

# Decay of False Vacuum via Fuzzy Monopole in String Theory

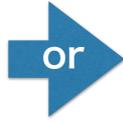
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## 1. String Landscape

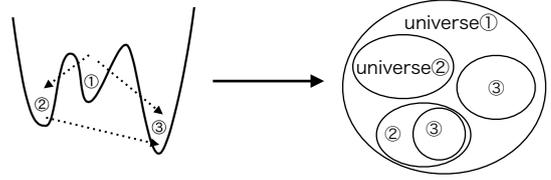
There are about  $10^{500}$  possible compactification in string theory!

We may ask

“Which is the correct model of our universe?”



We may change the question by the conjecture “multiverse”.



Then the question is “which lives as long as our universe?”

## 2. Impurities and Vacuum Decay

### Catalytic Effect by Impurities

bubble creation in carbonated drink and the wall of container

potential for bubble creation in bulk

On the wall



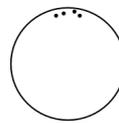
Catalytic effect on vacuum decay occurs in string theory?

↓ if yes

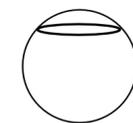
Present candidates for string model of our universe may be denied.

KPV model decays through following process (We treat similar process).

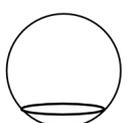
anti-D3 placed on  $S^3$



anti-D3 → NS5



NS5 through the  $S^3$



## 3. Monopole and Vacuum Decay in String Theory

### False Vacuum

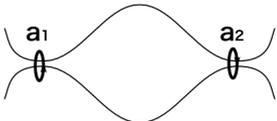
M. Aganagic, C. Beem, J. Seo and C. Vafa, Nucl. Phys. B 789, 382 (2008)

Geometry

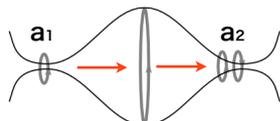
$$W'(x)^2 + y^2 + z^2 + w^2 = 0 \quad W'(x) = g(x - a_1)(x - a_2).$$

real 3D submanifold

$$y_i^2 + z_i^2 + w_i^2 = g^2(x_r - a_1)^2(x_r - a_2)^2$$



False Vacuum



True Vacuum

wrapped D5 on 2-cycle at  $a_1$

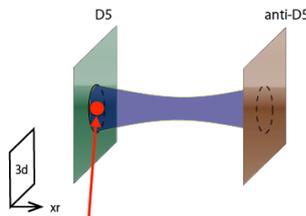
wrapped anti-D5 on 2-cycle at  $a_2$

No D-brane left

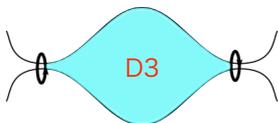
Transition process

=bubble creation

purple part=domain wall



~place monopole (impurity)~



D3 acts as a monopole in 4D spacetime.

	0	1	2	3	4	5	6	7	8	9
D5	○	○	○	○	△	△	△	x	x	x
DW	○	△	△	△	○	○	○	x	x	x
D3	○	x	x	x	○	○	○	x	x	x

### Vacuum Decay Rate

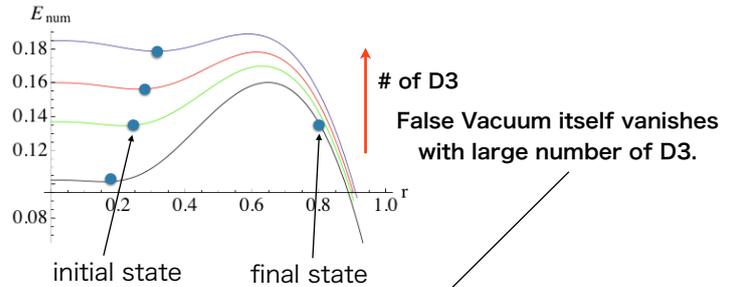
#### DBI action of domain wall D5

$$S = -T_{D5} \int d^6 \xi \sqrt{-\det(\partial_\alpha X^\mu \partial_\beta X_\mu + 2\pi\alpha' F_{\alpha\beta})} + \int dt \frac{4\pi}{3} R^3 \Delta V$$

monopole term (magnetic flux)

#### potential for bubble creation

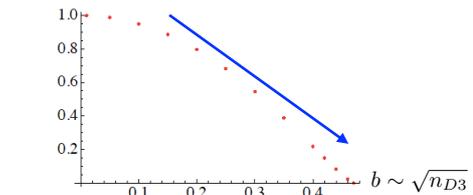
$$E_{\text{total}} = \sqrt{(T_{D5} 4\pi R^2 V_3)^2 + (n_{D3} T_{D3} V_3)^2} - \frac{4\pi}{3} \Delta V R^3$$



Calculate decay rate  $\exp(-B)$  in the case with small # of D3.

Define  $B_0$  as lifetime without monopole (Calculated by QFT)

$B/B_0$  tunneling rate  $\exp(-B)$  vs # of D3



Existence of monopole catalyzed the vacuum decay in String theory!

Conclusion:

Catalytic effect on vacuum decay by impurities possibly occurs in String Theory. Present string models may have much shorter lifetime. There might be much less long lived string model of our universe.