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1. Opening remarks

a) Very happy to be invited

b) 50 yrs ago I spent a few years in this area. Not at Hondai

The campus was in Osaka

This area ---

Progress ?

↓

Kikuchi

Yukawa

c) Speaking of progress

100 yrs since the electron

60 yrs " μ

30 yrs W-S

20 " ν

10 supernova neutrinos

d. Physicists are forward looking

But sometimes useful to stop & look back

Being the oldest participant, this would be the way I could contribute to the conference

The remarkable century

100 yrs since	the electron	1897	J.J. Thomson
	radioactivity	1896	Becquerel
	proton	1911	Rutherford
	neutron	1932	Chadwick
	μ	1937	Anderson
	π	1947	Powell

Theories — Relativity

Quantum mechanics

particle physics since 1930

Accelerators	1931	Lawrence
Meson theory	1935	Yukawa

Livingston's law

$$\log(E/\text{Mev}) = (\text{Yr} - 1930)/10$$

Where do we stand ? Standard Model

Where are we going ? ?

3-stage cycles of particle physics (M. Taketani)

1. phenomenology
   When we do not know anything, collect data, organize them, and find regularities

   1930s → SU(3)

2. Then make hypotheses and build models

   Quark Model

3. Then construct a precise and comprehensive mathematical theory

   Standard Model

4. Inevitable new physics
   → Goto 1.

But a change of character since the 1970s.

Three theoretical modes

	Yukawa	Einstein	Dirac
direction	exper → th	th → exp	th → exp
means (mostly)	particles	fields	
driven by	phenomen/ models	general principles	math. esthetics
nature	ad hoc	inclusive	speculative

Mode	Yukawa	Einstein	Dirac
monopole			X
meson	X		
renormal		X	
parity	X		
gauge th.		X	
quark	X		
broken sym		X	
Regge pole		X	
parton	X		
QCD		X	
CKM	X		
SUSY			X
Superstr.			X
SU(5)	X		
GUTS		X	
W-S		X	
SM			

Synthesis

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4. Theoretical modes

	"particles"	"fields"			
	Yukawa	Einstein	Dirac	Planck	Synthesis
	phen/model	gen principle	speculative	revolut.	or
	exp driven	theory driven	math driven	(exp driven)	
special rel		X		(X)	
photon	(X)			(X)	QM
gravity	X	X			
QM	(X)			X	
K-K			X	X	
neutrino	X				
Dirac eq		X	X?	X	
monopole			X		
π-meson	X				
renorm		X			
parity	X				
gauge th		X			
quark	X				
color	X	X			
SSB		X			
(bootstrap)		(X)			
Regge pole		X			
dual string	(X)				
asympt freed		X			
CKM	X				
superstring			X		
electroweak		X			
SU(5)	X				
SM					X
GUTS		X			
	8	10	4	3	1
		(1)			

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5. (major) Open problems of SM.

a, masses & mixings } exp, th
neutrinos }
b. Higgs boson
} mass problem
c. hierachy th

d. unification → GUTS
SUSY
superstring

6. Exercise in Sakata thesis of 1st stage / Yakawa mode
Remark: GUTS motivated by the gauge sector
Mass problem may be a separate problem.
a. mass spectrum leptons −3.5 4.5 8.5
7 4
b. gauge coupling consts.

Mass problem may be separate from the
7. unification problem.

Look at the data without prejudice.