AdS$_6$ solutions of type II supergravity

Marco Fazzi

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Motivation

We are interested in **higher-dimensional CFTs**,
hard to study with traditional methods.
especially d=6 and d=5

(2,0) on M5 unique. (1,0)?

[Heckman-Morrison-Vafa '13
Gaiotto-Tomasiello '14]

few examples of
5d conformal theories

[Seiberg '96
Morrison-Seiberg '96
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We are going to attack the problem **holographically:**

We will pave the way for a full classification of
***N* = 1 supersymmetric AdS$_6$ vacua in type IIB**:
classification problem reduced to two PDEs

Full classification of $\mathrm{AdS}_7 \times M_3$ [Apruzzi-MF-Rosa-Tomasiello '13]

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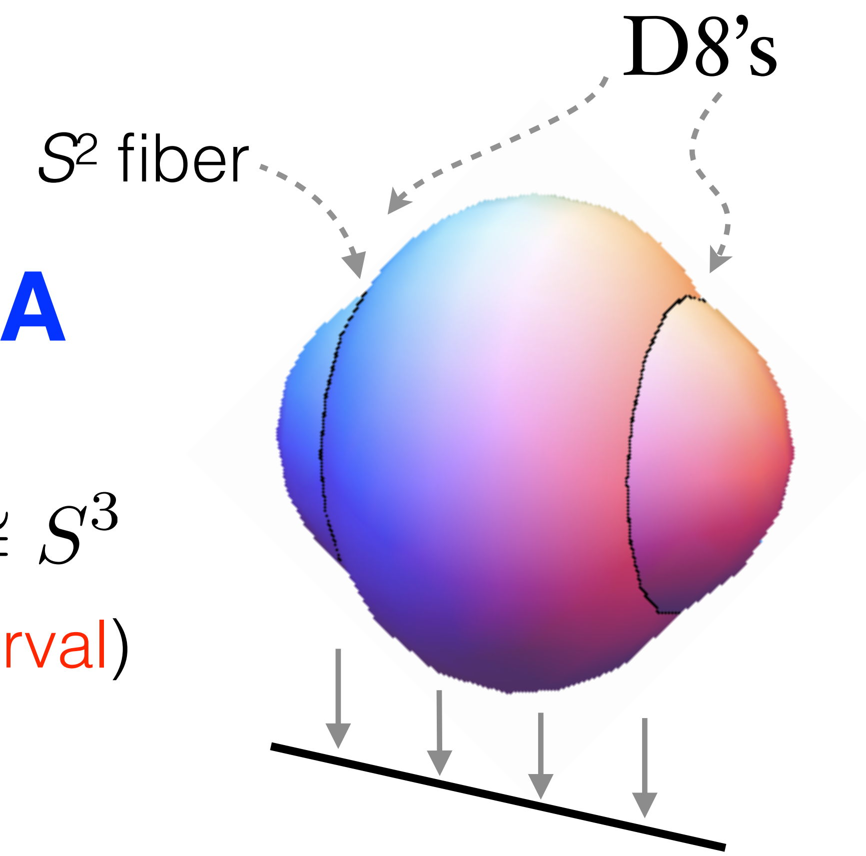

topologically $M_3 \cong S^3$

(S^2 fibration over interval)

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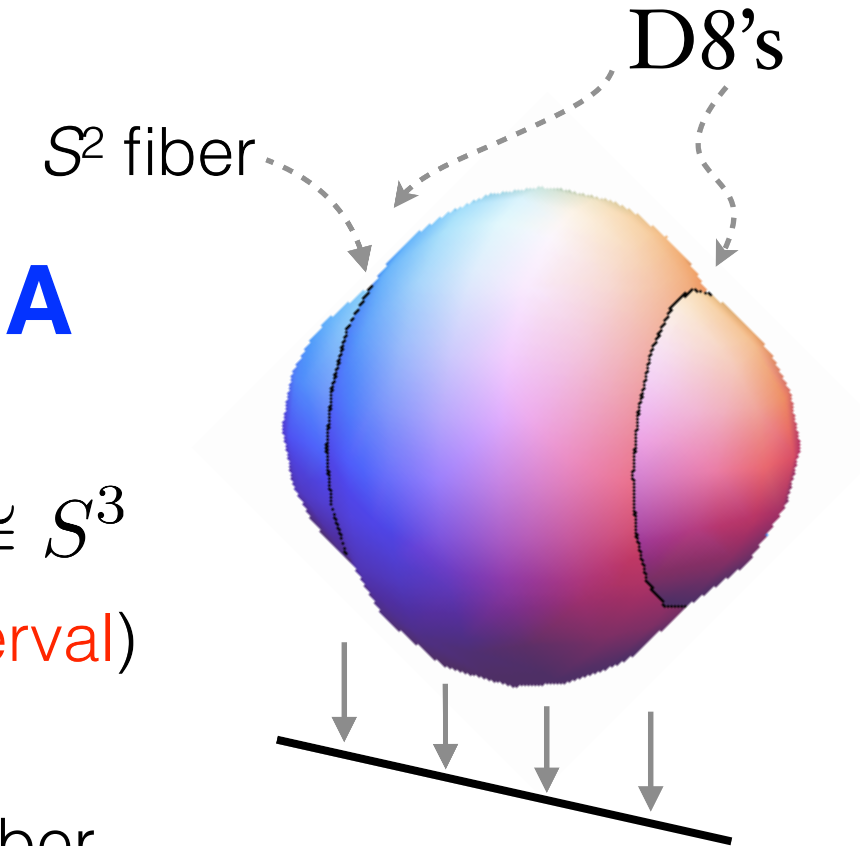

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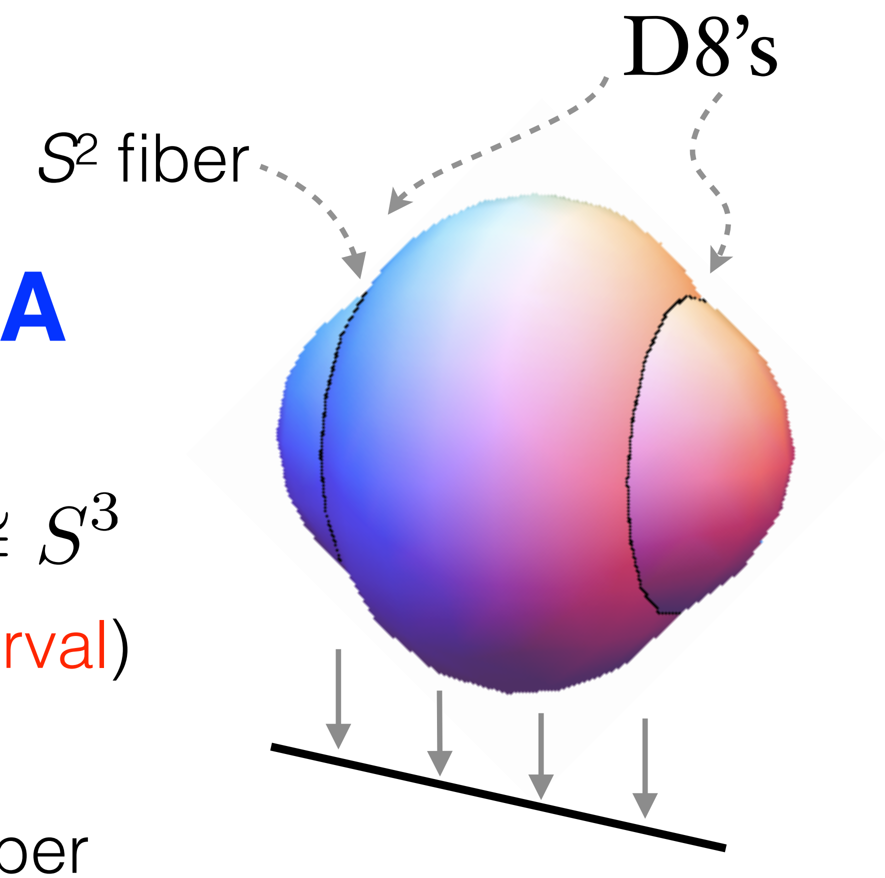

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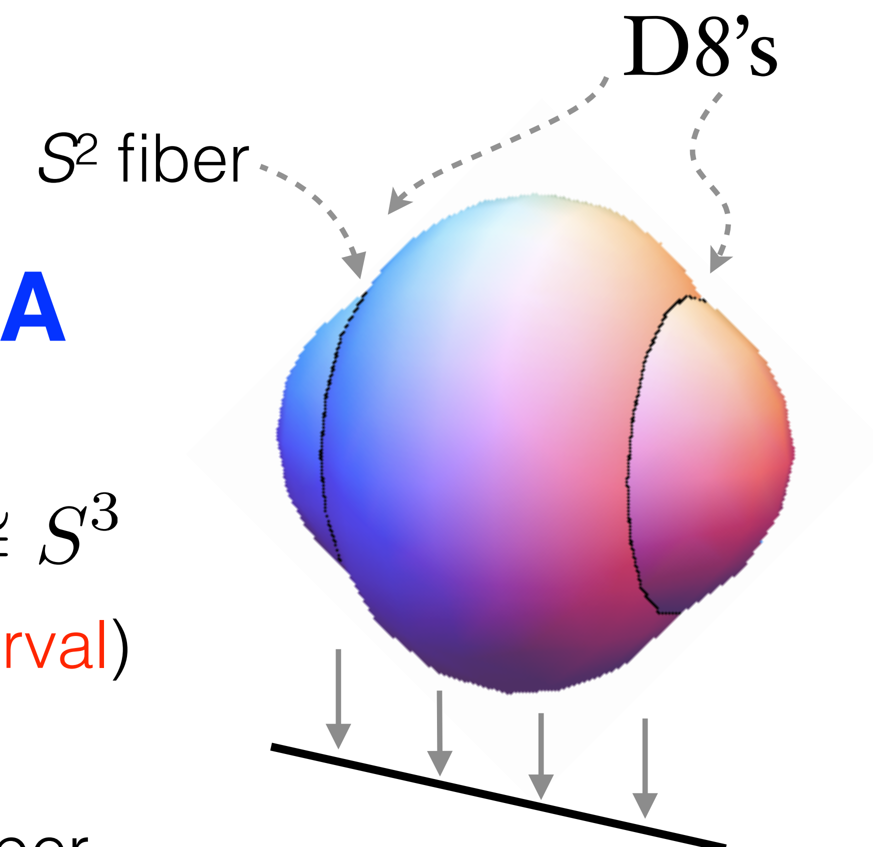

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near-horizon of NS5-D6-D8 system ◀·······▶ dual to 6d (1,0) SCFT

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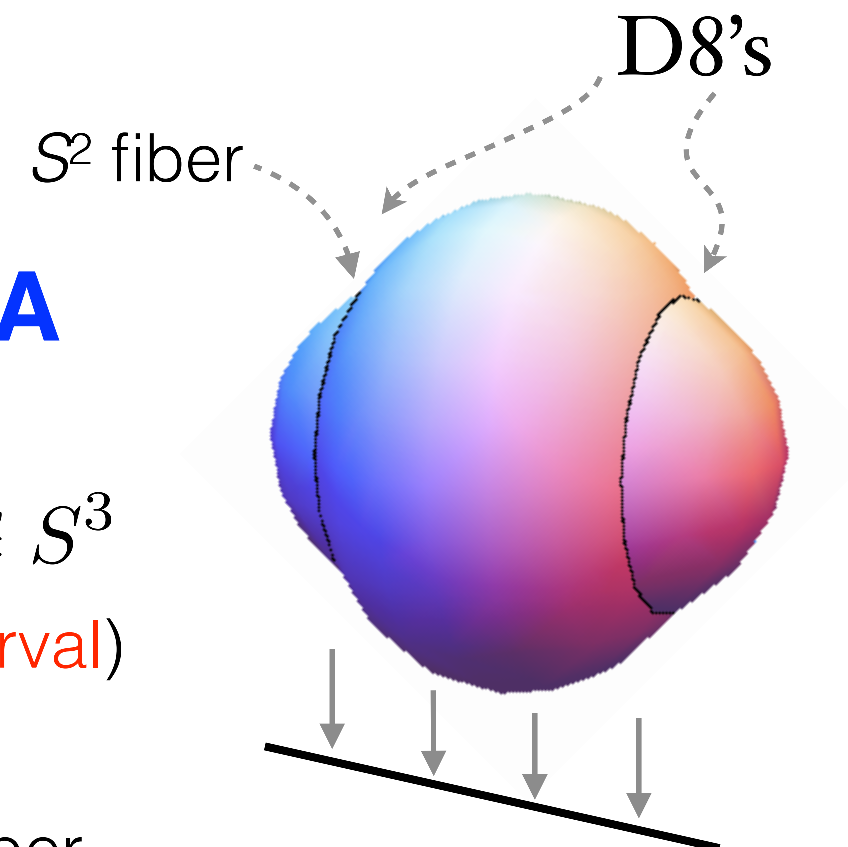

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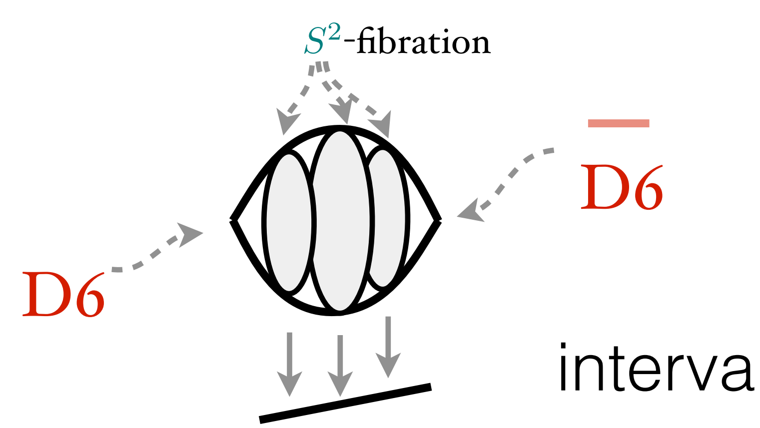
[Freund-Rubin '80]

massless IIA: reduction of AdS$_7$ x S^4 in 11d
D6 and **anti-D6** at poles of S^3



Pure spinor approach to type II theories

10d susy parameters $\epsilon_{1,2}$ define one ***G*-structure** Φ on $T \oplus T^*$

BPS eqs. to find vacuum

$$\delta\psi_{1,2} = 0$$
$$\delta\lambda_{1,2} = 0$$

[Tomasiello '11]

=

on any *M*10

NS 3-form

defined by Φ

total RR flux

$$(d - H\wedge)\Phi = (\tilde{K}\wedge + \iota_K)F$$

+ extra eqs., often redundant

gives system of differential eqs. for forms on internal space

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AdS6 x M_4

Id. x Id. structure ⊃ Vielbein

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original example: $\left.\begin{array}{l}\text{AdS}_4 \text{ x} \\ \text{Mink}_4 \text{ x}\end{array}\right\} M_6$

[Graña-Minasian-Petrini-Tomasiello '05]

SU(3) x SU(3) structure

(nice differential equations)

System for IIB on AdS$_6$ x$_w$ M_4*

$$d_H(\Psi_- - \Psi_+)^0 - 2(\Phi_- + \Phi_+)^0 = 0$$
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$$\|\eta^1\|^2 = \|\eta^2\|^2 = e^A$$

A = warping

F = total RR flux

$$d_H = d - H\wedge$$

*up to factors of dilaton and warping

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Clifford map = $\left[\begin{array}{c} \gamma^{i_1 \ldots i_k} \\ \cong \\ dx^{i_1} \wedge \ldots \wedge dx^{i_k} \end{array}\right]$

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$\Phi_\pm \ \Psi_\pm$: **SU(2)-covariant** differential forms on M_4

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$\alpha = 1,2,3$ SU(2)-**triplet**

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$$\Phi^0_\pm = \eta^1_\pm \otimes \eta^{2\,\dagger}_\pm$$
$$\Psi^{\alpha=3}_\pm = \eta^1_\pm \otimes \overline{\eta^2_\mp}$$

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- **Parametrizing** the forms, we can solve the systems

  one Vielbein $\{e_i\}$ and 4 angles $\alpha,\ x,\ S^2(\theta_1, \theta_2)$

  generalized structure on M_4 $\qquad$ M_4 is 4d

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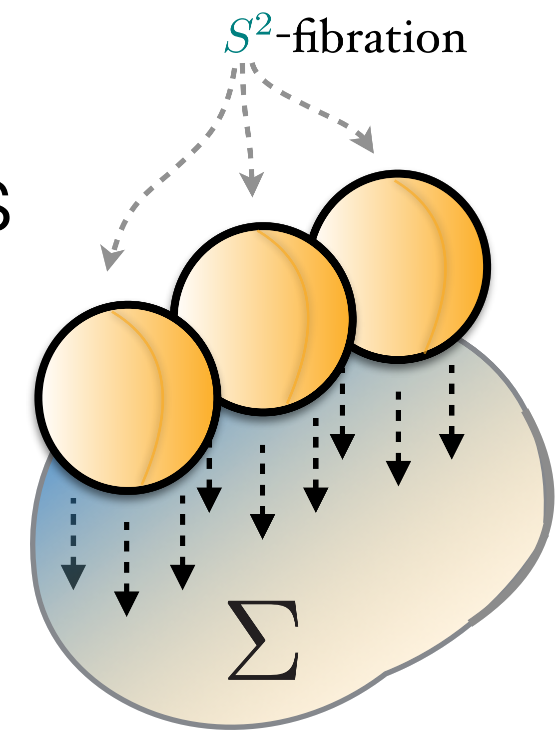
- **Determine explicitly** metric on M_4 and fluxes

  $M_4 = S^2$ fibration over a 2d space $\Sigma(\alpha, x)$

  nontrivial H, F_1, F_3



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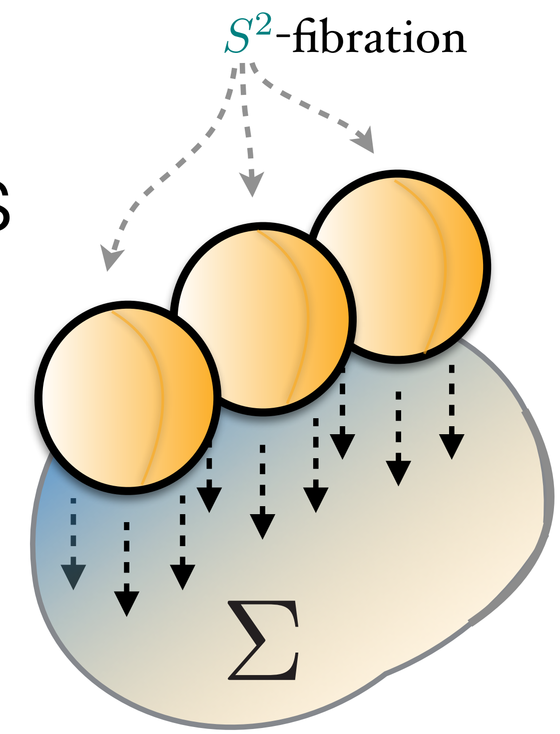

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  (in AdS7, modify Bianchi to include D8/D6-brane sources)

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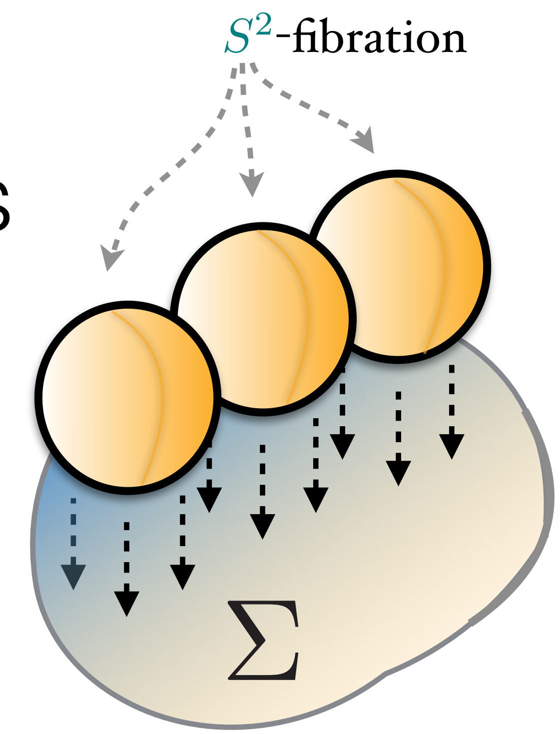

- M_4 has **SU(2) isometry** = **R-symmetry** of dual 5d CFT

  (N = 1 5d algebra unique. R-symmetry unique)

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So far: the pure spinor formalism has allowed us to solve (almost all) BPS equations, but… 2 differential equations still need to be solved: highly nonlinear PDEs

We reduced the classification problem to finding solutions to 2 PDEs*

PDEs govern geometry of $\Sigma(\alpha, x)$

*in AdS7, easier story: "just" 3 ODEs admitting solutions with sources (magnetized D8's wrapping S^2 fiber in M_3)

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solution depends on 2 functions at the boundary of Σ:

well-formed system

(using EDS machinery)

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Brandhuber-Oz solution

[Brandhuber-Oz '99]

in **massive IIA**, there exists **only one solution***:
near-horizon of N D4's probing O8 coincident with N_f D8's

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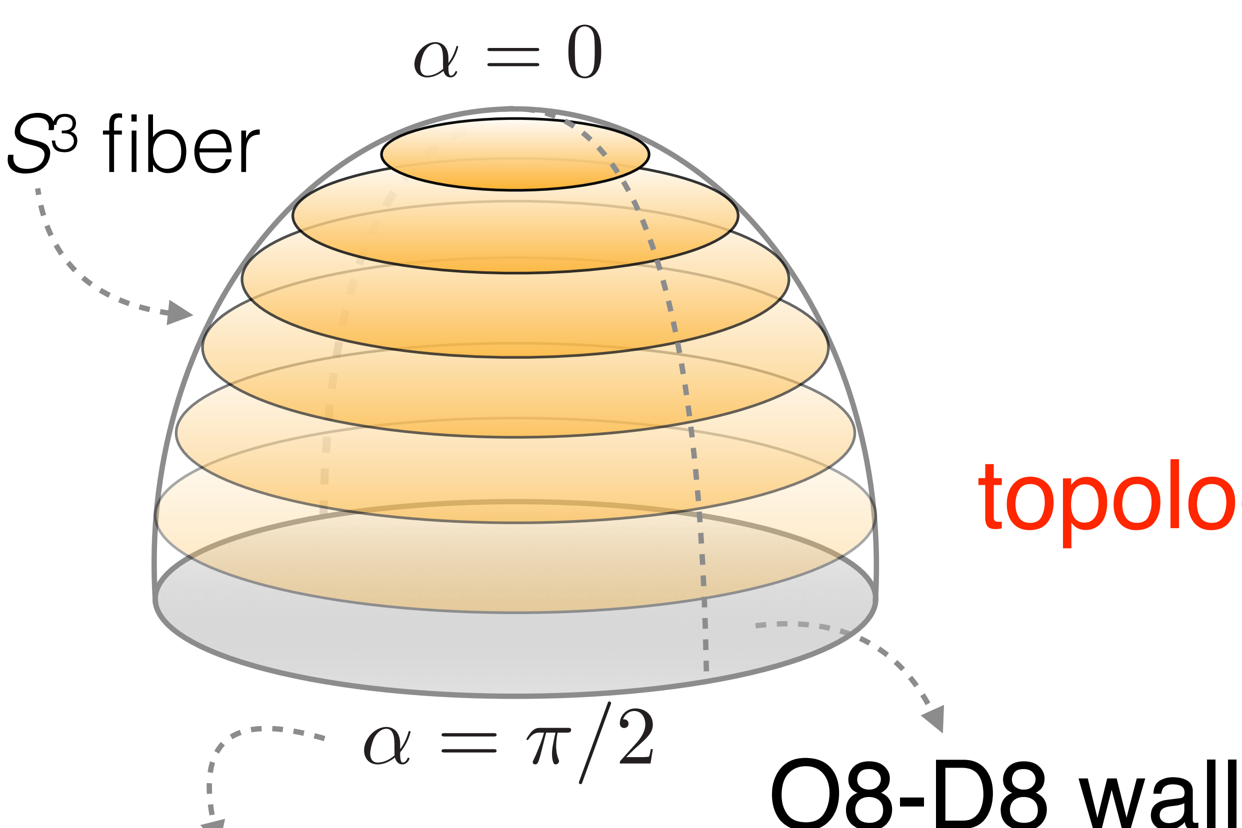

topology of internal space M_4 = **half-S^4**

singularity at equator:
dilaton and curvature blow up

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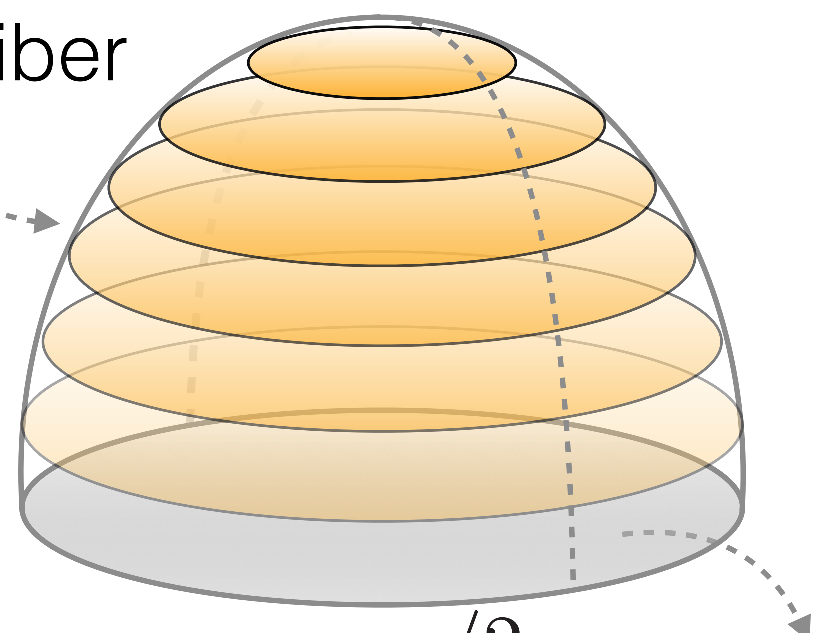

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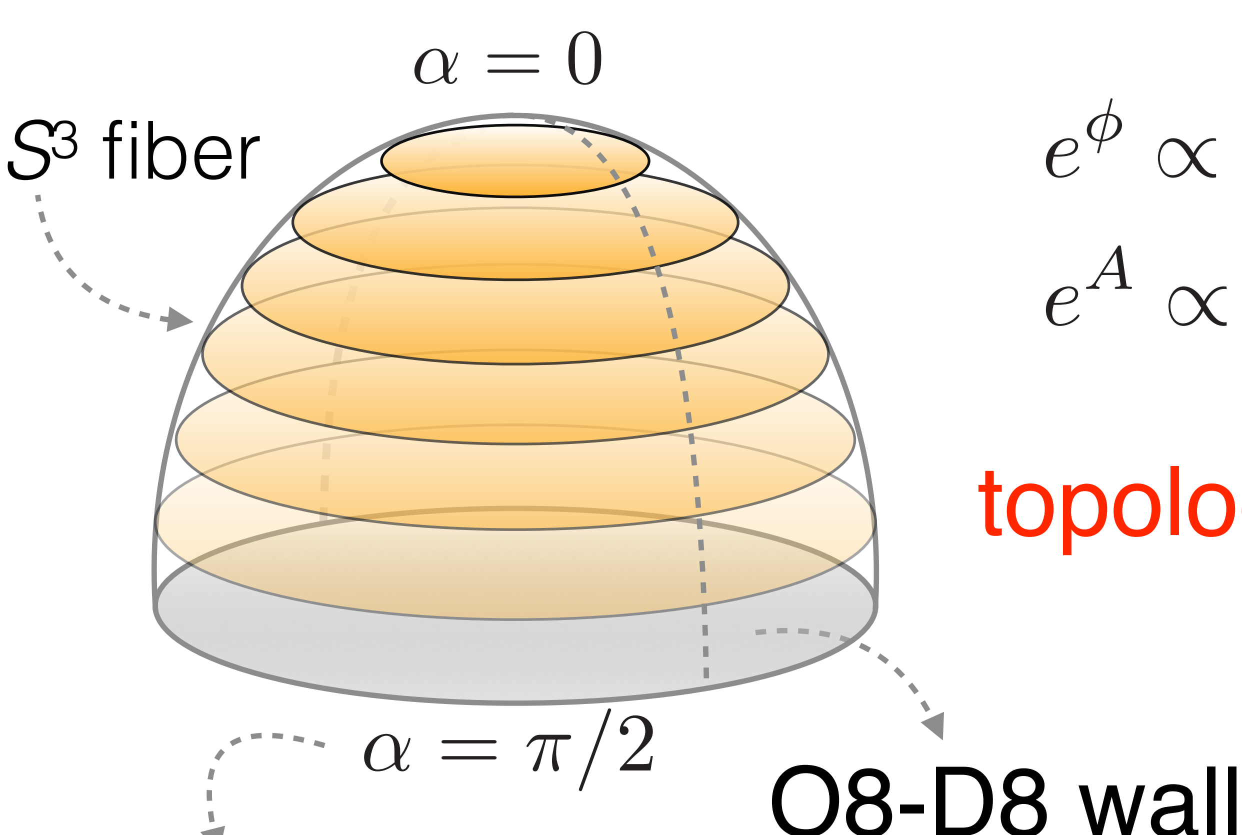
easily recovered from our formalism:
we read off the **physical fields from the forms** $\Phi_\pm$ $\Psi_\pm$



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$$e^\phi \propto (F_0 \cos\alpha)^{-5/6} \quad F_4 \propto (F_0 \cos\alpha)\mathrm{vol}_{S^4}$$

$$e^A \propto (F_0 \cos\alpha)^{-1/6}$$

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Abelian T-dual of Brandhuber-Oz

this IIB background was first constructed
via (Hopf) T-duality of BO

[Cvetic-Lu-Pope-Vazquez—Poritz ’00;
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In our language, it's an exact solution to the 2 PDEs which does not depend on the coordinate x

$$e^{\phi} \propto \sin^{-1}\alpha \cos^{-2/3}\alpha \qquad e^{A} \propto \cos^{-1/6}\alpha$$

(metric, fluxes are also determined)

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- inherits singularity at equator $\alpha = \frac{\pi}{2}$ of **dual** half-S^4

smeared O7-D7

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T-dualizing along a Hopf direction wrapped by a brane, one gets a **smeared brane** in dual background

- inherits singularity at equator $\alpha = \frac{\pi}{2}$ of **dual** half-S^4
- **new** singularity at $\alpha = 0$

smeared O7-D7

smeared NS5

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one can perform a so-called **nonabelian T-duality**

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Via a simple Ansatz, we recover it as solution to our PDEs

$$\phi = f(\alpha) + \log x \qquad e^f \propto \cos^{-1/3}\alpha \sin^{-3}\alpha$$

$$A = A(\alpha) \qquad e^A \propto \cos^{-1/6}\alpha$$

(metric, fluxes …)

(same singularities as abelian T-dual vacuum)

* operators in dual CFT with continuous spectrum of dimension

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Conclusions

To-do list:

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M_4 is an S^2 fibration over 2d space Σ geometry governed by PDEs

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- establish correspondence between new IIB backgrounds and 5d SCFT's which admit a gravity dual