

CLOSING REMARKS

David Gross
Kyoto, July 11
2003

Nambu

Sakita*

Kikawa

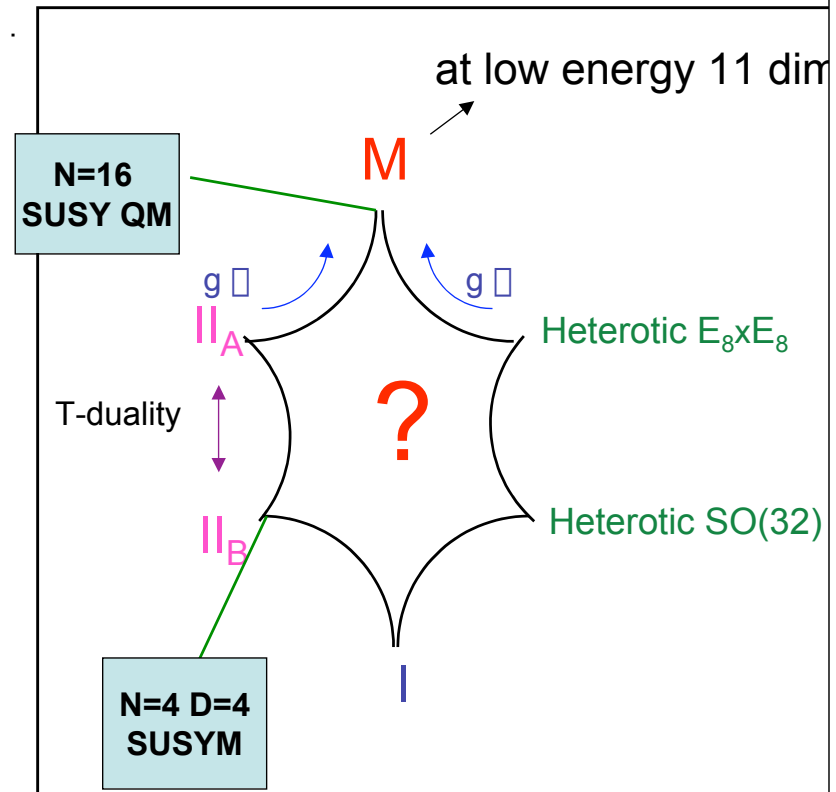
Yoneya

..... *many, many more*

OPENING QUESTIONS
ITP WORKSHOP----1985

2. HOW MANY STRING THEORIES ARE THERE?

Enormous
Progress



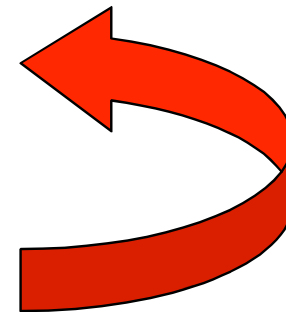
3. STRING TECHNOLOGY

Enormous progress in developing calculational techniques in string theory, and in supersymmetric gauge theory.

4. WHAT IS THE NATURE OF STRING
PERTURBATION THEORY?

Enormous
Progress

Matrix Models
Dualities
Branes
F-Terms
SFT: Tachyon Decay



6. What is the Nature of High Energy Physics

By this I mean what does physics look like at energies well above the Planck scale. This is a question that is addressable for the first time and may be of more than academic interest for cosmology. In analogy with past theories one might expect physics in this domain to look entirely different. Does the string undergo a phase transition at high temperatures or densities to a new phase, as perhaps indicated by the existence of a limiting temperature? Can one avoid in string theory the ubiquitous singularities that plague general relativity?

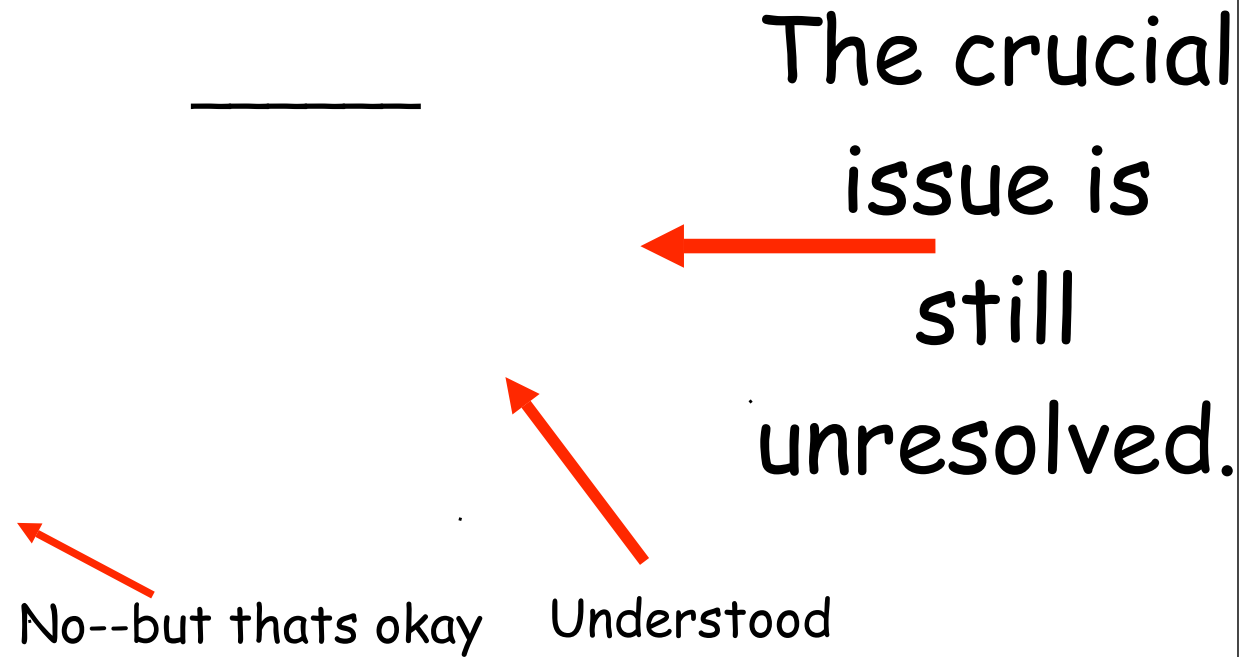
Remarkable
progress
for static
singularities

Not much
progress for
time dependent,
and especially
cosmological,
singularities

5. String Phenomenology

Great progress, but
still not constructed.

7. What Picks the Correct Vacuum?

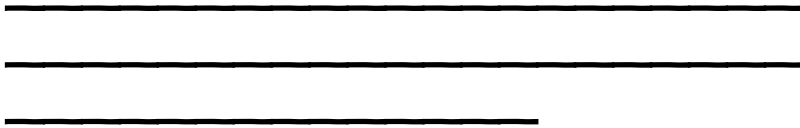


8. Is There a Measurable, Qualitatively Distinctive Prediction of String Theory?

New Scenarios:
Large Extra
Dimensions

But accessible
signatures seem
to be unlikely.

1. WHAT IS STRING THEORY?



This remains the most important unanswered question.

How many more string revolutions will be required?

EARLY 1960'S

There are no obvious fundamental constituents of hadronic matter and all attempts to describe the strong interactions by means of quantum field theory have failed.

THEREFORE:

There are no fundamental constituents, there is no dynamics only general principles (analyticity, unitarity ...)

THE BOOTSTRAP PRINCIPLE

EARLY 2000'S

There are $\sim 10^{1000}$ consistent metastable vacua and all attempts to find a a unique vacuum have failed.

THEREFORE:

There is no principle that picks a unique state. Many features of nature cannot be calculated or explained, except by appealing to our existence.

THE ANTHROPIC PRINCIPLE

THE BOOTSTRAP PRINCIPLE

QCD: An asymptotically free non-Abelian gauge theory of quarks and gluons

All dimensionless parameters are calculable
(neglecting quark masses)

The details of nuclear physics
necessary for stellar structure and
life are completely calculable.

We do not know what string theory is.

We may have 10^{1000} consistent metastable vacua,
but not a single consistent cosmology.

Perhaps there is a unique cosmology.

We suspect that a profound conceptual change in our
concept of space & time will be required for the final
formulation of string theory.

If so, the criterion for determining the state of nature
(the vacuum) could be very different.

“ NATURE IS CONSTITUTED SO THAT IT IS
POSSIBLE TO LAY DOWN SUCH STRONG
DETERMINED LAWS THAT WITHIN THESE LAWS
ONLY RATIONALLY COMPLETELY DETERMINED
CONSTANTS OCCUR, NOT CONSTANTS THEREFORE
THAT COULD BE CHANGED WITHOUT COMPLETELY
DESTROYING THE THEORY. ”

ALBERT EINSTEIN

No Free Parameters

No Arbitrariness

NEVER

NEVER

NEVER

NEVER

NEVER GIVE UP

Thanks to all the
organizers for an
exciting, stimulating
and extremely well
organized
conference

NEXT
YEAR IN
TORONTO