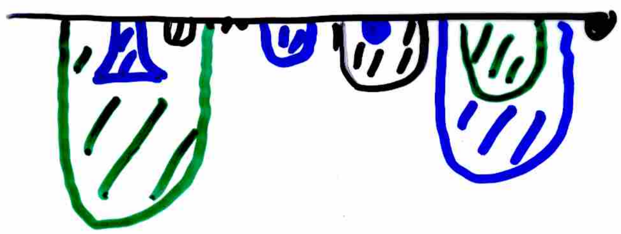
Measures and Eternal Inflation

Semi-classical picture of eternal inflation



Diverse regions w/ different properties.

2 questions:

1) How do we "map" this out?

2) How do we locate our universe + make predictions.

Making a Map

$P_p(x)$: prob. to find an object p w/ properties x.

Different objects p specify different maps, yielding different info.

For example:

How is volume distributed?	p = unit volume	Linde, Garriga, others....
How many bubbles of each type are there?	p = bubbles	Garriga, Vilenkin, others....
How/which vacua are accessed on a single worldline?	p = segment of a worldline	Bousso
How many transitions of a given type are there?	p = transitions	Aguirre, Gratton, Johnson

In semi-classical picture: all maps are good

Quantum: Are all maps created equally?

Does the global description break down?

Do we understand how initial conditions work when necessary?

Making Predictions

$$P_X(x) \propto p_p(x)\, \Lambda_{p,x}(x)$$

$\Lambda_{p,x}(x)$ - connects map (prior) to what a randomly chosen object X sees.

Now, not all maps are useful.

1) The objects p must be appropriate for making anthropic predictions.

   ie - in dS, most of the volume is dead, so p = unit volume is ill-suited.

2) May need to specify initial conditions or gauge (w/ justification for doing so...)

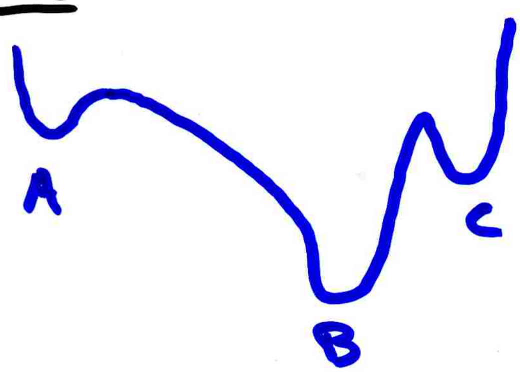
3) Lots of infinities - how are they regulated?

4) Do they provide enough information to answer questions of interest?

Info. about vacua alone is insufficient!

Cosmological observables are history-dependent, so need a measure over histories.

<u>Example</u>:



A→B yields many e-folds

C→B yields few efolds

Define a measure that counts transitions of a given type - along a worldline or globally.

- Can sum over all transitions into each vacua to recover vacuum-counting.

This measure may be more closely related to $\Lambda_{x,p}(x)$ than one that counts vacua:

Entropy production or galaxy formation may be history dependent.

Predictions:

Cosmological constant

Priors determined by transition rates + other high-scale properties of the potential.

⇒ No correlations systematically favoring particular Λ.

Prior flat over anthropic window.
(if enough low-cc vacua...)

of inflationary e-folds

Transition-counting yields:

$$\frac{P(C\to B)}{P(A\to B)} = e^{S_I^{AB} - S_I^{CB}}$$

<< or >> 1

Strong correlations between # of e-folds and instanton action.

Wide anthropic window ($N_e > 59$-60)

⇒ ! Prior may dominate predictions!

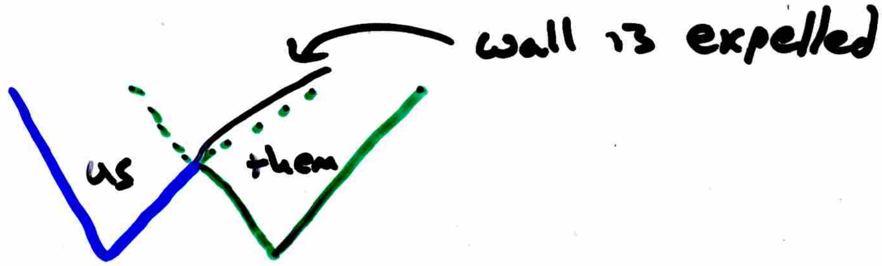
Do we actually live in a universe undergoing eternal inflation?

Possible test - Bubbles certainly collided w/ ours
Can we see them?

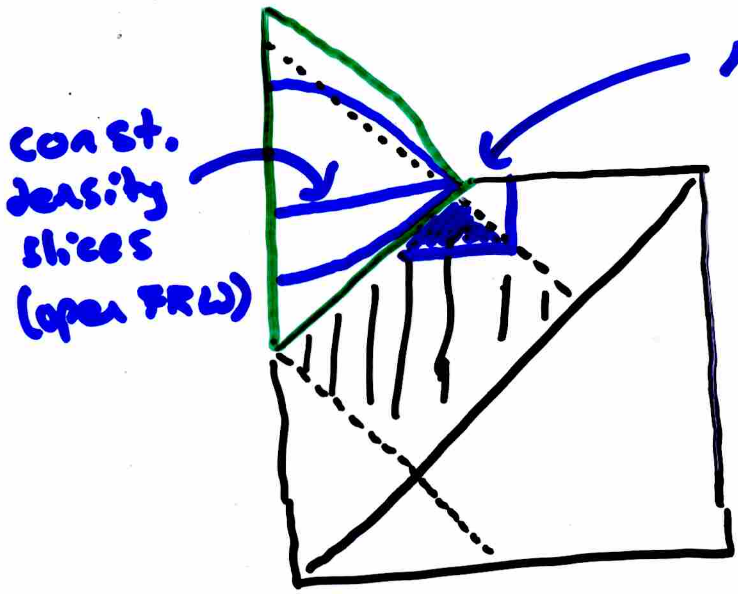
Perhaps, if a number of criteria are met:

1) Compatibility - At least 1 collision type admits our cosmology in its future light cone.

- Maybe possible if colliding bubble has a larger Λ



2) Probability - should be likely for us to observe collisions:



2 ways to see lots of collisions:

- go far from origin on const. density slice

  This is where most of the 3-volume is - we should expect to be here!

- wait a long time

  But, you only see a collision if $H_T < H_F^{-1} \lambda^{1/2}$ ← tunneling rate

3) observability - inflation should not dilute collision products away.

- Need a small # of efolds (related to measure problem above)

what would the collisions look like?