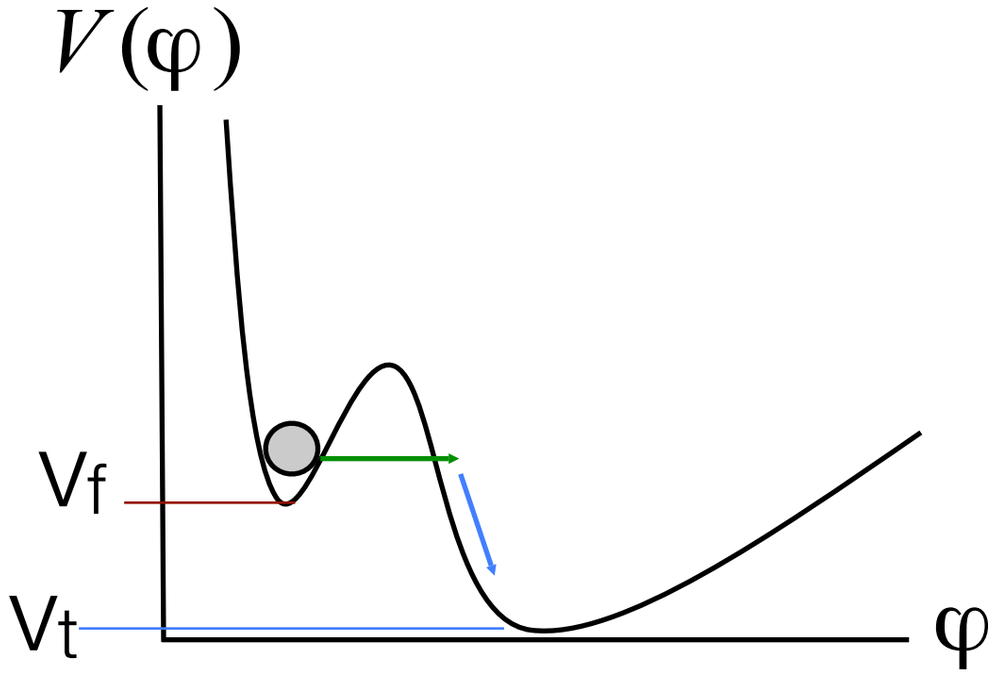
Can we see other universes?

based on work by Anthony Aguirre, Matt Johnson & Assaf Shomer

Everlasting inflation

- (Multiple minima) +
  (slow transitions)
  = **eternal inflation**



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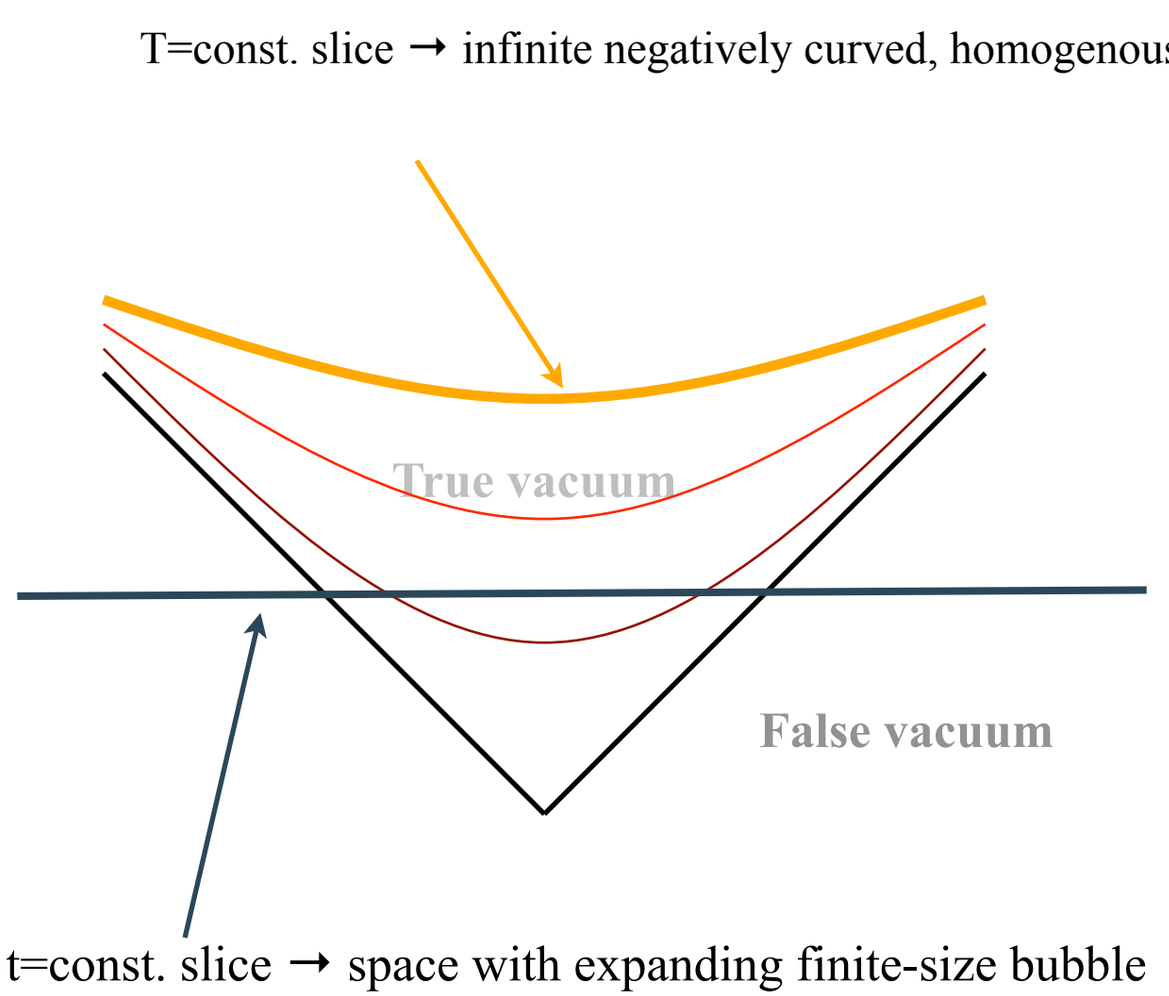

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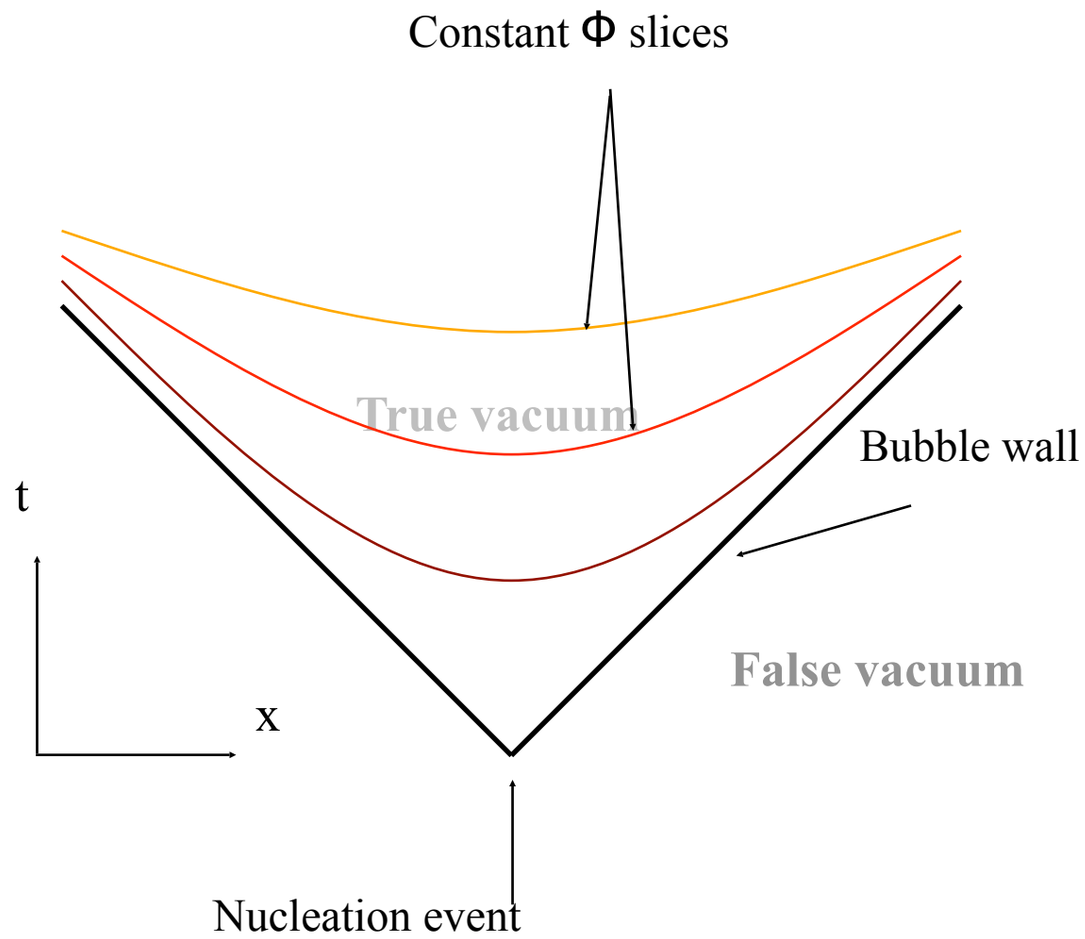

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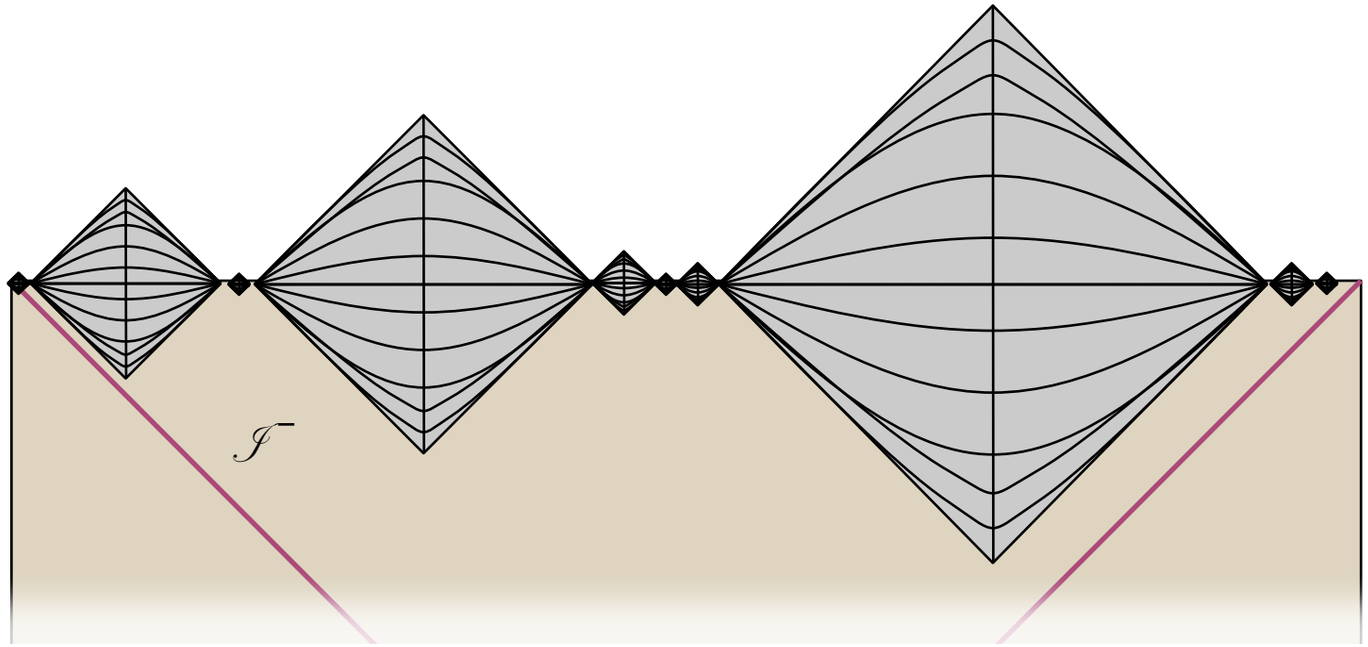

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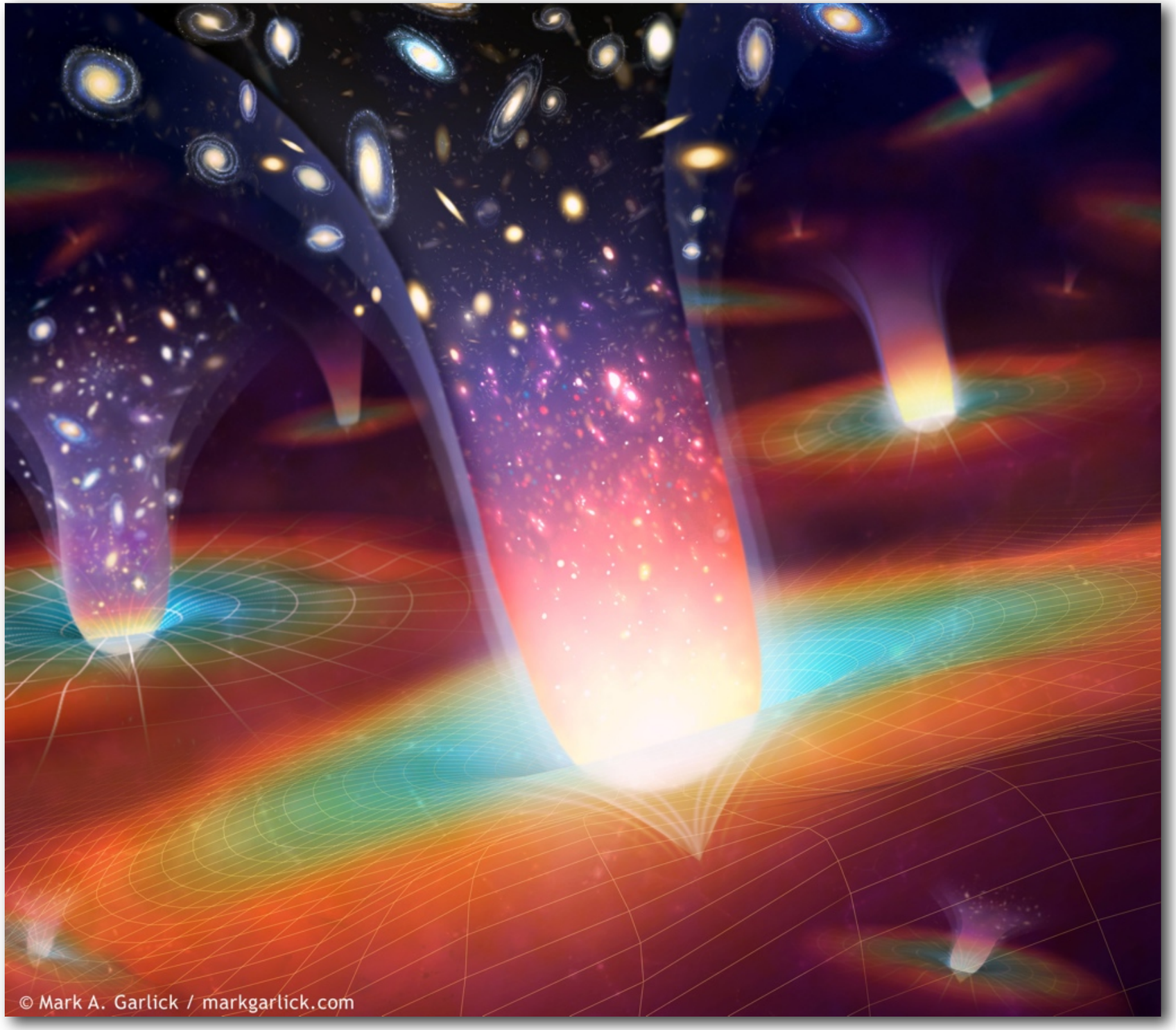
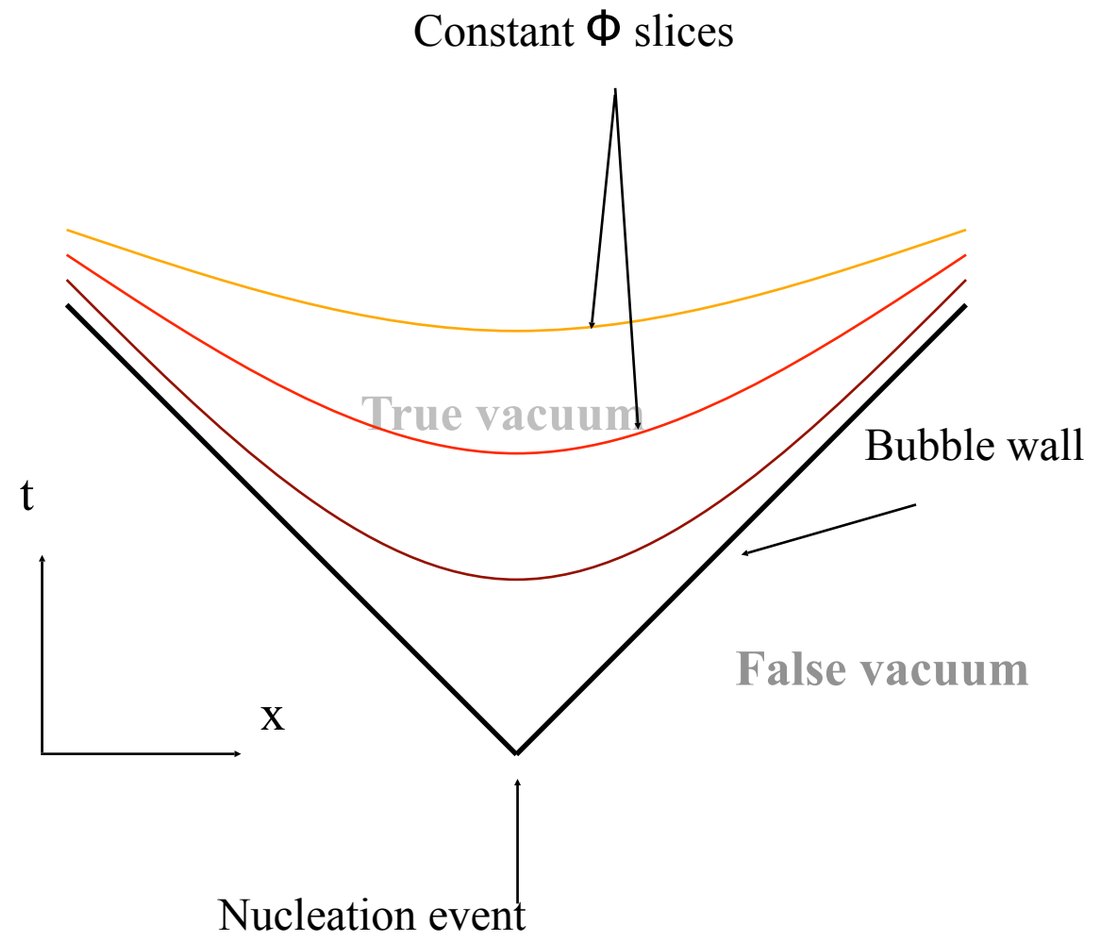
- How do we test this picture?



Everlasting inflation

- Each bubble has **open FRW cosmology** inside.

- Can't get out.

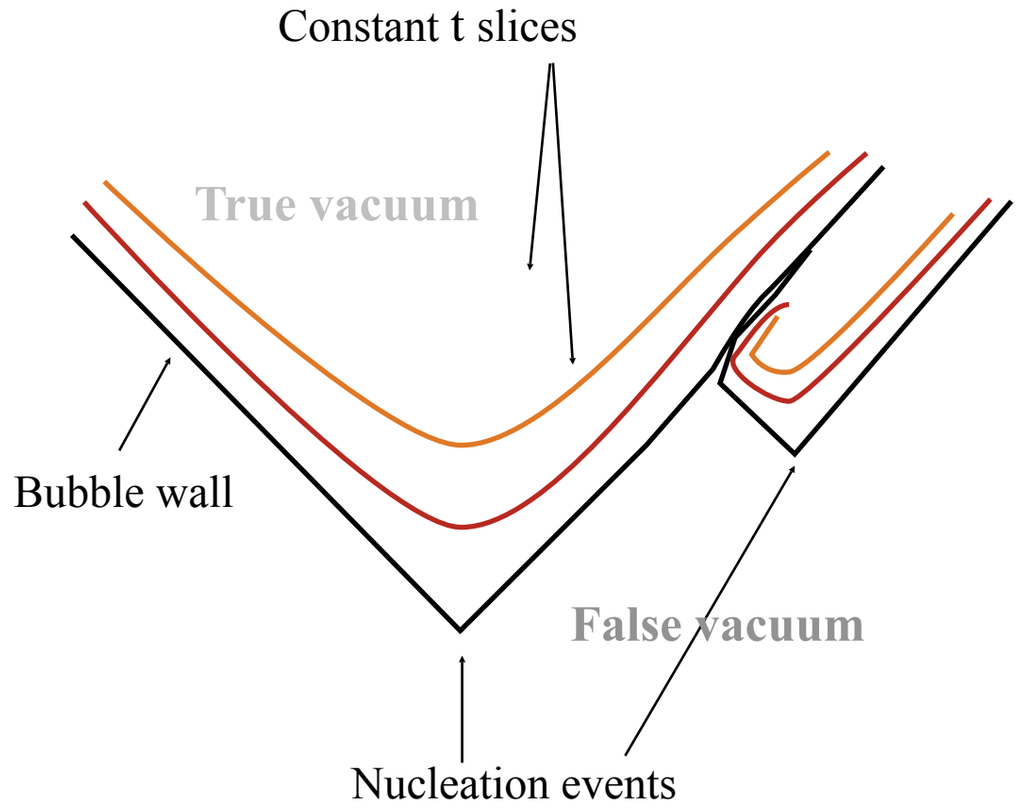


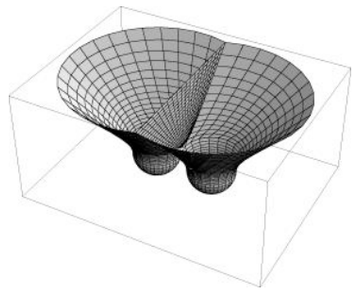
Bubbles collide. Can we see the other ones?

- **Probability: Most observers must have collisions in past.**

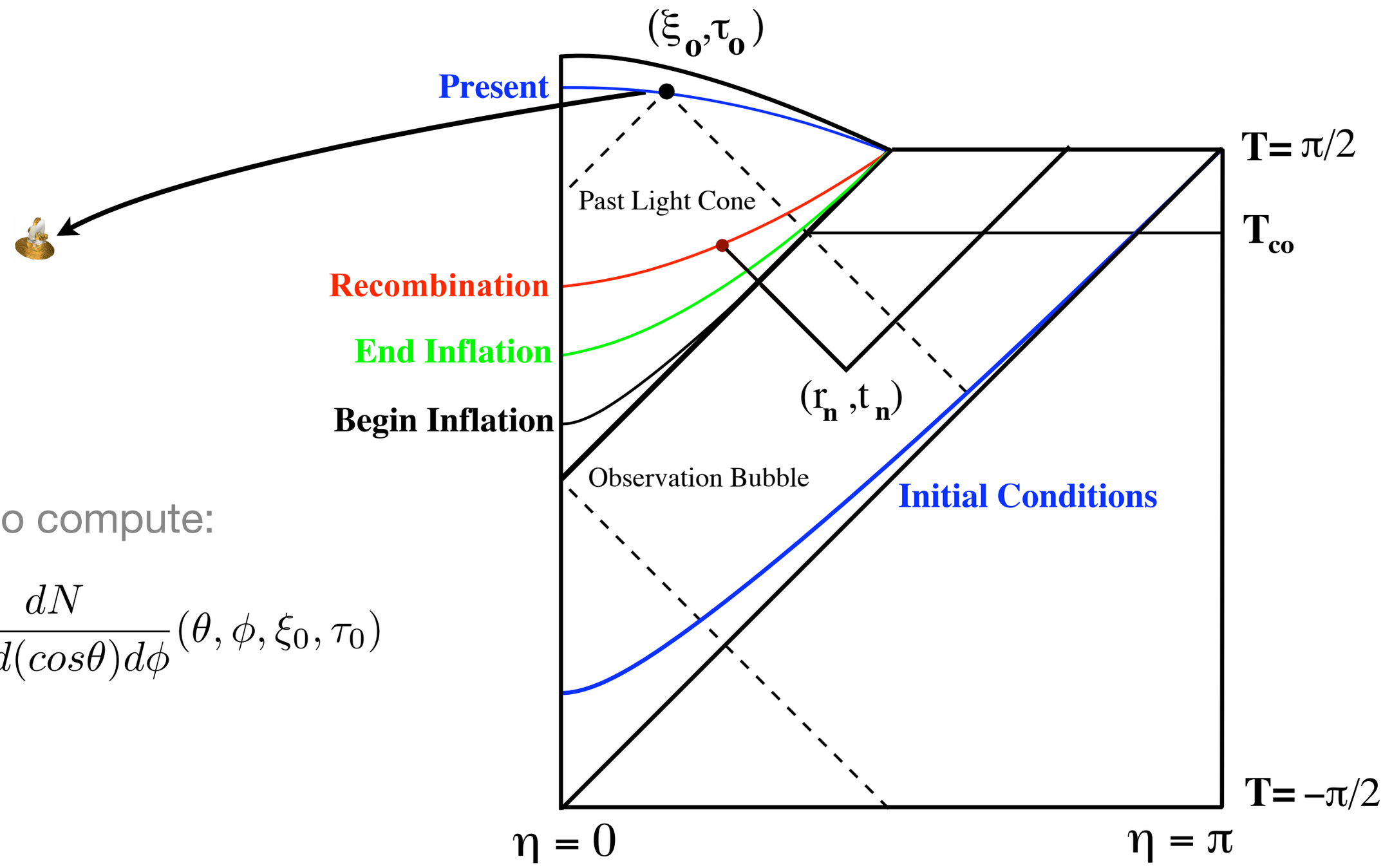
- Suvivability: The collisions must not preclude the existence of the observers in question.

- Observability: The collision must be significant enough to be observable.





The setup



- Want to compute:

$$\frac{dN}{d\psi d(cos\theta) d\phi}(\theta, \phi, \xi_0, \tau_0)$$

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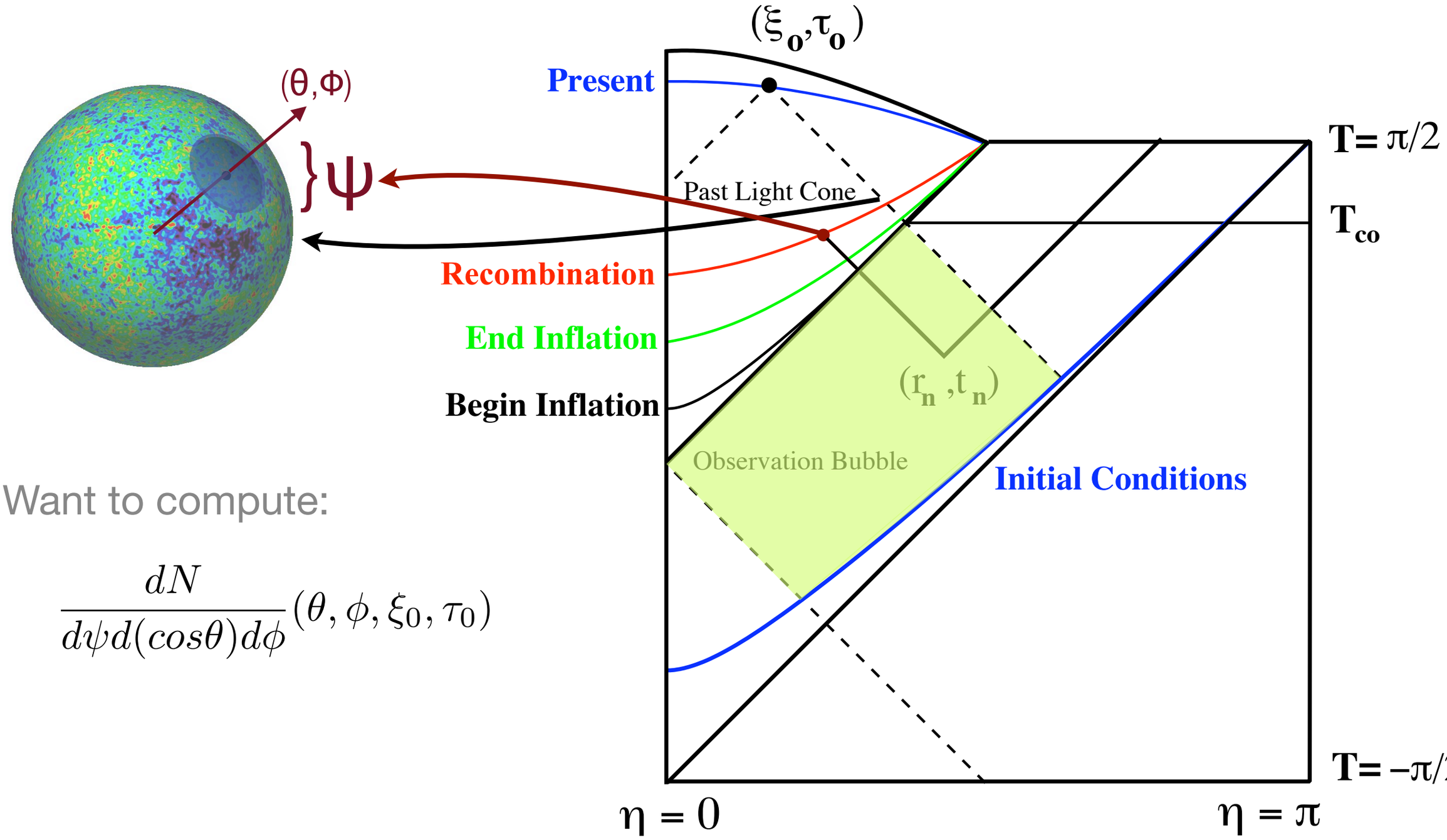

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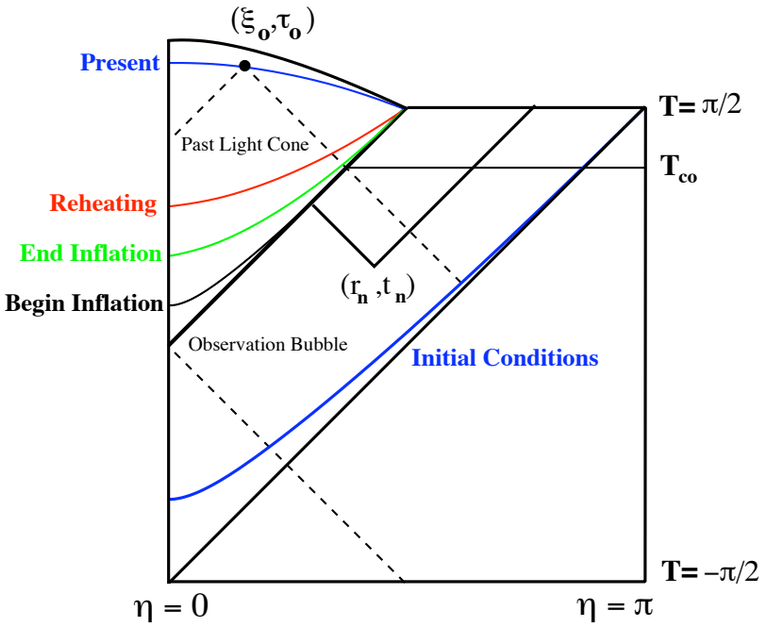
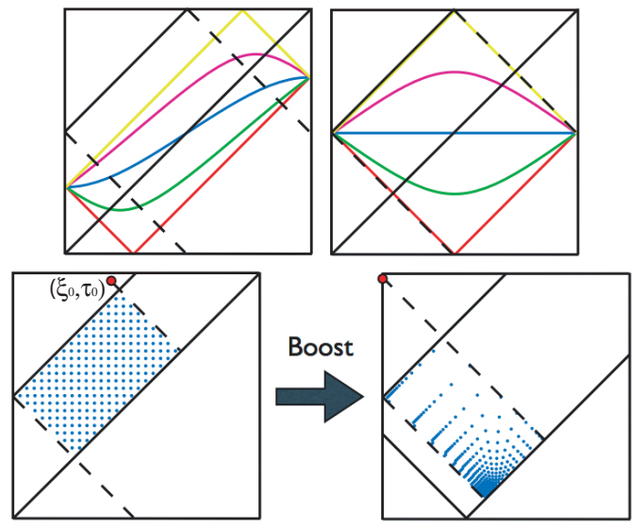
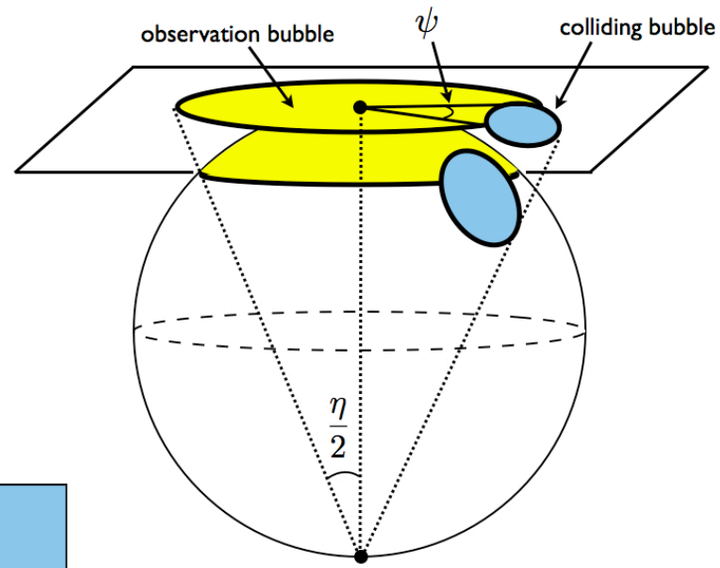
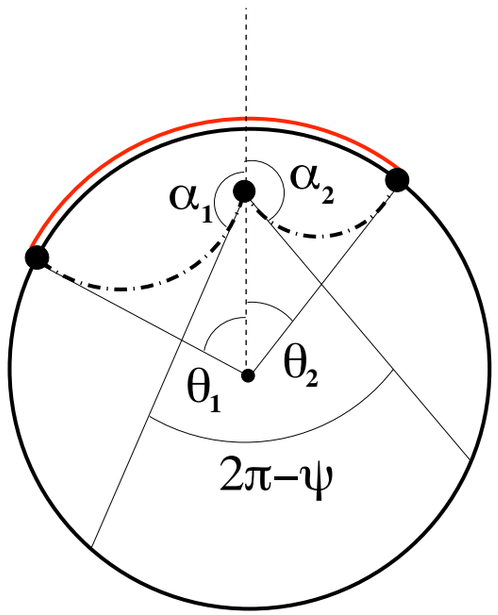
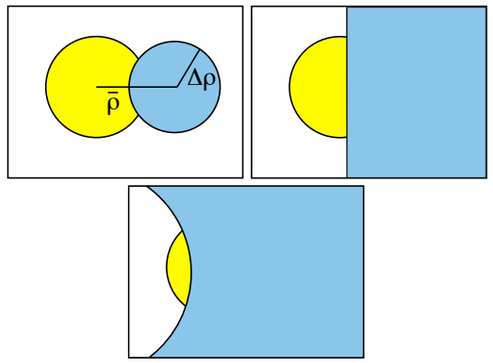
Horrible geometry problem...





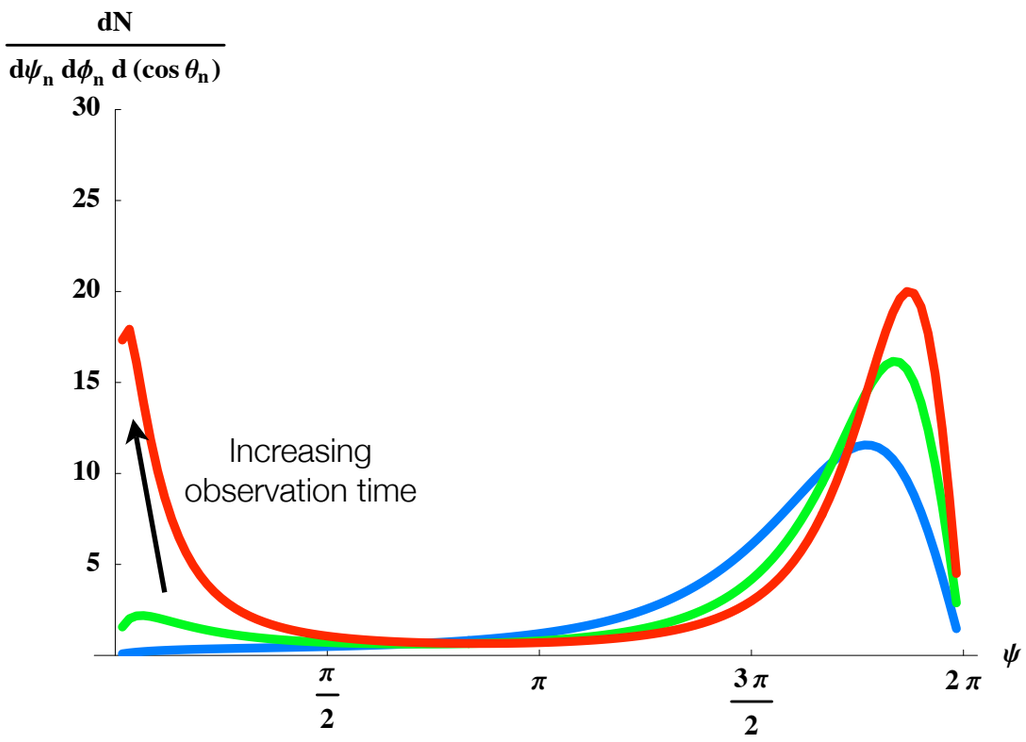






Results

- Two large-N regimes:
  - Late, small bubbles (as $\tau_o \to \infty$, N $\to \infty$ and $\psi \to 0$)
  - Early, large bubbles (as $\xi_o \to \infty$, N $\to \infty$ and $\psi \to \infty$)
- Anisotropic distribution (divergences where $\theta = \theta_o$)



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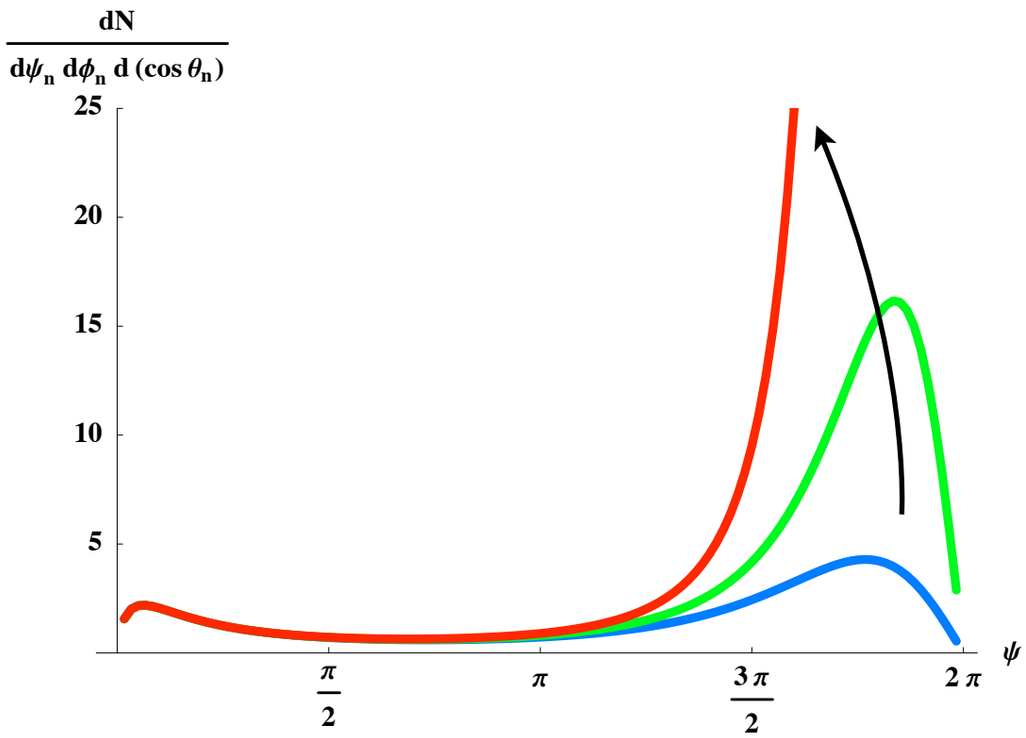


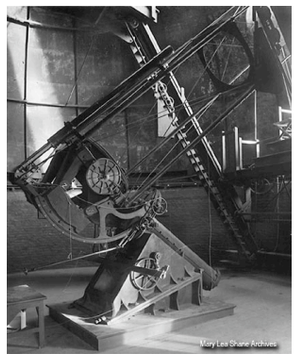
Implications

- Small late bubbles:
  - Almost certainly ‘perturbative’. ☺
  - Only seen if $\lambda H_F^{-4} > (H_T/H_F)^2 \sim 10^{-100}$. ☹
  - Essentially point sources, isotropically distributed. ☹
- Large early bubbles:
  - Seen at all but set of measure zero of points in open universe. ☺
  - But *not* perturbative. ☹

Key open questions

- What does a general bubble collision (including inflation inside bubbles) look like?

- Can the observers with big observable collisions survive to observe them?



- Are there reasonable scenarios with small observable bubbles?

- How would bubbles appear in the CMB? What other consequences might they have? and/or, can any scenarios can be ruled out given the CMB we see?