

Strings 2021, ICTP-SAIFR, São Paulo, June 21-July 2, 2021

Discussion Session on String Universality, Particle Physics and Cosmology

Outline:

Part One: Particle Physics Constructions M.C.

Part Two: Moduli Stabilization, Cosmology Gary Shiu

Part Three: Further Comments & Outlook Miguel Montero; Pablo Soler; Ling Lin

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Discussion Session on String Universality, Particle Physics and Cosmology

Part One: Particle Physics Constructions

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Focus: Standard Models & Globally Defined (Calabi-Yau) Compactification Spaces

I. Heterotic $E_8 \times E_8$ string \rightarrow particle physics promising Candelas Horowitz Strominger Witten '85

SM \times $U(1)_{B-L}$ (w/ two Higgs doublets): He Ovrut Pantev'04...

MSSM (w/ one Higgs doublets): Bouchard Donagi'05; Bouchard M.C. Donagi'05...

Orbifold constructions:...Lebedev Nilles Raby Ramos Ratz Vaudrevange Wingerter'07-'10...

Landscape analysis (Complete intersection Calabi-Yau's): Anderson Gray Lukas'09-'18...

(10^{10} SMs; phenomenological issues)

c.f., Lara Anderson's talk

II. Type II string \rightarrow intersecting/magnetized branes – geometric/CFT techniques Berkooz Douglas Leigh '96

Aldazabal Franco Ibañez Rabadan Uranga '00; Angelantonj Antoniadis Dudas Sagnotti'00;
Ibañez Marchesano Rabadan '00; Blumenhagen Kors Lüst Ott'01..

SM (w/ chiral exotics): M.C. Shiu Uranga '01... landscape analysis: ...M.C. Halverson Langacker'05-'11...

III. F-theory \rightarrow strong coupling regime – geometry of singular elliptically fibered CY four-folds

Donagi Wijnholt'08; Beasley Heckman Vafa'08

Towards SM: Krause Mayrhofer Weigand'12.... First SM: M.C. Klevers Peña Oehlmann Reuter'15

Landscape of quadrillion $O(10^{16})$ QSMs (w/ gauge coupling unification) M.C. Halverson Lin Liu Tian'19...

Raghuram Taylor Turner'19-'20...

Towards exact vector-like matter spectra: Bies, Mayrhofer Pehle Weigand'14...

Quantitative vector-pair jumps (Brill-Noether; ML) Bies M.C. Donagi Ruehle Lin Liu'20

Vector pairs in QSMs (root-bundles) \rightarrow MSSMs Bies M.C. Donagi Liu Ong'21... \rightarrow comment by Martin Bies

Globally consistent particle physics constructions → include quantum gravity →
Program to quantify Constraints on Global Gauge Structures & Charged Matter Spectra
→ Leading to Universal Structures in String Theory

D=4 top-down approaches extremely limited:

F-theory constraints

on matter representations: M.C. Klevers Peña Taylor'15...Klevers Morrison Taylor'17...

also, w/ U(1)'s ...M.C. Lin'18... bound on # of U(1)'s Lee Lerche Weigand'19...

...

c.f., Irene Valenzuela's review talk

...

constraints on N=1 superpotential: Palti Vafa Weigand'20

More progress in D>4, in particular D=8 top-down:

Constraints on global gauge structures:

M.C. Dierigl Lin Zhang'20 (higher-form symmetries) '21 (F/M-theory; string junctions); Montero

Vafa'20 (cobordism); Font Fraiman Grana Nunez ParraDeFreitas'20 (heterotic) ... Hamada Vafa'21...

c.f., Cumrun Vafa's talk

→ Further comments/outlook by Ling Lin, Miguel Montero & Pablo Soler

Highlighted developments in the gauge and charged sector of string compactification
w/ particle physics implications

Important (complementary) issues:

Moduli stabilization...supersymmetry breaking...cosmological implications... - not unrelated

→ Part Two