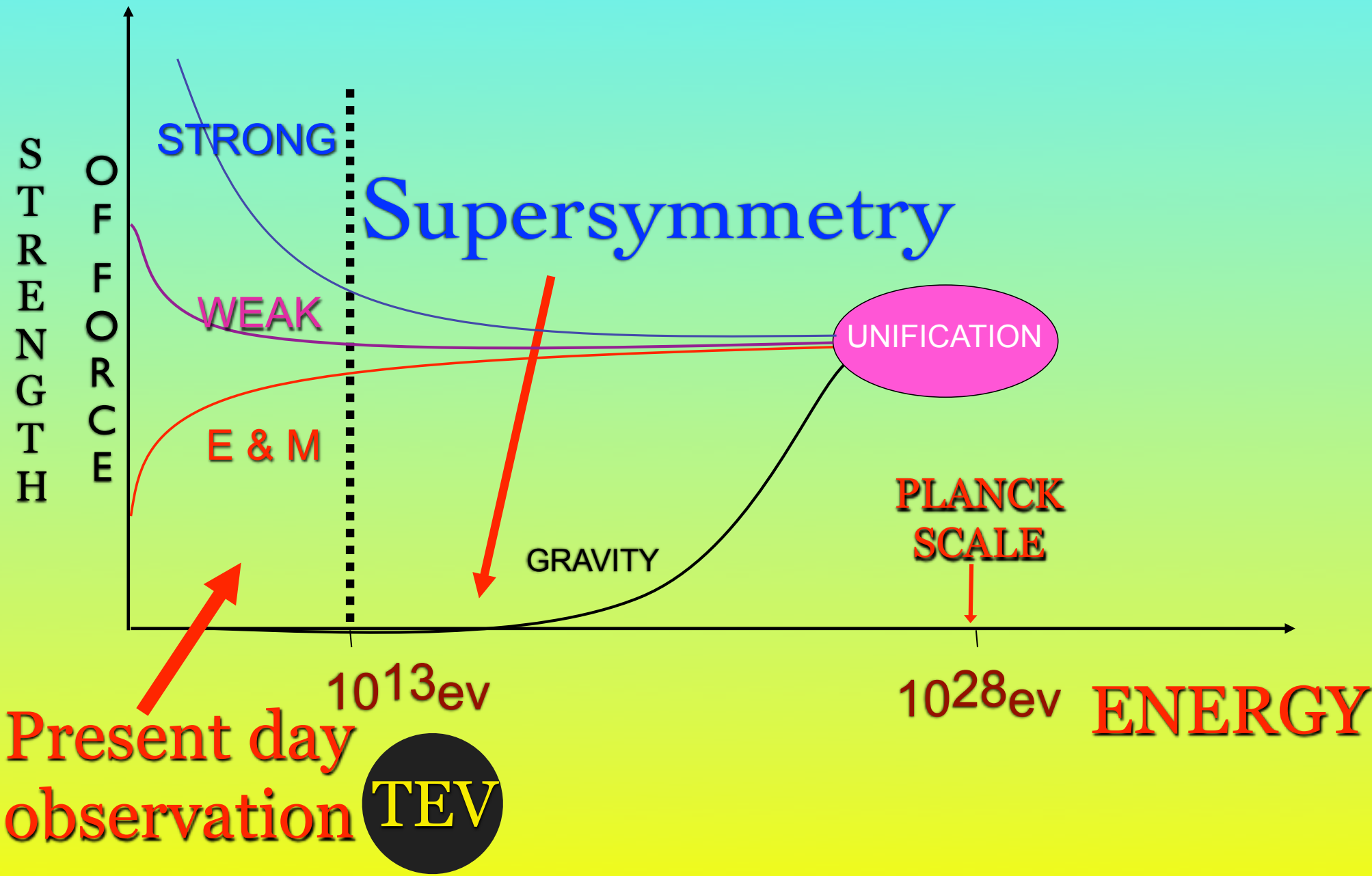
TEV

- Unification ✓
- Electroweak scale, “hierarchy” ✓
- Flavor masses, mixings, generations
- Cosmology, inflation, vacuum energy

Th

SUSY = QUANTUM
DIMENSIONS of SPACE TIME

BEYOND THE STANDARD MODEL



AN IMPORTANT CLUE
FOR UNIFICATION

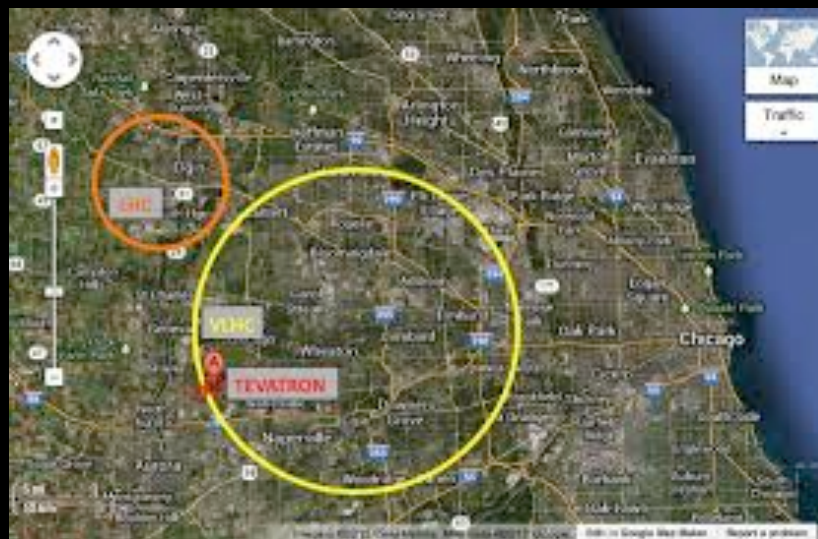
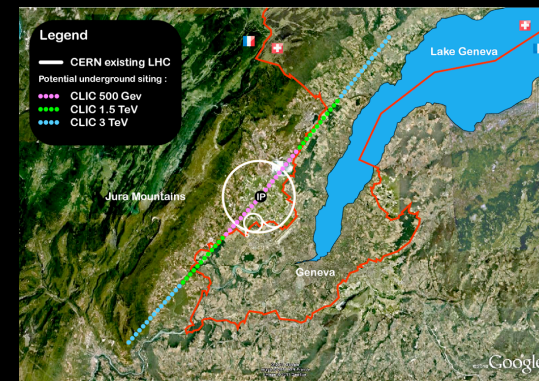
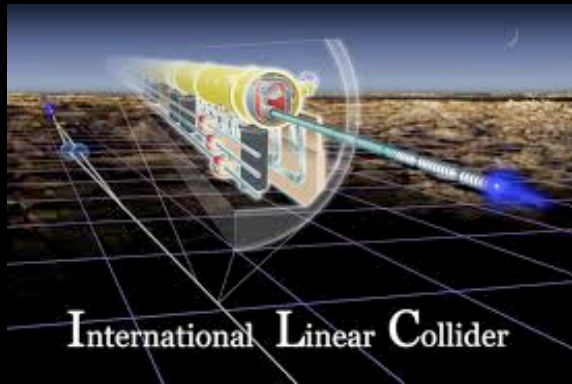
(INCLUDING GRAVITY)

AND SUSY AT \sim TEV

OR

A COINCIDENCE

WE MUST FULLY EXPLORE THE 10-100 TEV ENERGY RANGE



THE FUTURE

2 EXTREME SCENARIOS

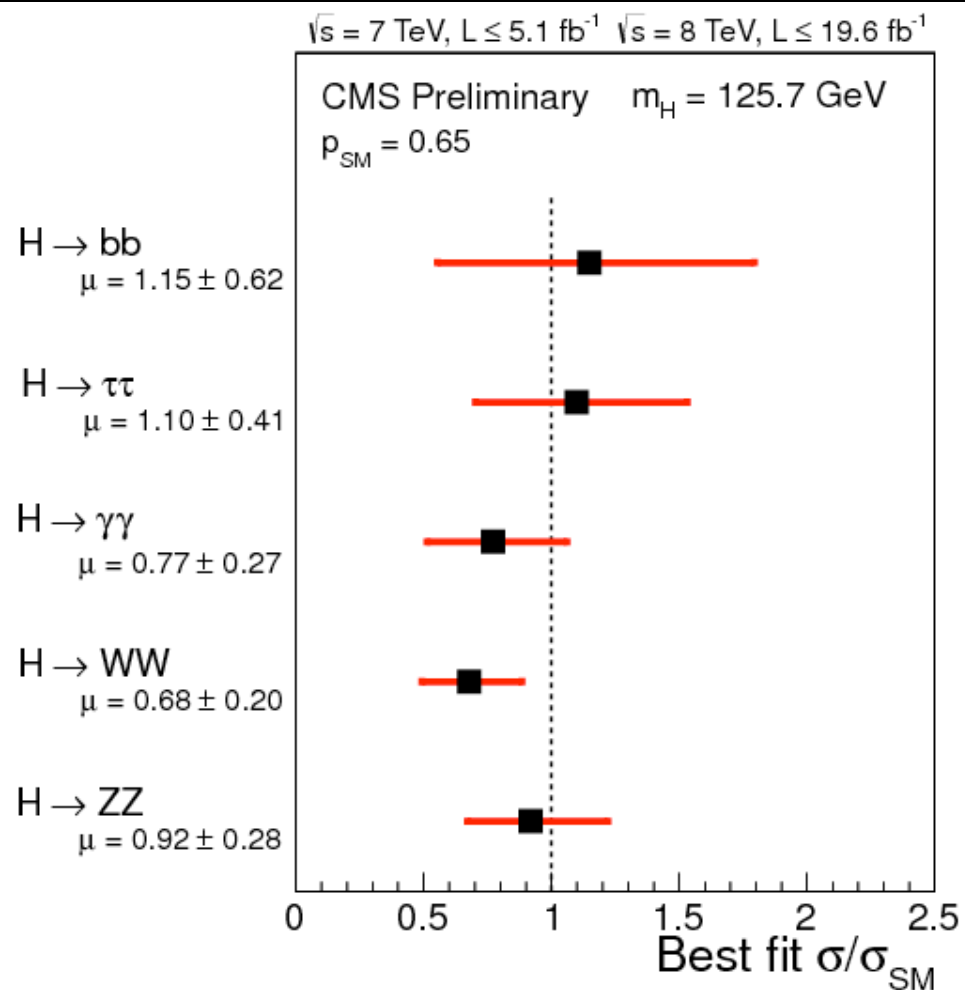
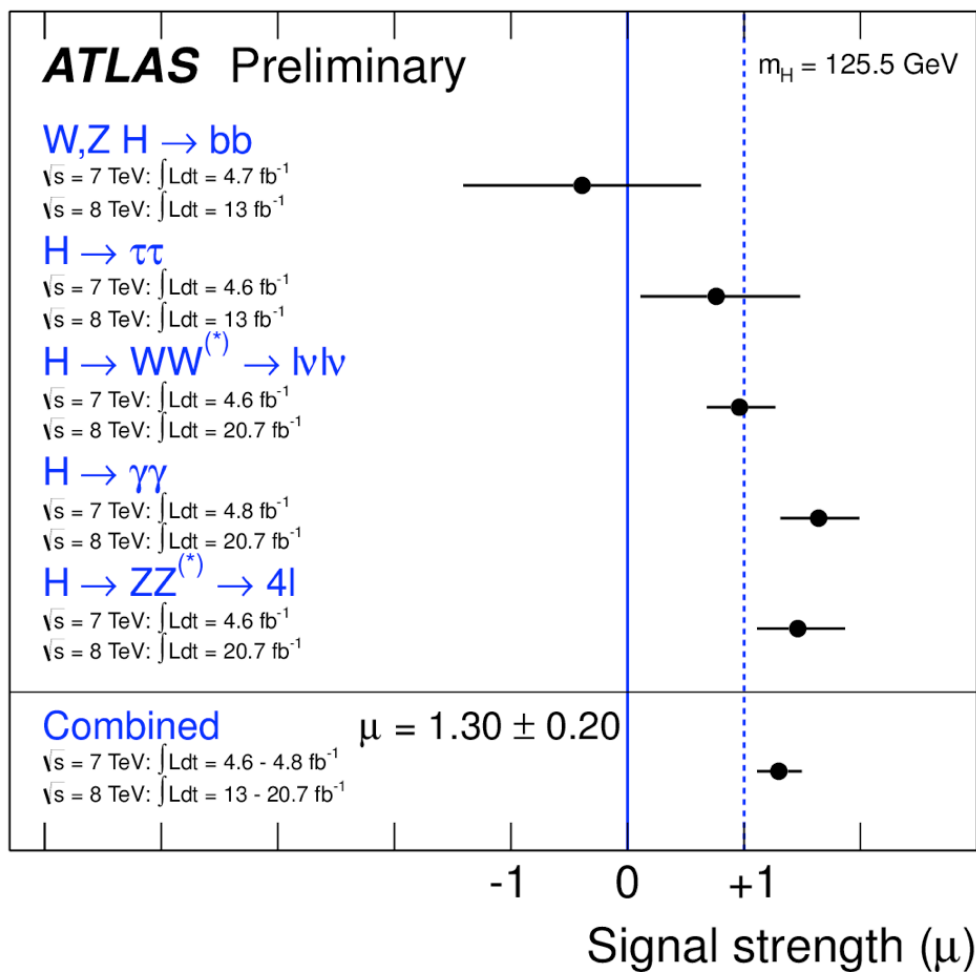


OPTIMISM



PESSIMISM

The Extreme Pessimistic Scenario



★ The Higgs(-like) boson = SM Higgs.

★ No direct signal for SUSY
(or anything else) .

★ No detection of Dark Matter, in the
sky, underground or at the LHC.

★ No direct indication of the next threshold!

Maybe 10^{10} -- 10^{19} GeV

WHAT TO DO ?

The Extreme Optimistic Scenario

- ★ The Higgs(-like) boson \neq SM Higgs
- ★ Direct production of SUSY particles
- ★ Detection of Dark Matter, in the sky, underground and at the LHC
- ★ Strong guidance for the next steps!

ILC, CLIC, HL-LHC, VLHC, HHC, ...

The Framework of Theoretical Physics

QUANTUM
FIELD
FRAMEWORK

Standard Theory

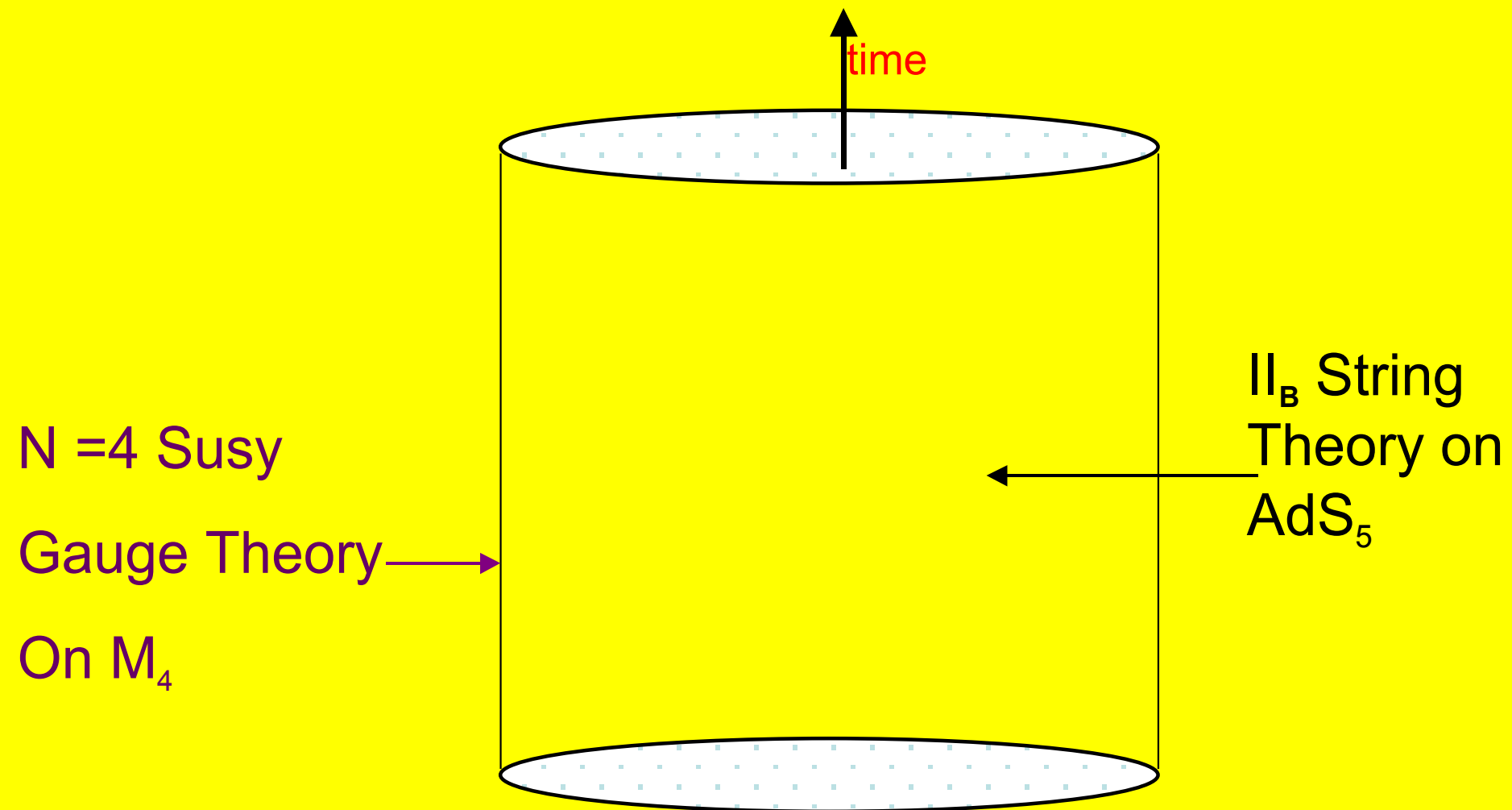


The Framework of Theoretical Physics

An incredible
FRAMEWORK

that includes strings, branes,
all consistent field theories
and quantum gravity.

GAUGE--STRING DUALITY



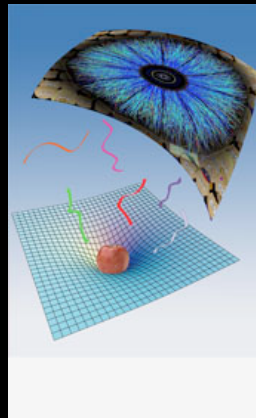
NEW INSIGHTS INTO GAUGE THEORY

STRING THEORY OF QCD

**TRANSPORT COEFFICIENTS OF
QUARK-GLUON FLUID**

**QUANTUM PHASE TRANSITIONS IN
STRONGLY CORRELATED SYSTEMS**

**RESOLUTION OF THE PUZZLES
OF QUANTUM GRAVITY**



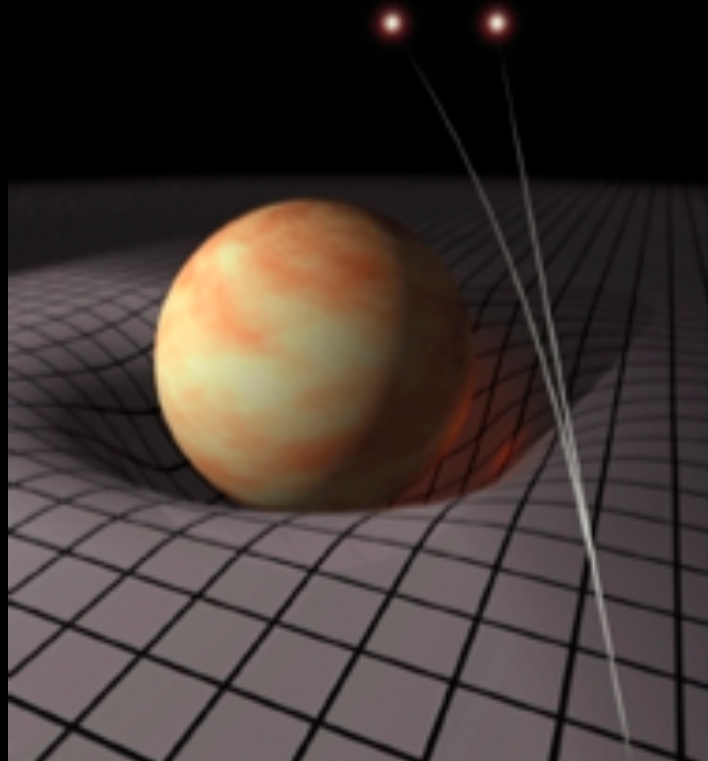
NEW CONCEPTS OF SPACE-TIME

WHAT FIXES THE
DYNAMICS?

WHAT FIXES THE INTIAL
(FINAL) STATE ?

SPACE-TIME

IS ALL OF SPACETIME
EMERGENT?



IS GRAVITY
EMERGENT?

SPACE-TIME

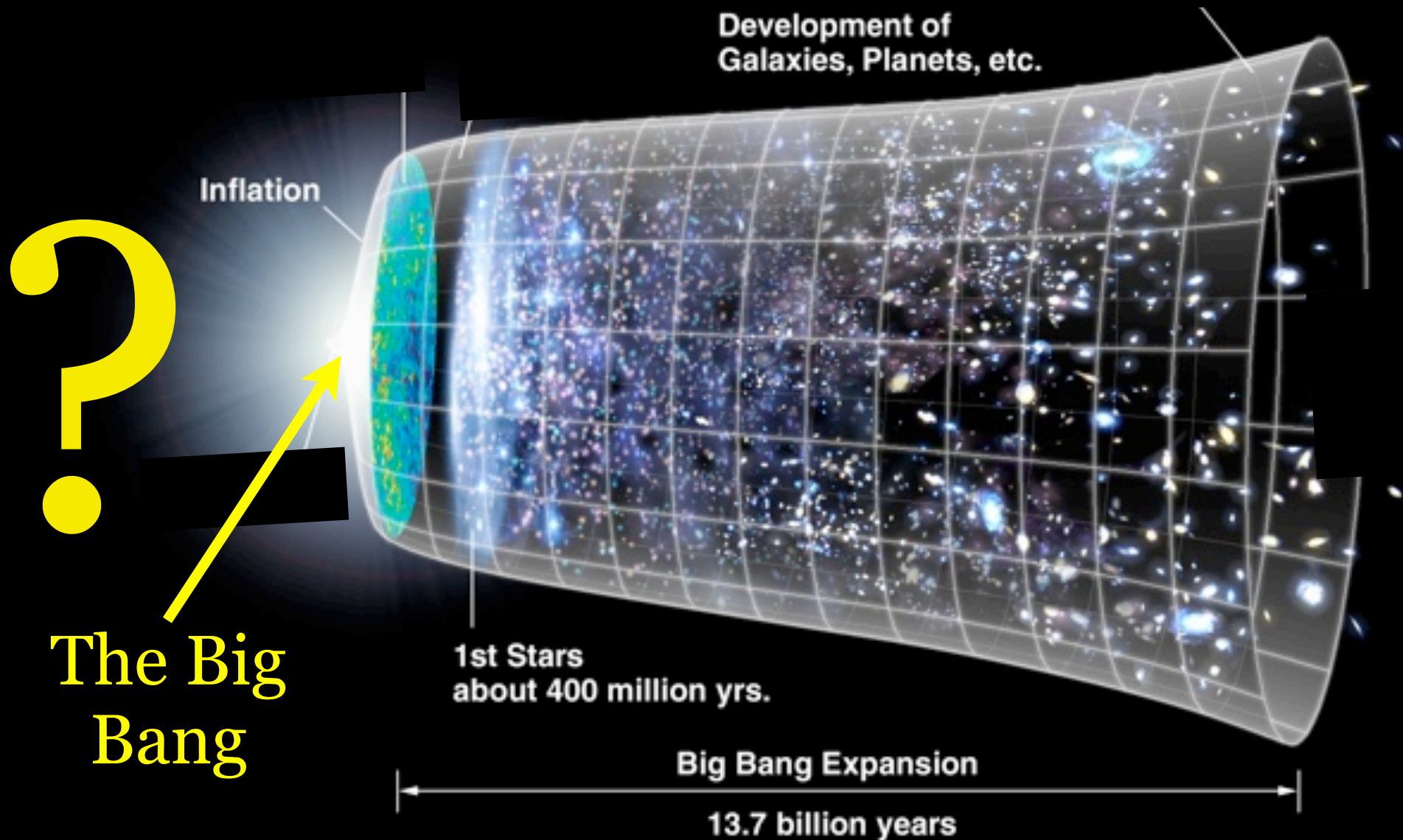
Smooth Manifold

Fixed Topology

Fixed Number of Dimensions

What are the rules of physics
without spacetime?

THE UNIVERSE



Λ

*De Sitter space
Eternal Inflation...*

THE END

B
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Y

THE
UNIVERSE
=
SPACETIME
HISTORY

WHAT ARE THE
OBSERVABLES?

WHAT ARE
THE RULES ?

THE BEGINNING

**WE HAVE A WONDERFUL
THEORY OF ELEMENTARY
PARTICLES**

**BUT THE MOST EXCITING
QUESTIONS REMAIN TO BE
ANSWERED**

**NEW EXPERIMENTS AND
NEW ACCELERATORS
ARE COMING SOON**

**EXCITING NEW
DISCOVERIES ARE
AROUND THE CORNER**

THE BEST
IS YET
TO COME

Congratulations !

Xin Chuc Mung

Jean Tran Thanh Van

ICISE

VIETNAM