

Vector-like spectra in F-theory 1

Martin Bies

University of Pennsylvania

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With M. Cvetič, R. Donagi, L. Lin, M. Liu, F. Rühle – 2007.00009

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- Need (massless) vector-like pair(s) to accommodate the Higgs.
- Vector-like spectra in F-theory: non-topological.
- How can we control vector-like spectra in F-theory?

Jumps from complex structure deformations

- Massless matter localizes on *matter curves* C_R .
- Line bundles L_R on C_R count vector-like spectra:

[M.B. Mayrhofer Pehle Weigand '14], [M.B. Mayrhofer Weigand '17], [M.B. '18]

$$h^0(C_R, L_R) \leftrightarrow \text{chiral matter}, \quad h^1(C_R, L_R) \leftrightarrow \text{anti-chiral matter}.$$

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- Challenges in F-theory:
 - L_R **not** pullback from a (toric) ambient space.
 - In realistic setups, L_R has to satisfy subtle conditions (cf. talk by MUYANG LIU).
 - Jumps from complex structure deformation $C_R \rightarrow \tilde{C}_R$: $h^0(\tilde{C}_R, L_R) = h^0(C_R, L_R) + 1$.

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- In 2007.00009 – investigate jumps in **simple** setup:

- Curves $C(P) = \{P = 0\} \subseteq dP_3$ and $L_R = \mathcal{O}_{dP_3}(d)|_{C(P)}$.
- Identify $h^i(C(P), \mathcal{O}_{dP_3}(d)|_{C(P)})$ for different **coefficients** of P and different d .
- Compute with https://github.com/homalg-project/ToricVarieties_project

Run on Plesken.mathematik.uni-siegen.de, Oxford Hydra cluster, Google cloud.

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- ⇒ 1.8×10^6 data sets: <https://github.com/Learning-line-bundle-cohomology>

- We use decision trees, to analyse our data:

- 1st origin of jumps: Curve factors, e.g. $C(P) \rightarrow \mathbb{P}^1 \cup \tilde{C}(P)$.
- Example (factor-off combinations of \mathbb{P}^1 s):

$$h_{\text{generic}}^0 = 15 \quad \rightarrow \quad h_{\text{split}}^0 \in \{15, 17, 18, 19, 20, 21\}.$$

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- Deeper insights from algebraic geometry:

- 2nd origin for jumps: Brill-Noether theory

[1874 Brill, Noether] – more modern exposition in [Mumford '75], [Griffiths, Harris '94] ...

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- Muyang Liu will tell you about our current work, now.

Thank you for your attention!

