Mordell–Weil and the Global Gauge Group of F-theory

based on arXiv:1706.08521

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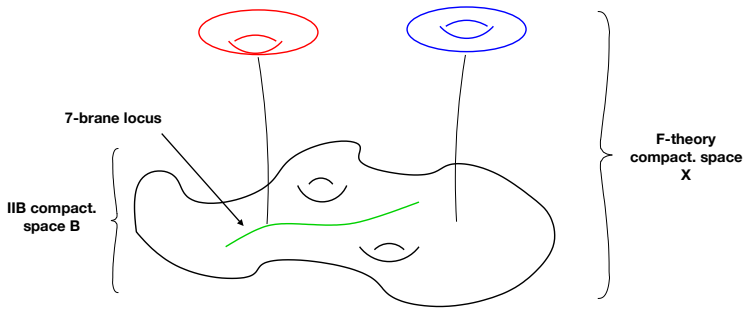
Geometry/Physics dictionary of F-theory

F-theory geometrizes 7-brane gauge dynamics in non-perturbative type IIB compactifications. Physics is encoded in fiber singularities of elliptic fibration X.



By now: well-established correspondence between geometry and physics. E.g.:

non-abelian gauge algebra $\longleftrightarrow$ ADE fibers (codim. 1),

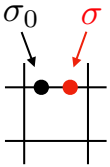
massless matter $\longleftrightarrow$ codim. 2 singular fibers,

...

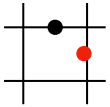
Significance of the Mordell–Weil group

- Rank n $\mathrm{MW}(X) \longleftrightarrow \mathfrak{u}(1)^{\oplus n}$ abelian gauge symmetry ([Morrison/Vafa, '96], [Morrison/Park, '02])
- Shioda homomorphism $\varphi : \mathrm{MW}(X) \to \mathrm{NS}(X) \quad \Longrightarrow \quad \varphi(\sigma)$ dual to $\mathfrak{u}(1)$ gauge field.
  φ splits isomorphism $\mathrm{MW}(X) \cong \mathrm{NS}(X)/\mathcal{T}$, where $\mathcal{T}$ = zero section + fibral divisor.
- Intersection theory on $X \longrightarrow$ precise form of φ restricts allowed $\mathfrak{u}(1)$ charge for non-abelian matter representations.
  $\Longrightarrow$ **non-trivial global structure of gauge group**.
  Extension of analysis for torsional sections ([Mayrhofer et al, '14])

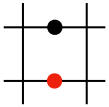
Example:



$$G_{\mathrm{glob}} = SU(4) \times U(1)$$



$$G_{\mathrm{glob}} = \frac{SU(4) \times U(1)}{\mathbb{Z}_4}$$



$$G_{\mathrm{glob}} = \frac{SU(4) \times U(1)}{\mathbb{Z}_2}$$

Physical implications

- Model building: F-theory models with Standard Model gauge symmetry ([LL & Weigand, '14], [Cvetič et al, '15]) 'naturally' realizes full gauge group $[SU(3) \times SU(2) \times U(1)_Y]/\mathbb{Z}_6$.
  $\longrightarrow$ What about spectrum of line operators?
- Charge constraint is stronger than other consistency conditions (anomaly cancellation, charge minimality) $\Longrightarrow$ can be used to rule out supergravity models in the 'swampland'.
  $\longrightarrow$ Possible connection to weak gravity conjecture?

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Thank you for your attention!