

# T-Duality

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# What is T-Duality?

- It is a string theory duality that is used to relate Type IIA string theory and Type IIB.

# What's the point?

- The difference between Type IIA is that it has even numbered D-Branes (D0, D2, D4, D6) and IIB has odd numbered ones (D1, D3, D5)
- T-Duality allows you to map a D0 brane onto a D1

# How?

- T-duality explains that if you were to roll up one of the IIA dimensions on a circle that is much smaller than observable length scales, then it looks like string theory only has 9 dimensions

# Why?

- In the new 9 dimensional world, the claim is you can't tell the difference between IIA and IIB
- By wrapping a IIA D1-brane all the way around a circle, it would look like a D0-brane to an observer without extremely powerful equipment

## Why? (cont.)

- D1-brane would seem like it didn't have any spatial extent, it would seem like a point particle: a 0-brane.
- A D2-brane could also be wrapped to form something similar to a long hose
  - The 'hose' could extend across 9 dimensions!

## But...

- It seems as if T-Duality is only an "approximate truth"
- IIA and IIB look the same to a 9 dimensional observer only if they don't look too closely.
- Actually, they can be the same!



## How?(Part 2)

- A Type IIA string wrapped around a circular dimension is the same as a Type IIB that isn't wrapped, but is moving around the circle, and the vice-versa is also true!
- However, the circles must be different sizes!



## How(Part 2, cont.)

- If the circle is very small, the momentum of the moving string (and its energy) must be very big.
- If the circle is big, the momentum and energy can be very small
- When a string is wrapped, the mass is proportional to its length.
  - A string wrapped once around a big circle is heavy, and one wrapped around a small circle is light

# Finally

- In order for a moving IIA string to replace a winding IIB string, the energies must match
- Ex, If the IIA string is moving around a small circle, the IIB must be winding around a large circle