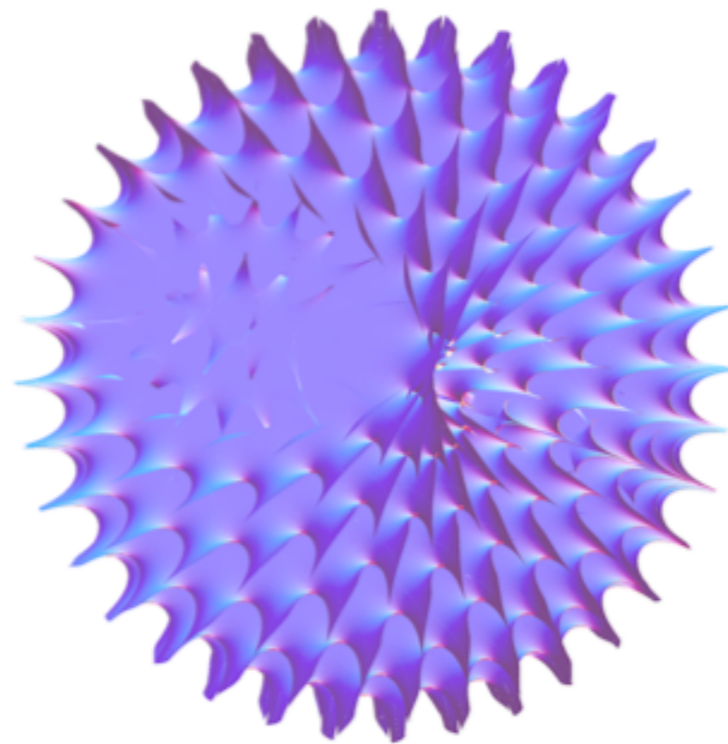
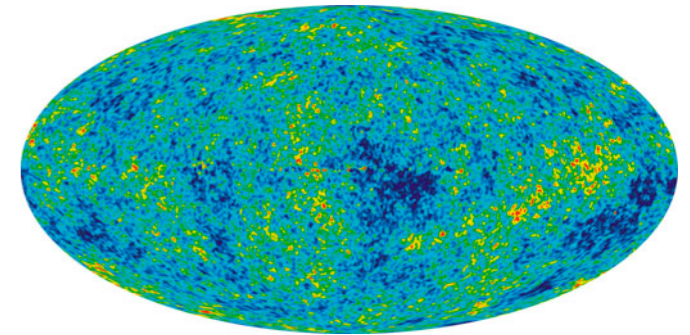


# String Compactifications: Theory and Applications

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and  
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Les Houches 6/11/2009

# (My) Background

Interested in string compactifications since early '90s, when I first came to CERN as a graduate student

- Mirror Symmetry
- Moduli spaces of Calabi-Yau manifolds
- Matter from singularities in four dimensions using either Calabi-Yau or  $G_2$  manifolds
- Type IIB flux compactifications
- Applications to cosmology and particle physics

**Goal:** studying mathematical properties of the extra dimensional spaces (Calabi-Yau,  $G_2$  manifolds) in compactifications of string/M-theory in order to learn about (our) four dimensional universe

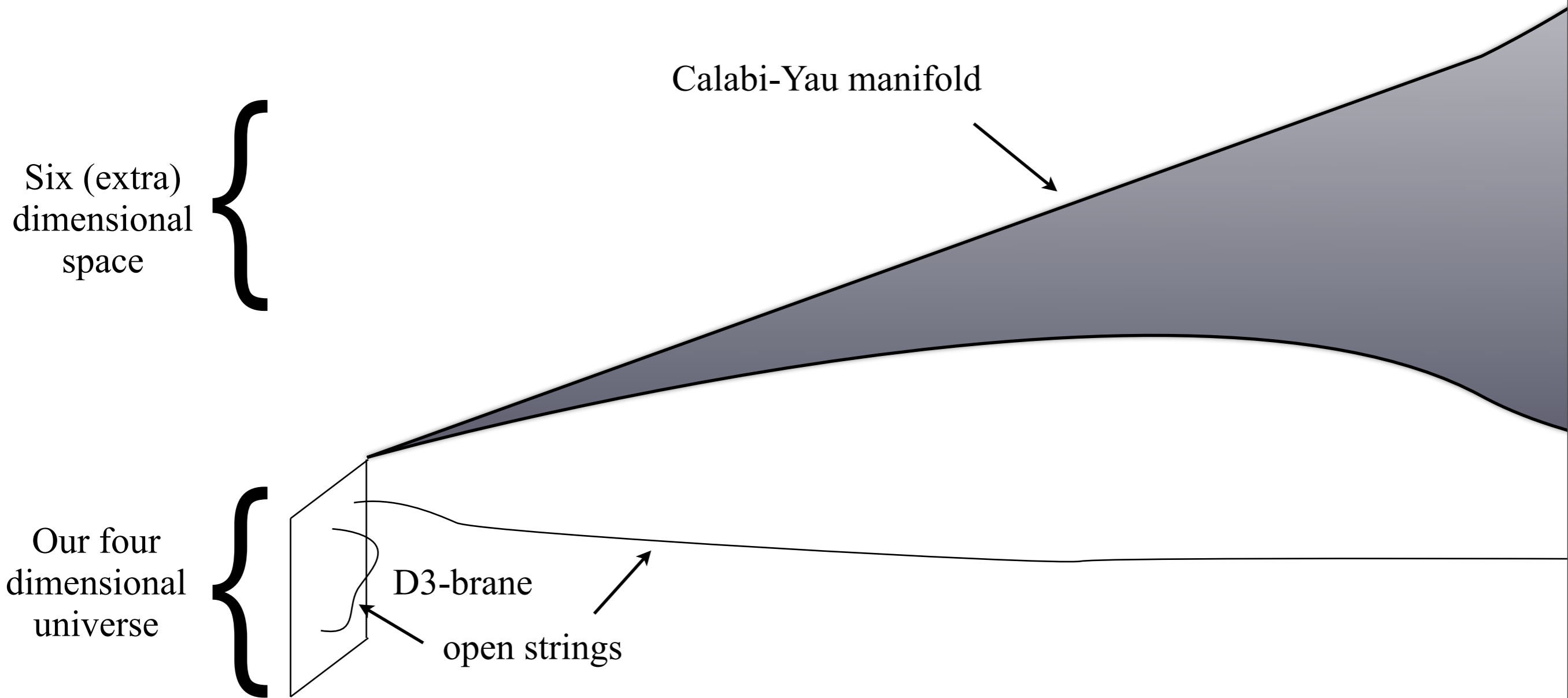
# Approaches (I)

- Different amount of supersymmetry in four spacetime dimensions
- $N > 1$ , in particular  $N=2$ , allows us to study the space of metric deformations of the Calabi-Yau manifold, without direct knowledge of the metric on the Calabi-Yau manifold itself. Although, this is not a realistic scenario (no chiral fermions), it has lead to important results (eg mirror symmetry)
- $N=1$ , string models (heterotic, type I, type II orientifolds, F-theory) have been constructed which (very closely) reproduce the standard model

# Approaches (II)

- Bottom-up versus top-down
  - Bottom-up allows for construction of the gauge sector, ie (the generalization of the) standard model, ignoring gravity (the closed string moduli) by focusing on a small (local) part of the Calabi-Yau manifold, eg branes at singularities, intersecting brane models and local F-theory constructions
  - Top-down allows for including moduli stabilization of the closed string moduli via eg fluxes (through cycles in the compact Calabi-Yau manifold) which then can become naturally candidates for (multi-field) inflationary scenarios.

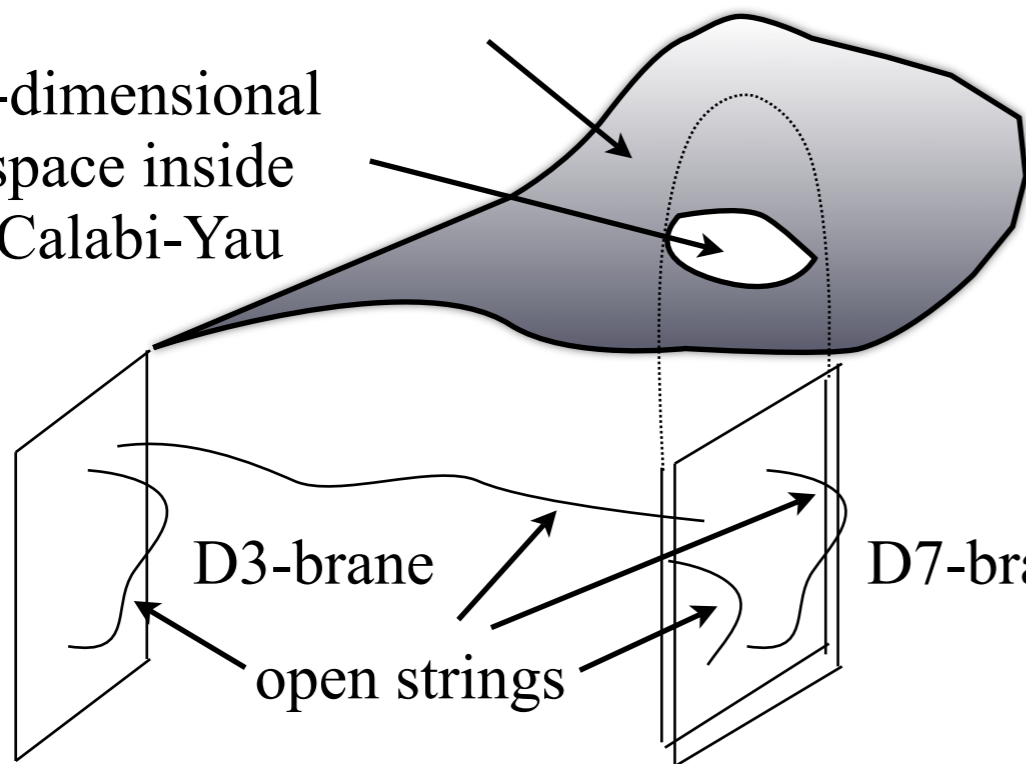
# Local Calabi-Yau Manifold



# Global Calabi-Yau Manifold

Calabi-Yau manifold

4-dimensional  
space inside  
Calabi-Yau



Six (extra) dimensional space

Our four dimensional universe

# Ultimate Goal

- Combine these different approaches, and the various lessons learned, eg in the toy models with  $N=2$  supersymmetry and the local string models, to construct **global** string compactifications that
  - stabilize all the string moduli
  - give realistic multi-field inflationary models
  - provide generalizations of the standard model, including sectors that describe supersymmetry breaking and dark matter



# Final words



- The retreat has shown that there are great resources at CERN in all of these areas
- I look forward to talking to and learning from these experts during my stay at CERN
- This will be extremely valuable when I go back to University of New Hampshire
- Encourage you to visit New Hampshire any time!

