

Exotic Branes and String Theory

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YITP lunch seminar

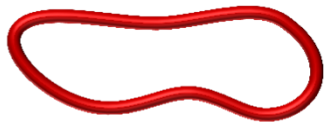
May 29, 2013

with Iosif Bena, Jan de Boer, Stefano Giusto, Daniel Mayerson & Nick Warner

1004.2521, 1107.2650, 1110.2781, 1209.6056, 1306.xxxx

Branes in string theory

String theory: theory of the string



tension: $T = \frac{1}{2\pi l_s^2}$

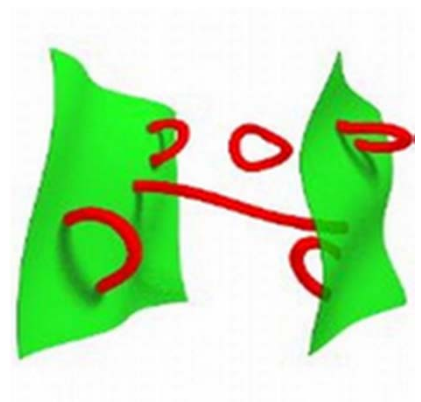
coupling: g_s

But there are also other objects: *branes*

- ▶ Extended
- ▶ Non-perturbative; $T \sim g_s^{-1}, g_s^{-2}$

Examples:

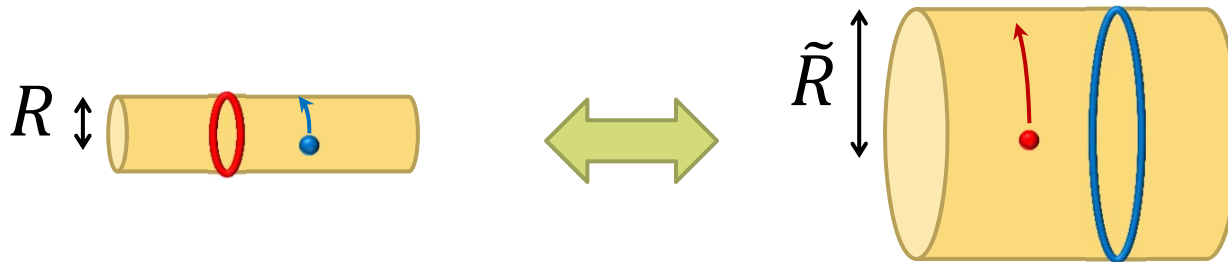
D-branes, NS5-branes, ...



Dualities in string theory

- ▶ Gauge symmetry of string theory
- ▶ Relate different spacetimes

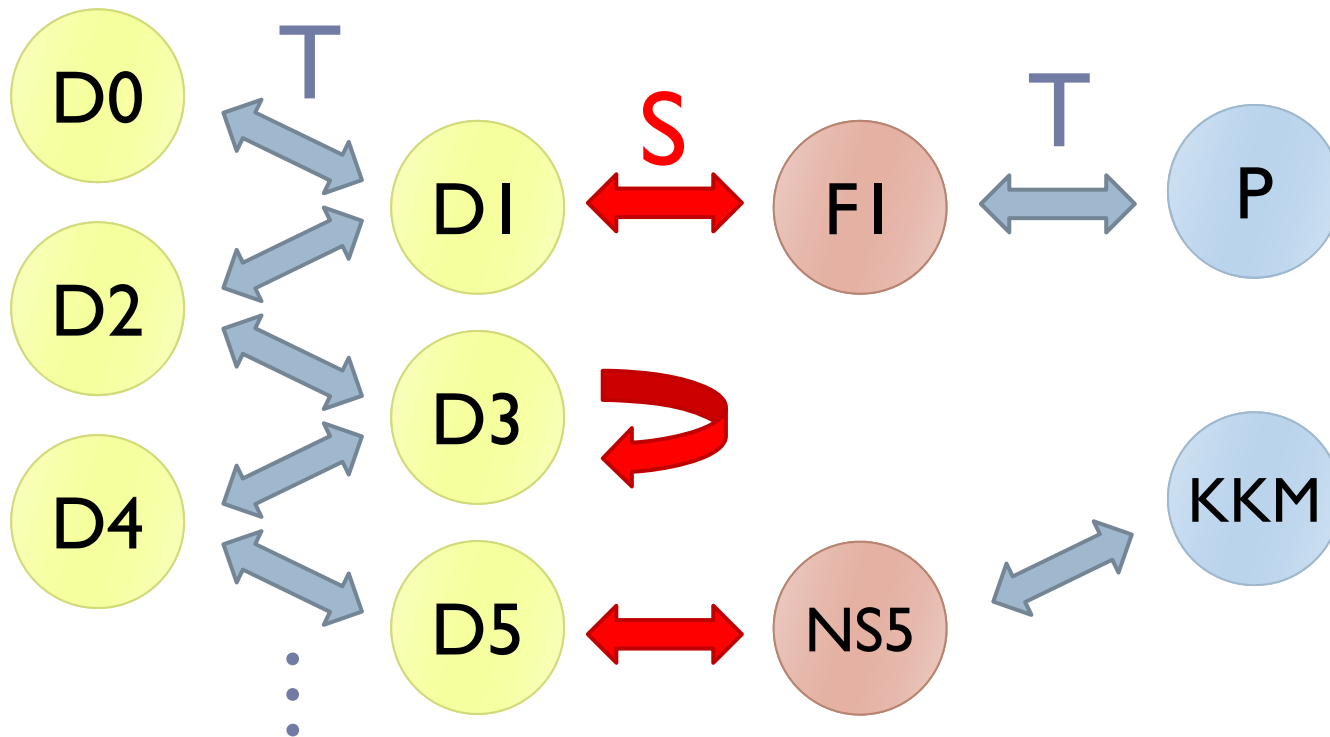
E.g. T-duality:



$$S^1 \text{ with radius } R = S^1 \text{ with radius } \tilde{R} = \frac{l_s^2}{R}$$

Dualities and branes

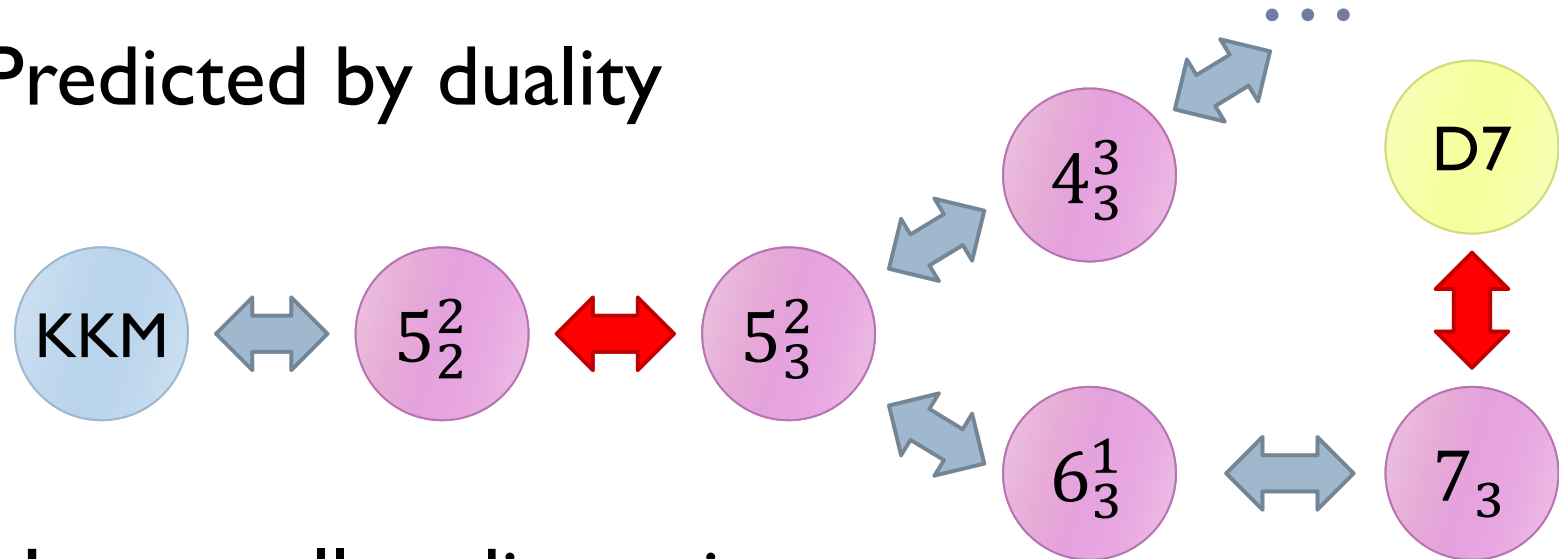
- ▶ Map various branes into one another



- ▶ Form duality group $G(\mathbb{Z})$

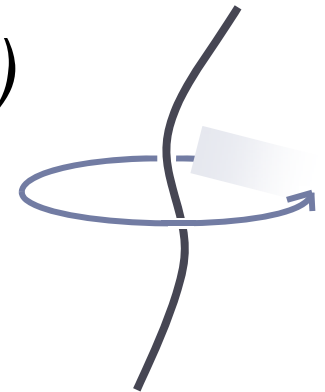
Non-standard branes

- ▶ Predicted by duality



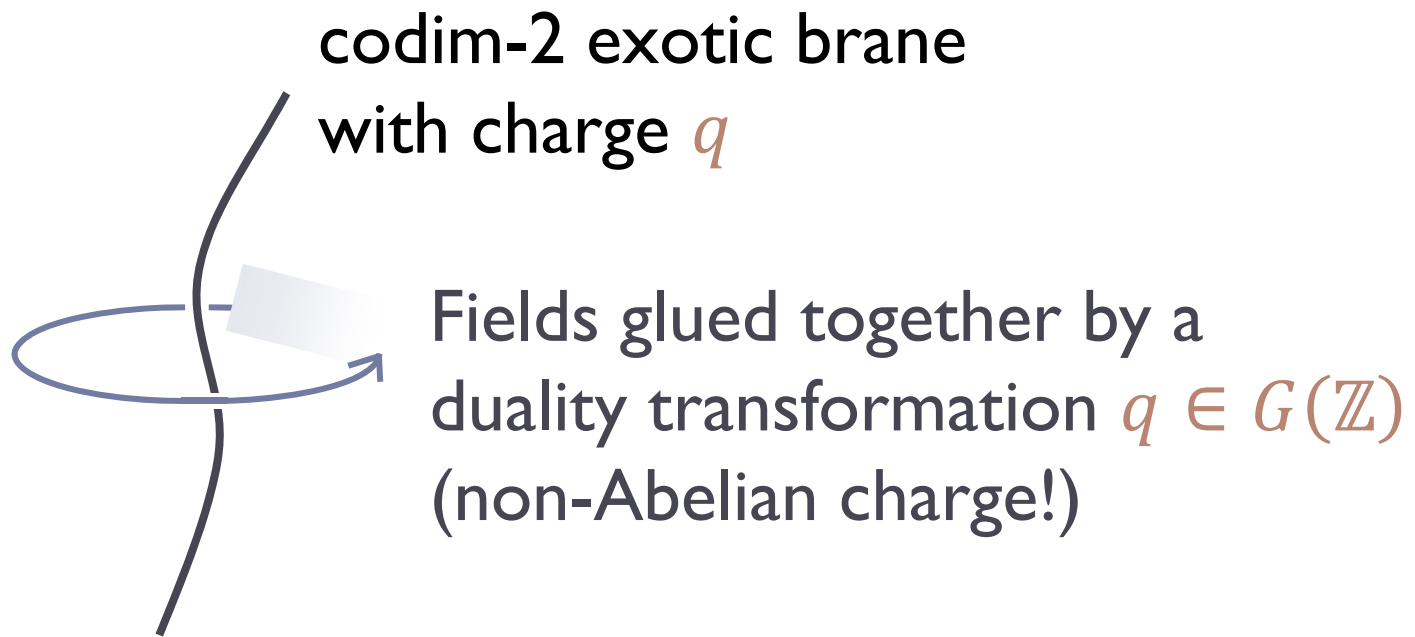
- ▶ Have small codimensions

- ▶ codim-2: defect branes (*exotic branes*)
- ▶ codim-1: domain walls
- ▶ codim-0: space filling

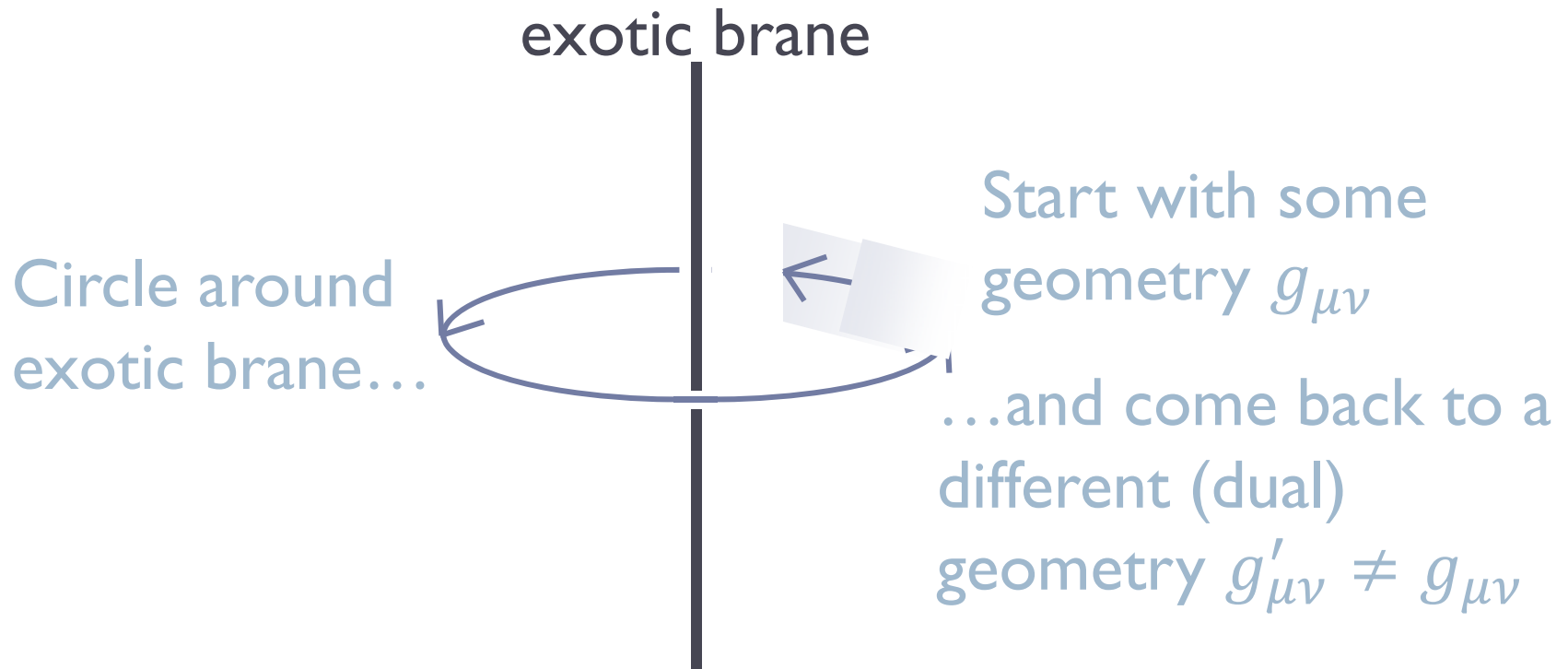


Exotic brane

- A “defect” around which spacetime is twisted by a duality transformation



Non-geometric nature



- ▶ Locally geometric, but not globally
- ▶ Example of “non-geometric backgrounds”

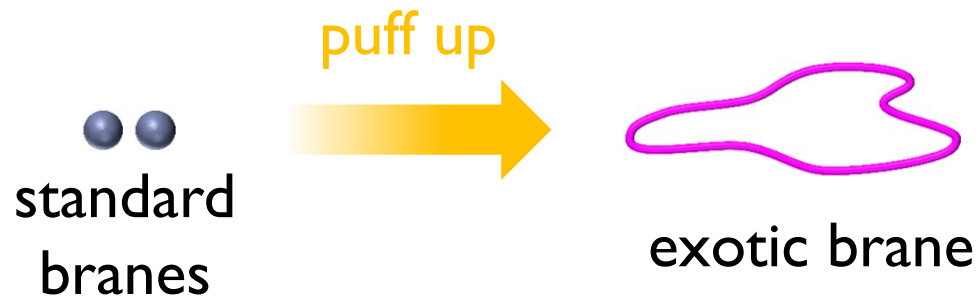
Supertube effect

- ▶ A spontaneous polarization phenomenon in string theory



Exotic supertubes

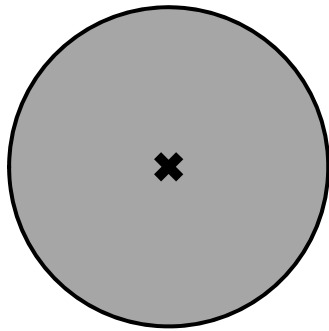
- ▶ Ordinary branes can puff up to produce **exotic dipole** charges



- Exotic branes relevant to non-exotic physics; More common than previously thought!
- Black hole physics?

Fuzzball proposal

- ▶ BHs are filled with stringy fuzz?



“Conventional”
picture of BH



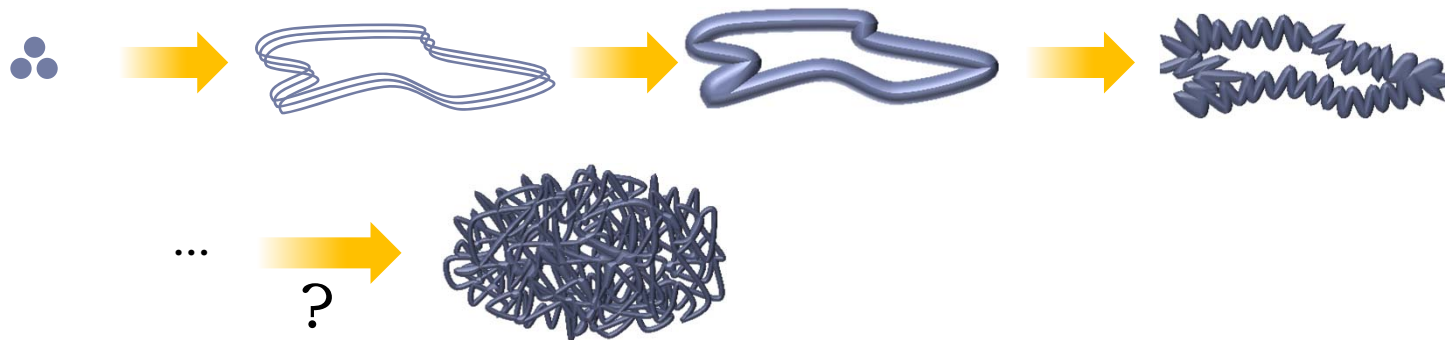
“Fuzzball”
picture of BH

No horizon
No singularity

- ▶ Many “microstate geometries” indeed found in gravity (metric + gauge fields + CS + matter)

Cf. [Gibbons+Warner 2013]

A possible scenario:



- ▶ **Generic BH microstates involve exotic branes?**
 - ▶ Constituent branes can polarize into exotic ones
 - ▶ Non-geometric microstates?
 - ▶ To be proven! (work in progress...)

Summary

- ▶ **Non-standard branes in string theory:**
 - ▶ Largely unexplored
 - ▶ Non-geometric
 - ▶ Ubiquitous in string theory
 - Relevance in black holes?
- ▶ **Interesting dynamics as non-Abelian vortices?**