Title: Classical fields as the natural ontic structure for quantum theory

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URL: http://pirsa.org/09060031

Abstract: Although most realistic approaches to quantum theory are based on classical particles, QFT reveals that classical fields are a much closer analog. And unlike quantum fields, classical fields can be extrapolated to curved spacetime without conceptual difficulty. These facts make it tempting to reconsider whether quantum theory might be reformulated on an underlying classical field structure.
This seminar aims to demonstrate that by changing only how boundary conditions (BCs) are imposed on ordinary classical field equations, a psi-epistemic quantum theory naturally emerges. Uncertainty and basic quantization naturally result from imposing BCs on closed hypersurfaces (as in Lagrangian QFT); further quantization results from extending Hamilton's principle to restrict the BCs as well as the field equations. The partial dependence of field parameters on future BCs implies an effective contextuality, naturally avoiding the usual arguments against realistic quantum models. Successful applications to the relativistic scalar field will be presented, further motivating an ambitious research program of reformulating quantum theory in terms of ontic classical fields.

San José State
UNIVERSITY

Classical Fields: A natural ontic structure for quantum theory?

Ken Wharton
Department of Physics and Astronomy
San Jose State University

Outline

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Motivation and Basic Framework:

- The Newtonian Schema vs. Reality

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- The measurement problem in a classical light

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Photoelectric Effect
Kochen-Specker theorem
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Single-Photon Detection
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3) Determine initial state via IBCs.
4) Time-evolve initial state w/ EoMs.

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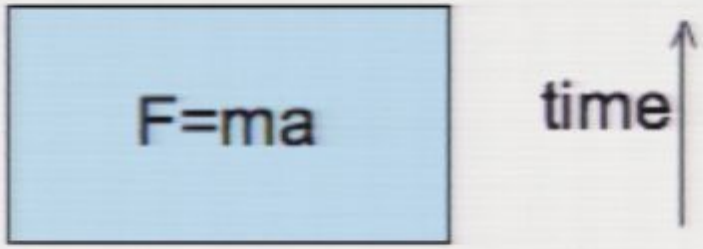

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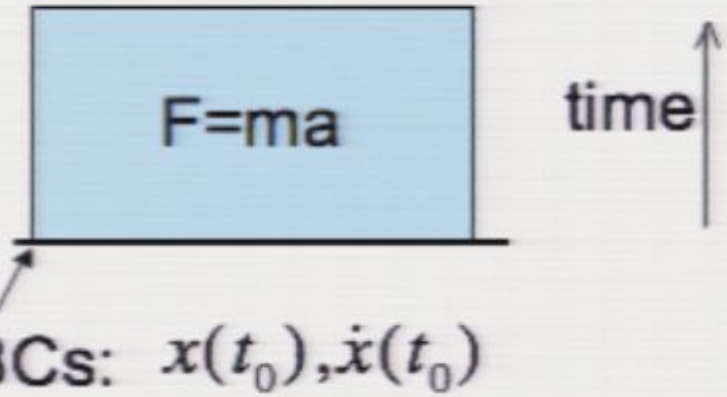

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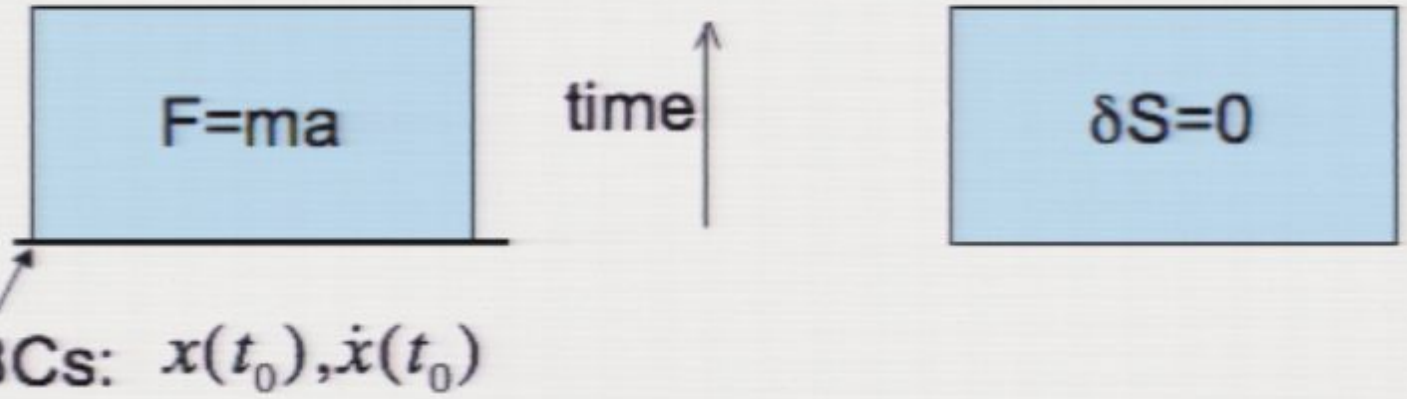

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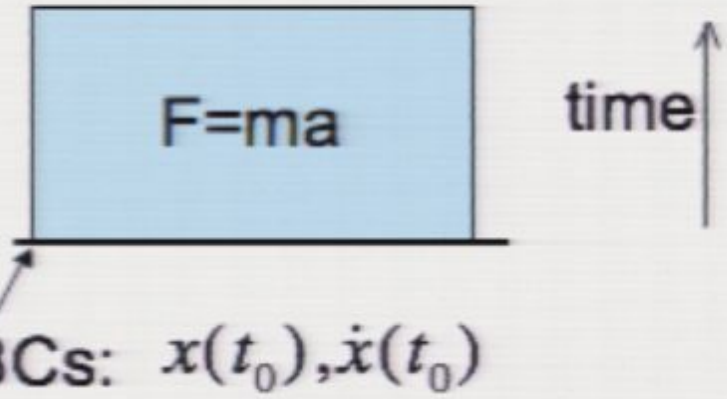

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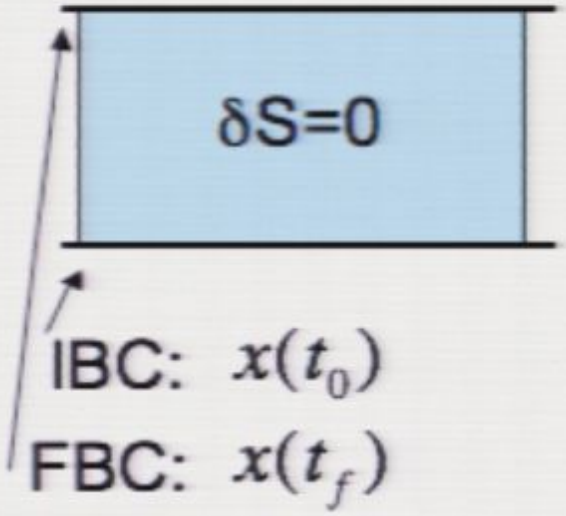

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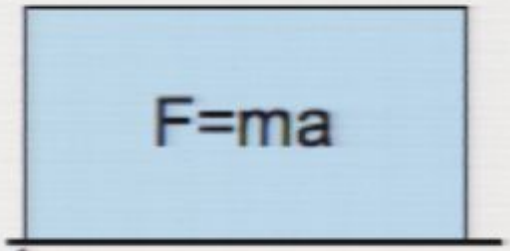

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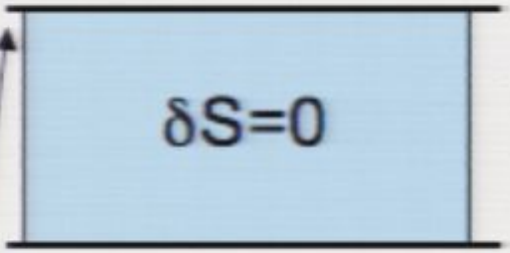

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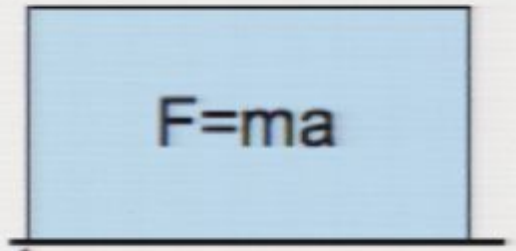

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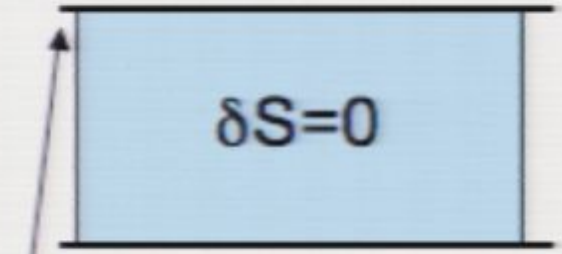

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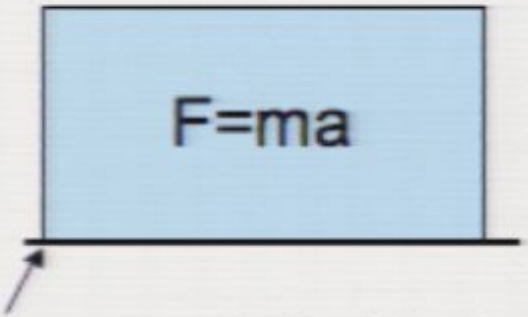

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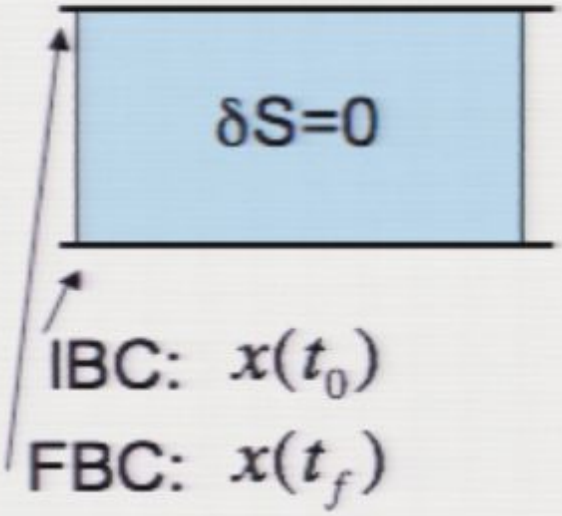

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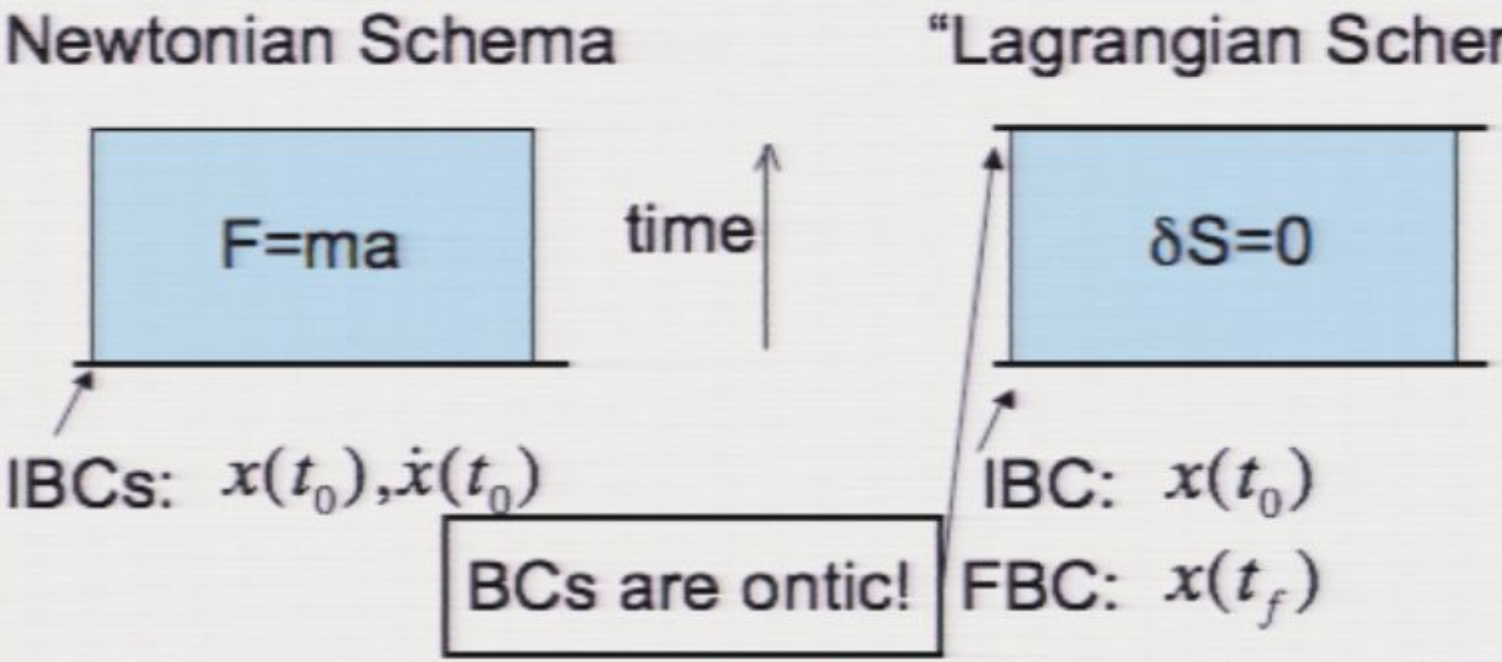

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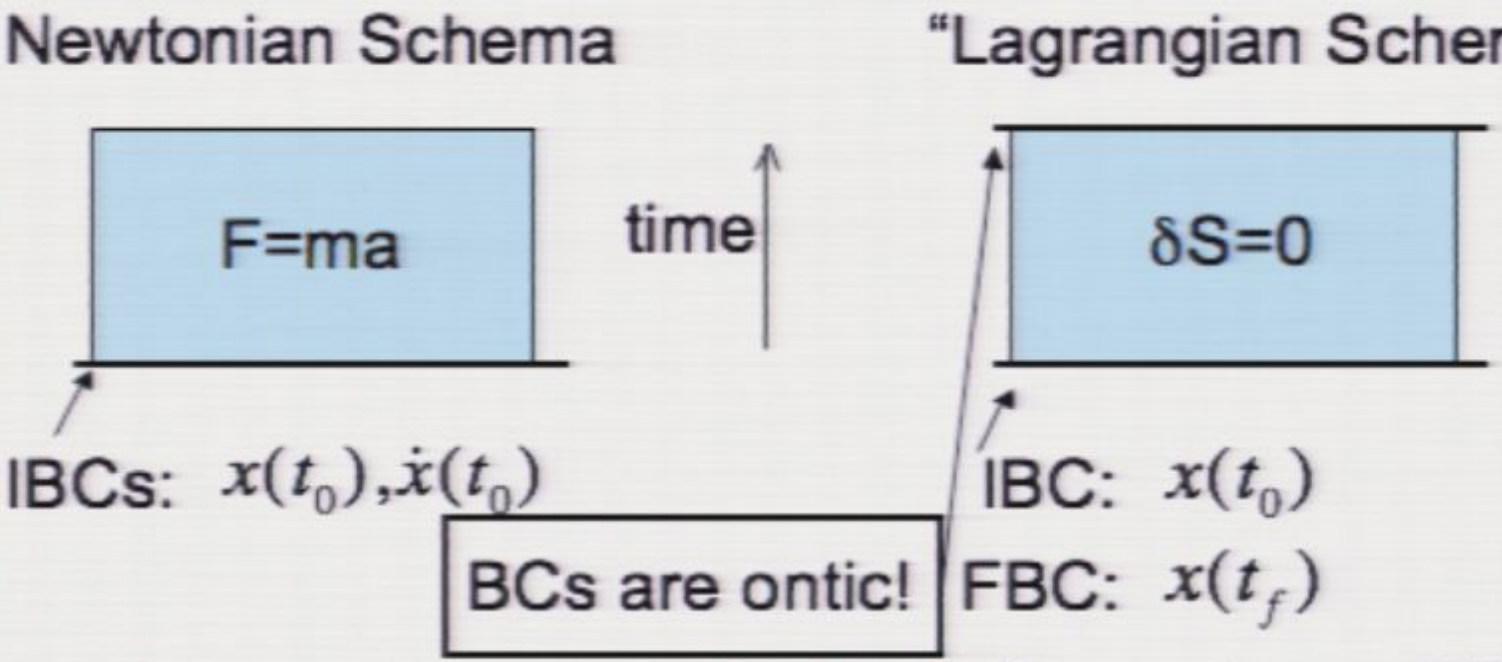

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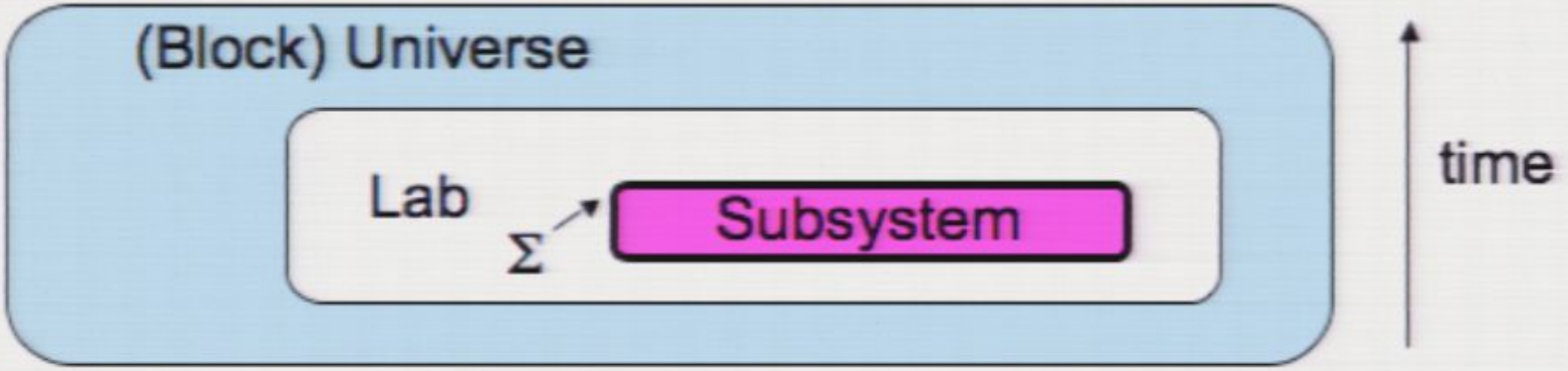
Thesis of this seminar: Applying the Lagrangian Schema to classical fields results in a quantum-like, ψ-epistemic theory.

Further motivation: compatibility with spacetime



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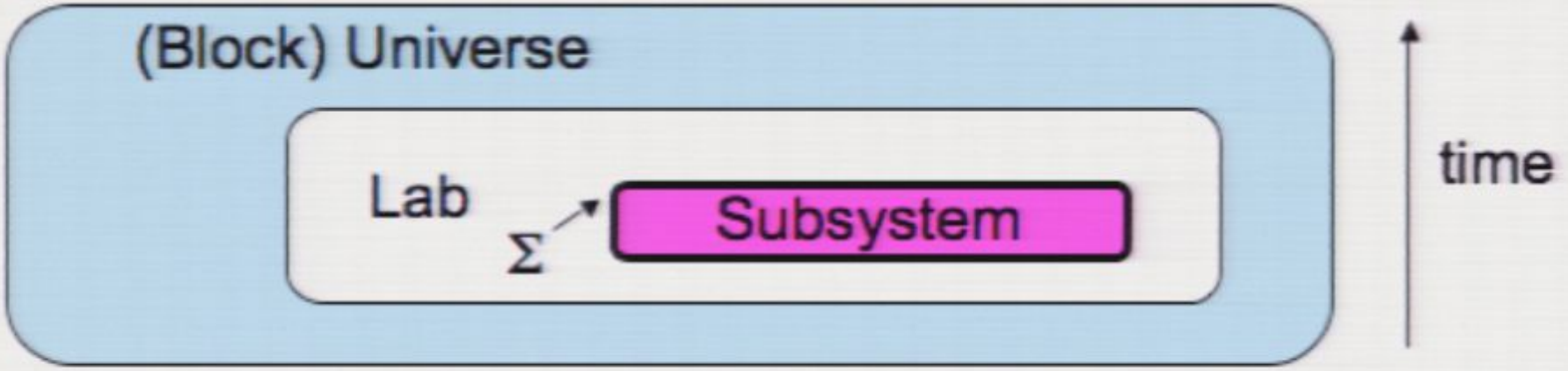

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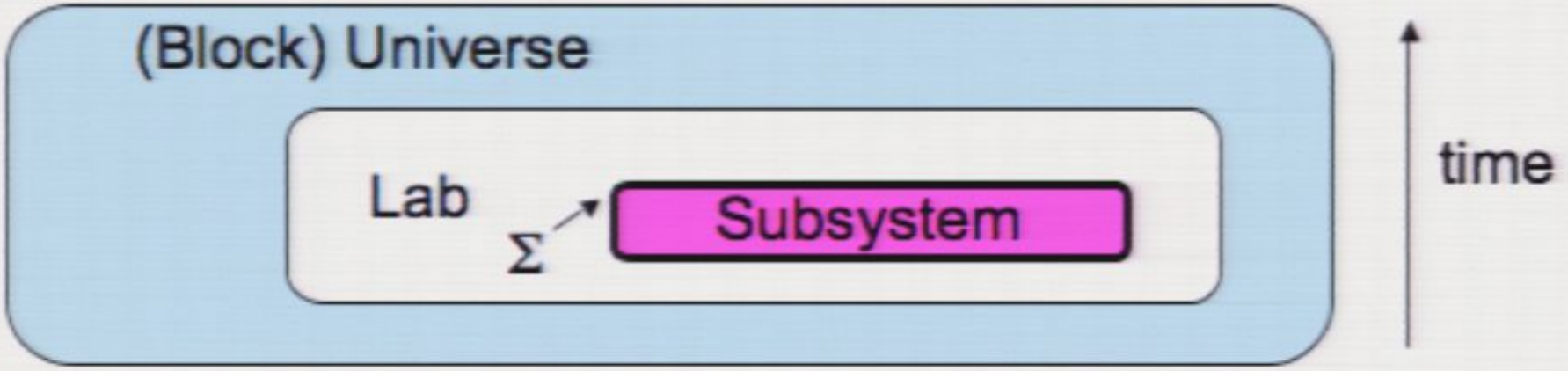

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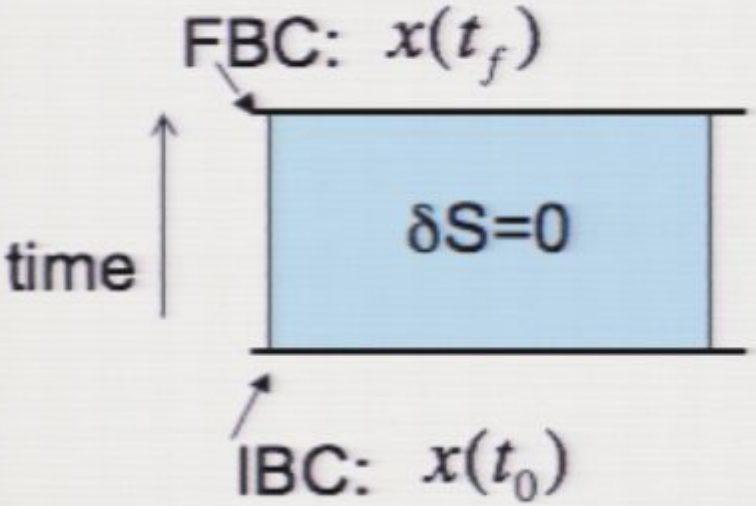

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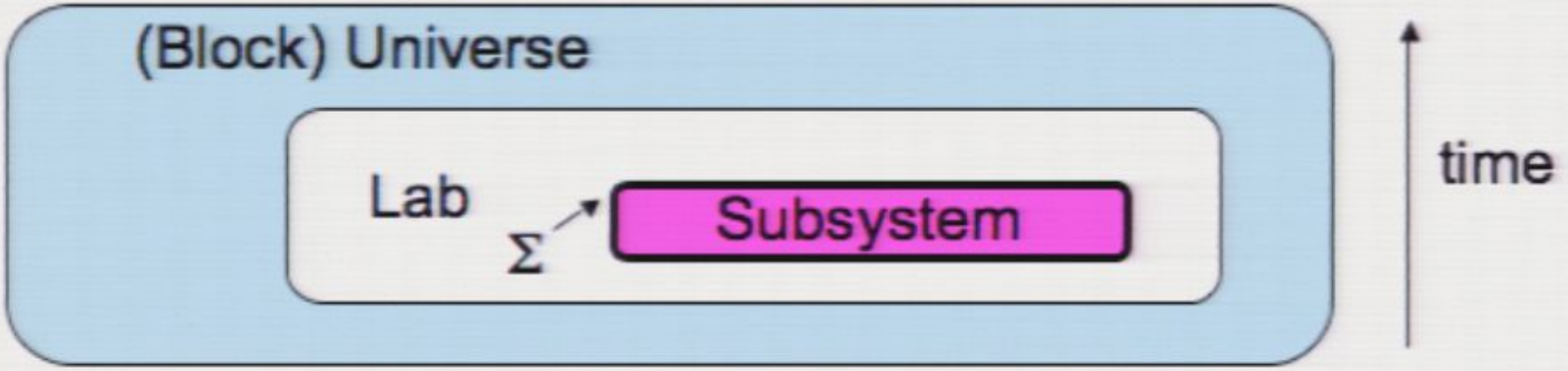

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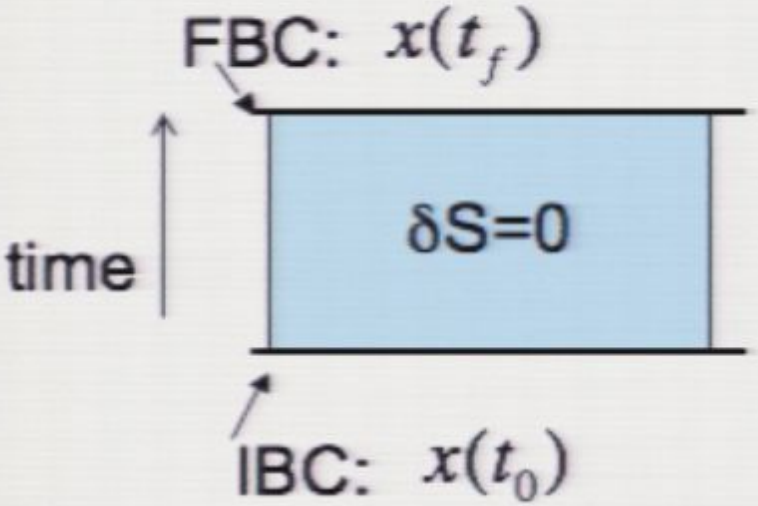

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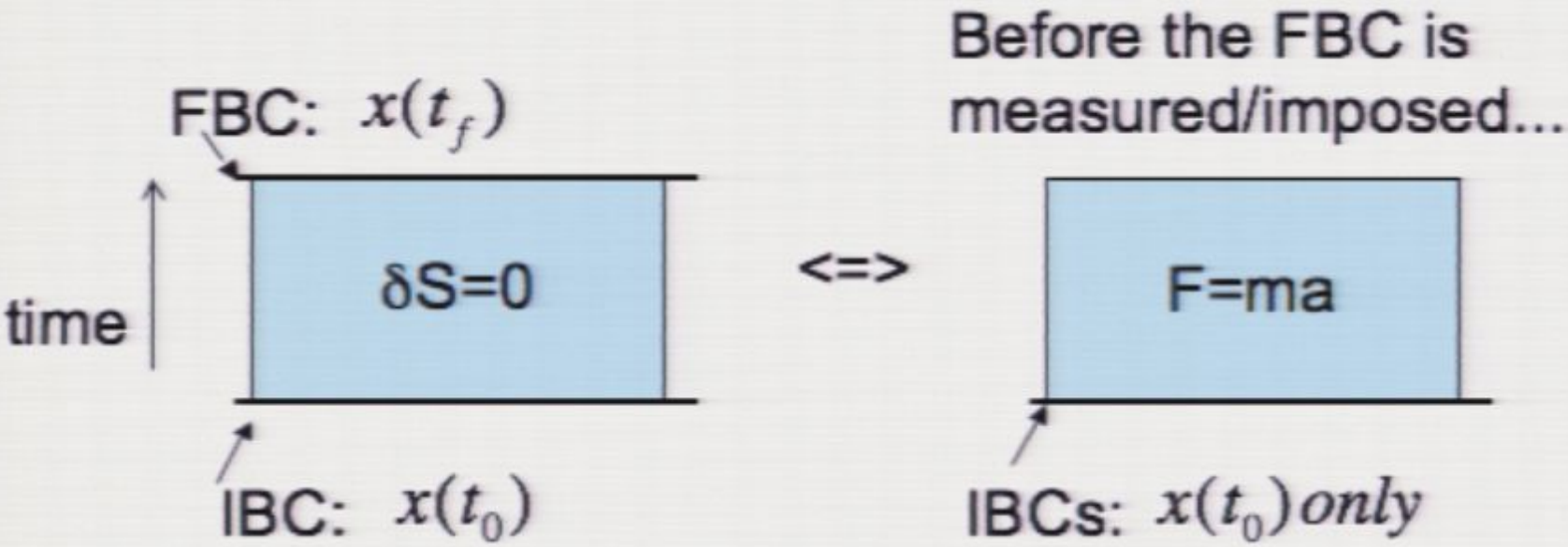

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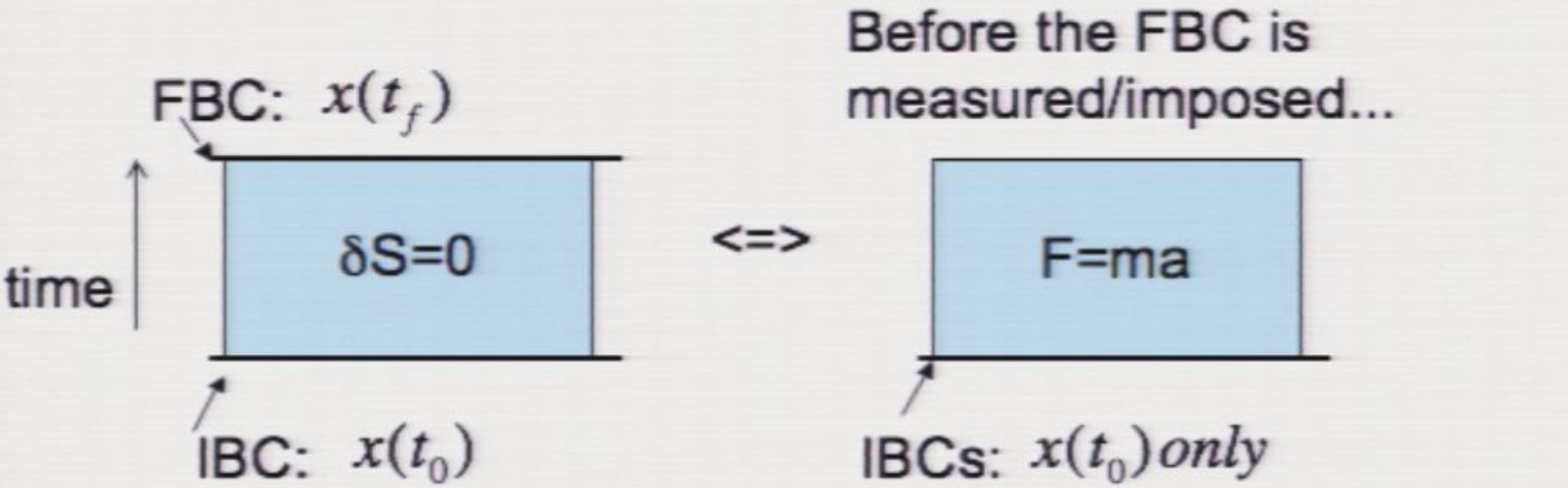

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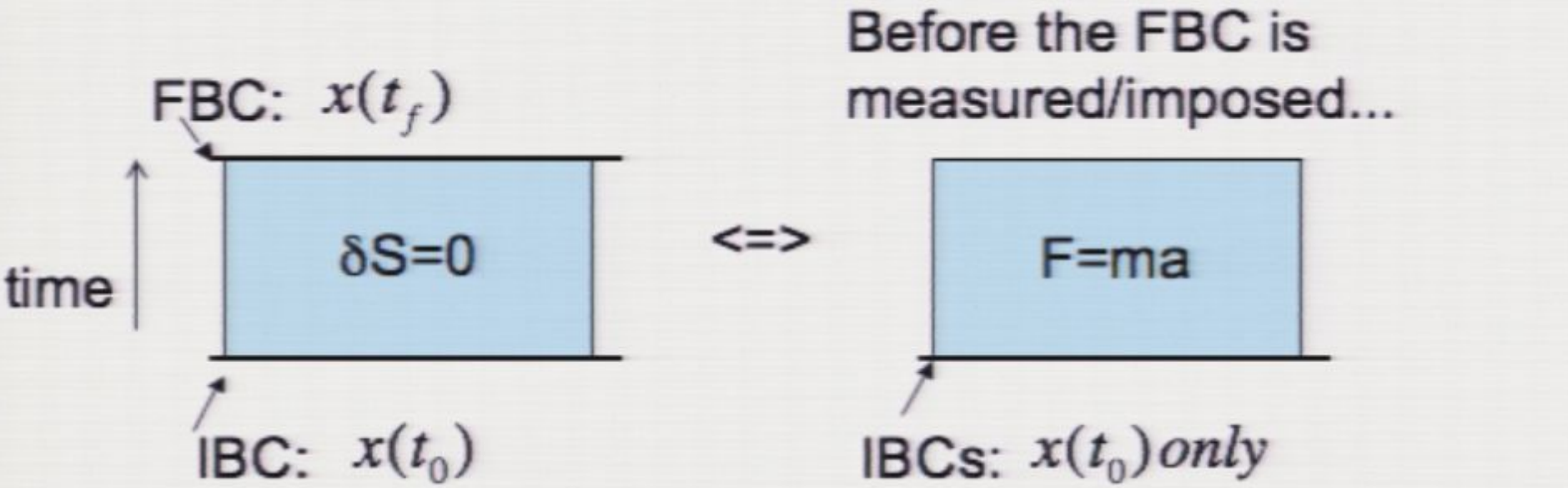

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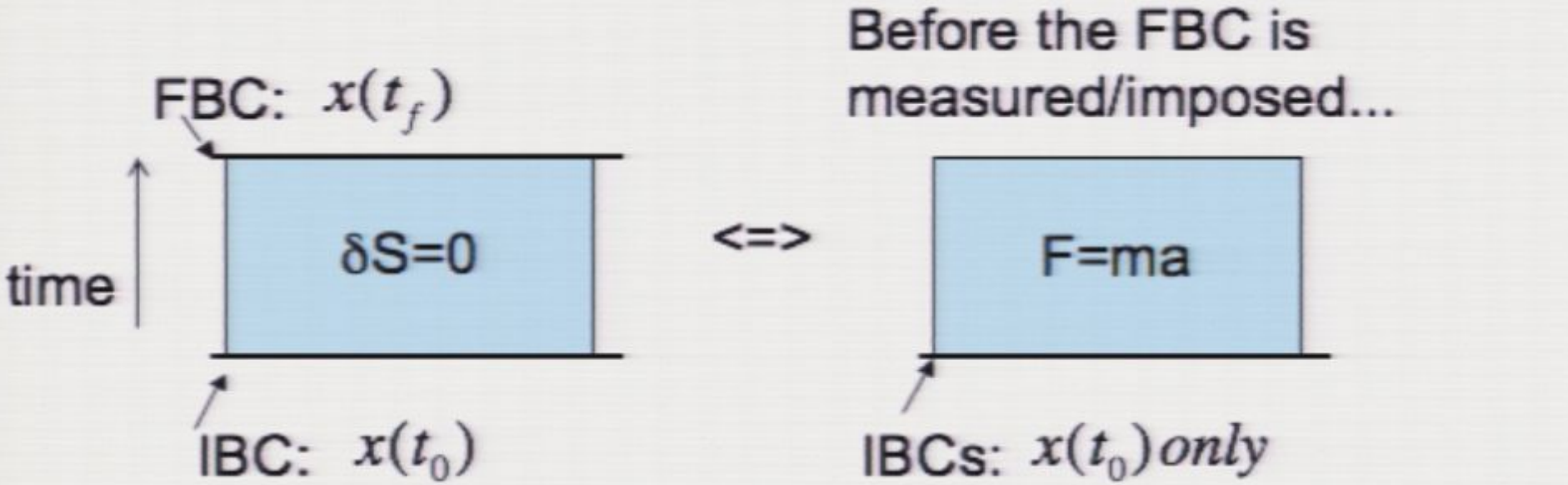

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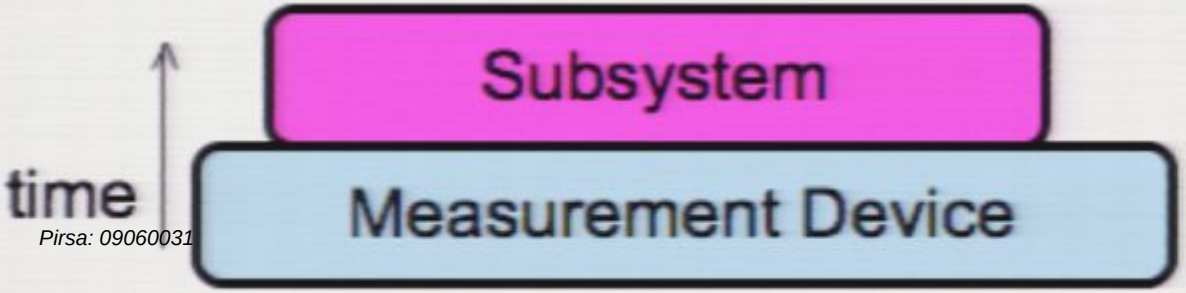

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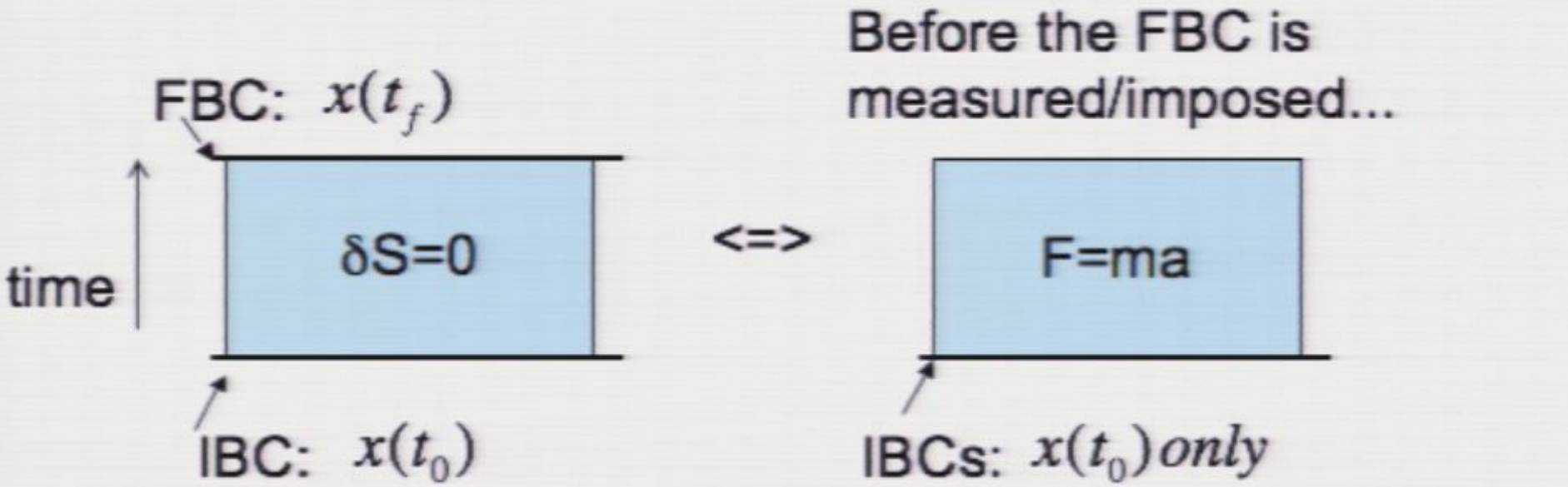

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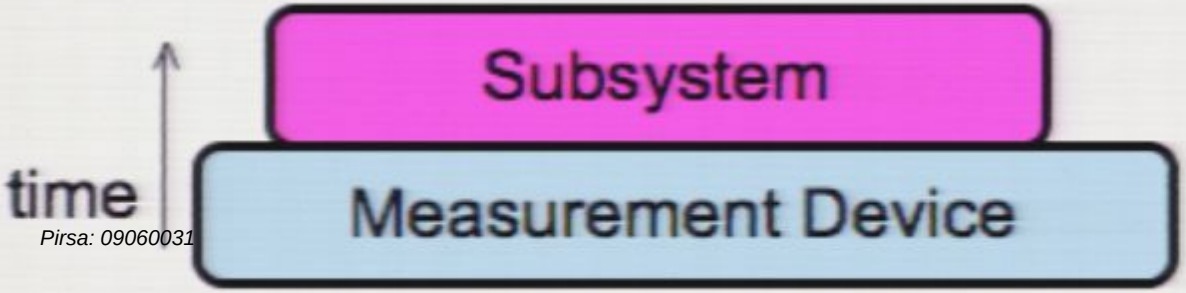

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Consequence #2: Quantization

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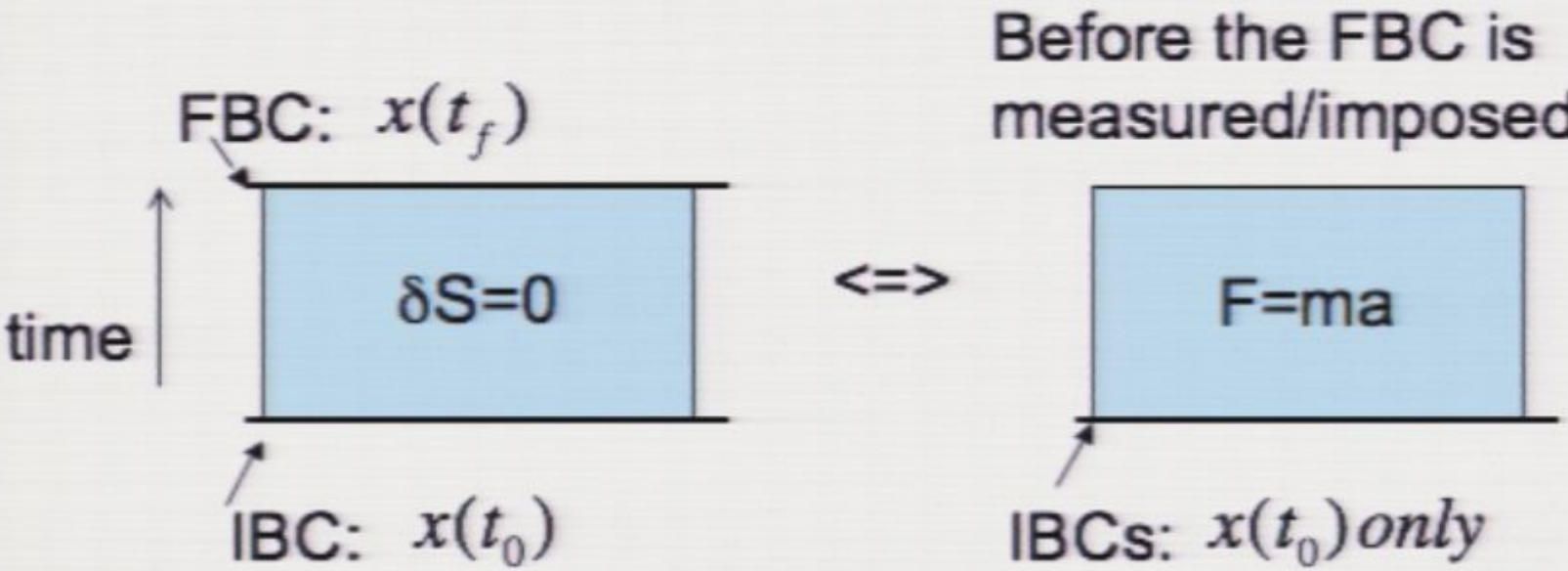

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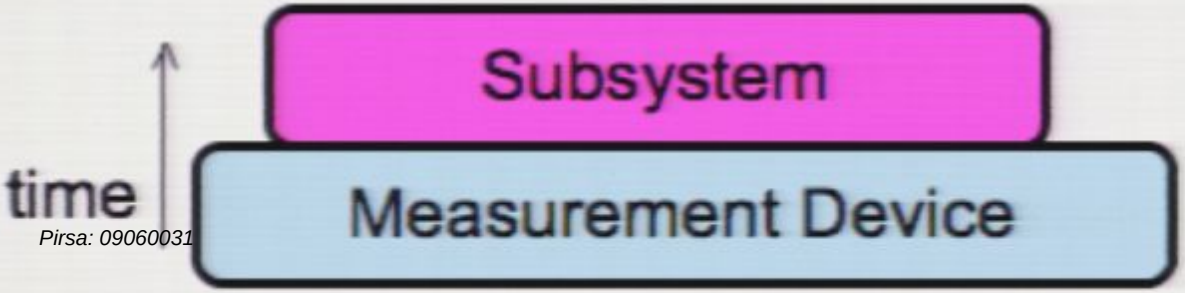

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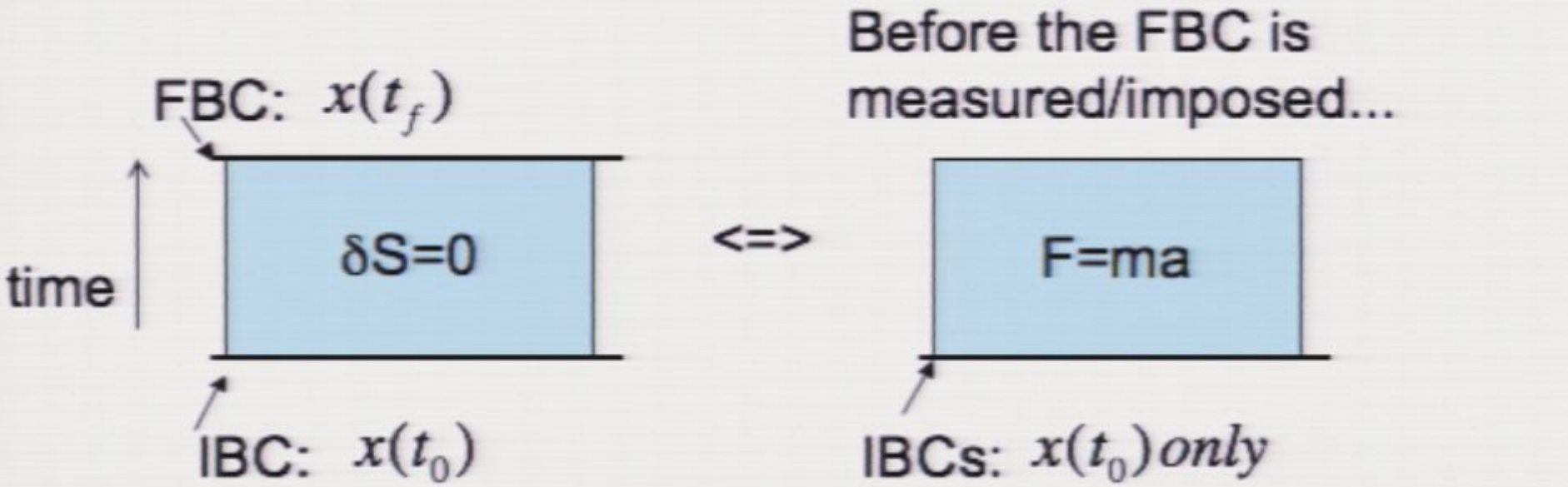

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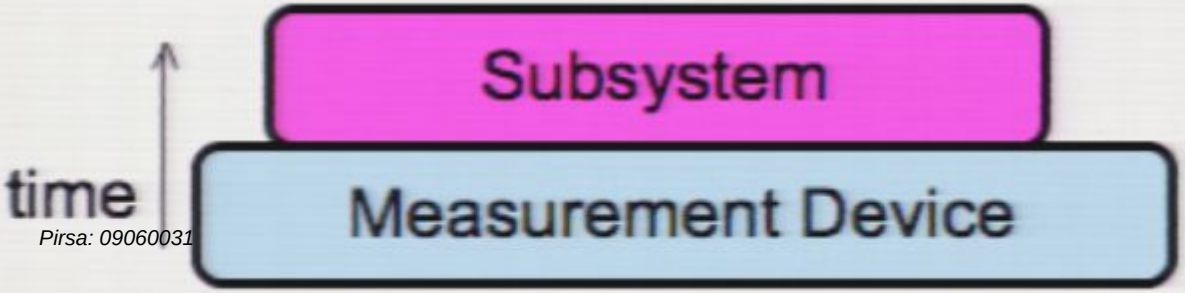

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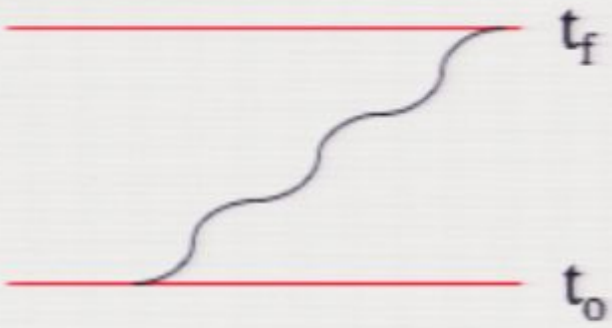

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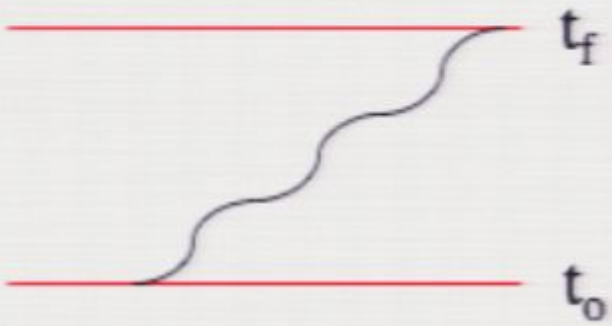

$$\frac{n}{2f} = t_f - t_0 \longrightarrow \omega_n = n\frac{\pi}{\left(t_f - t_0\right)}$$

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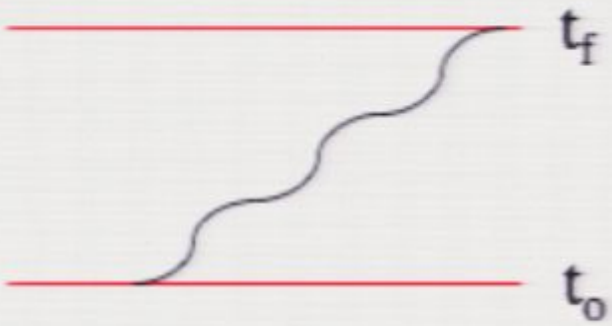

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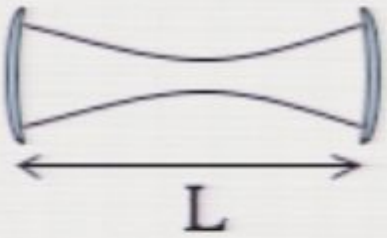

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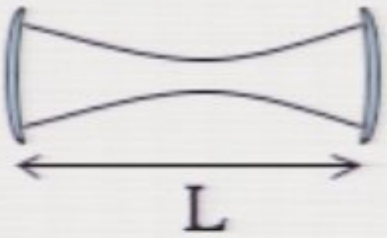

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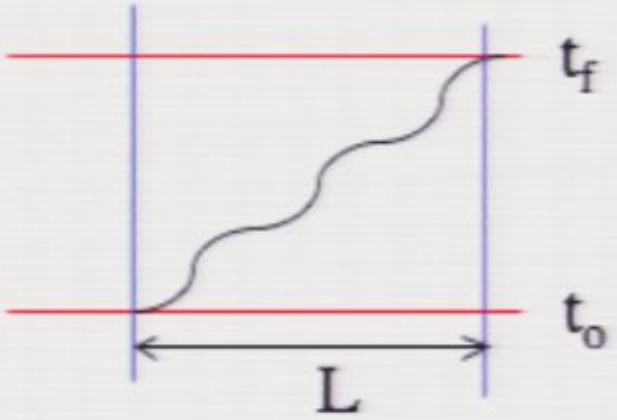

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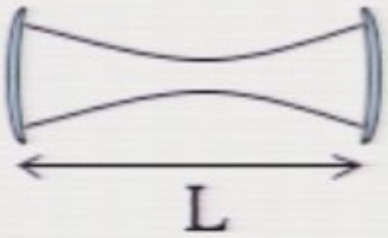

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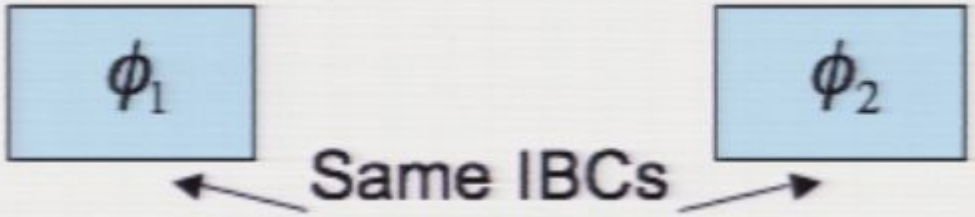

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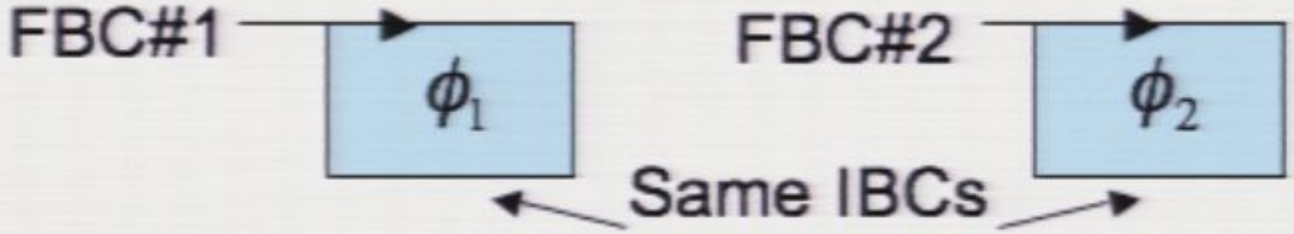

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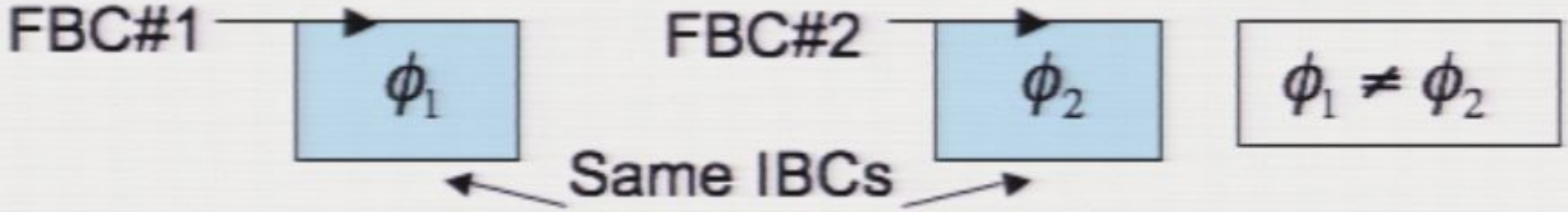

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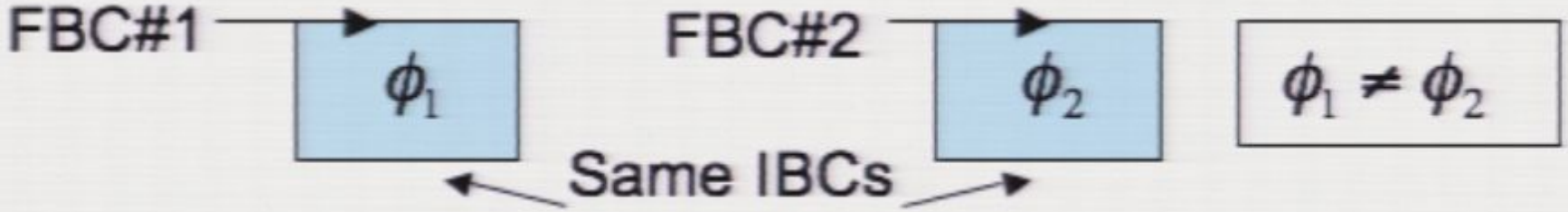

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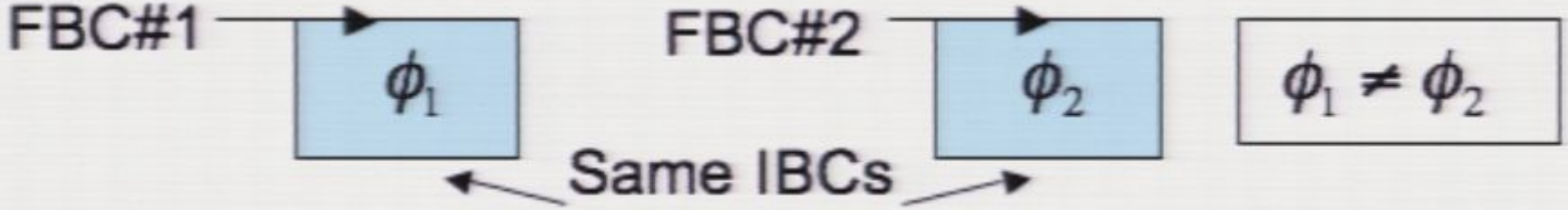

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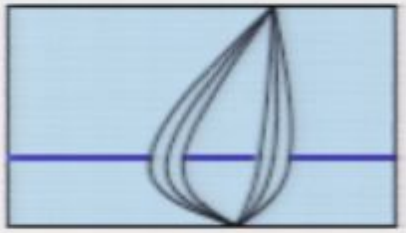

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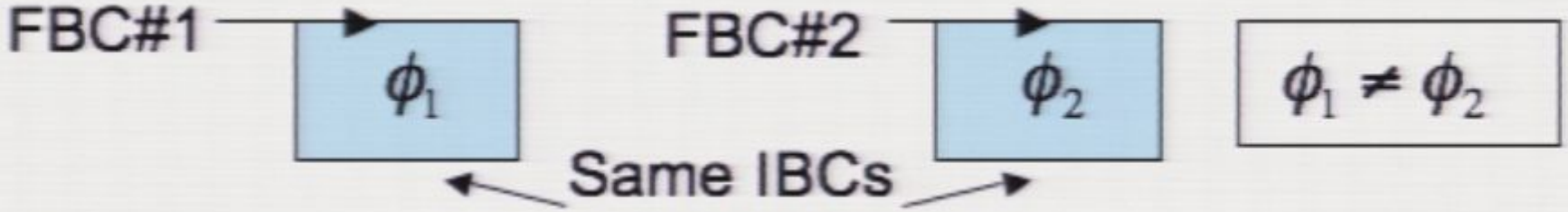

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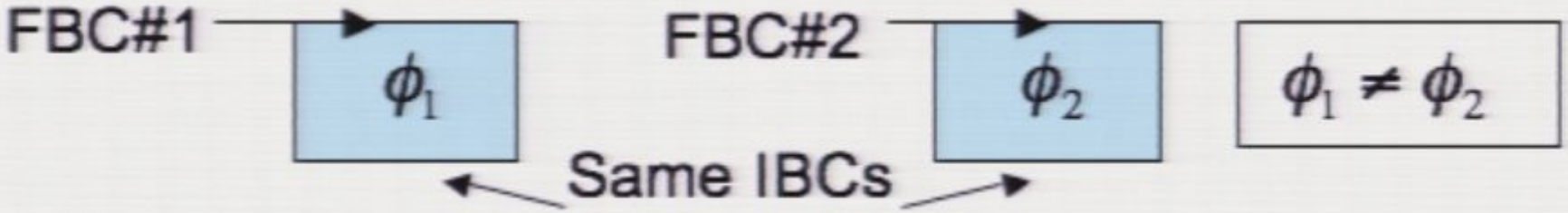

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The very feature that repels most physicists from taking the Lagrangian Schema seriously (a counter-intuitive view of causality) naturally addresses Kochen-Specker/Bell-style criticisms of realistic, classical models!

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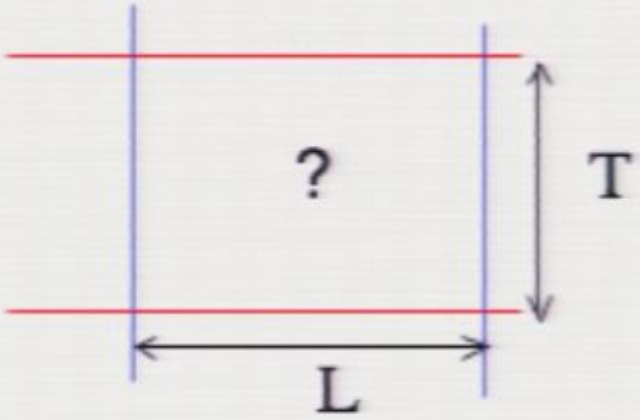

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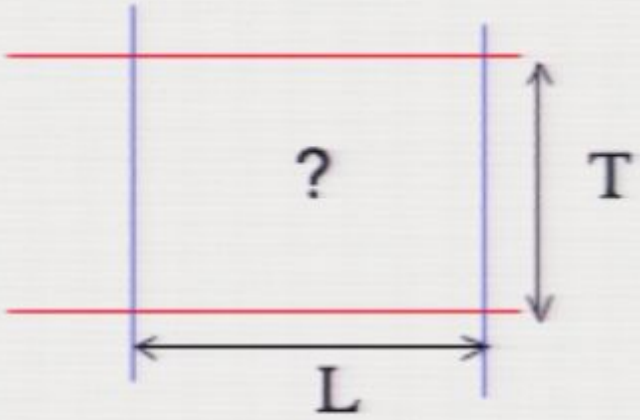

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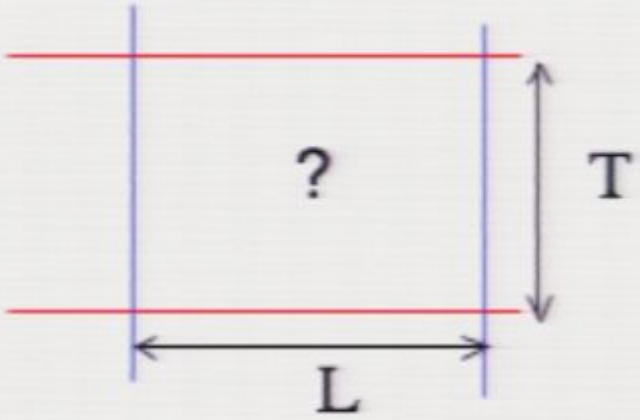

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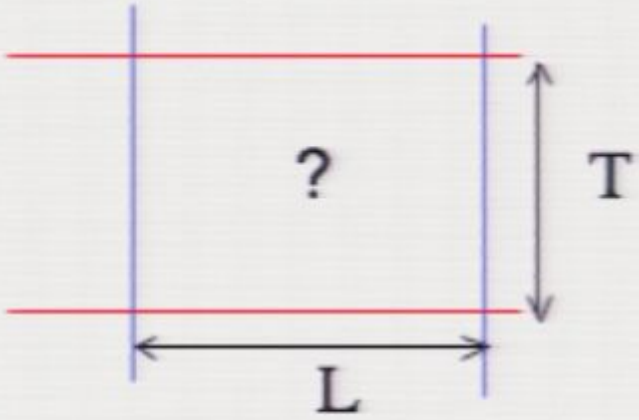

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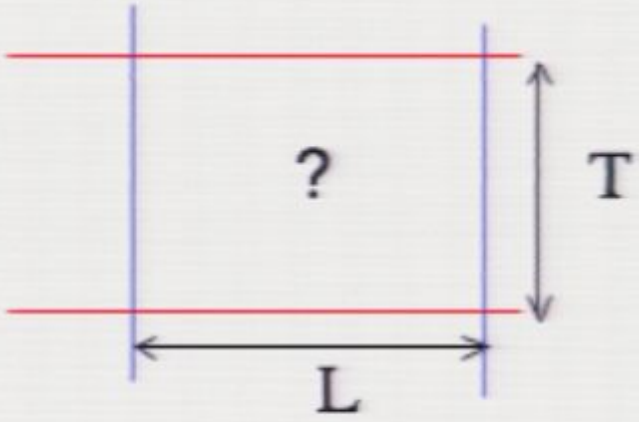

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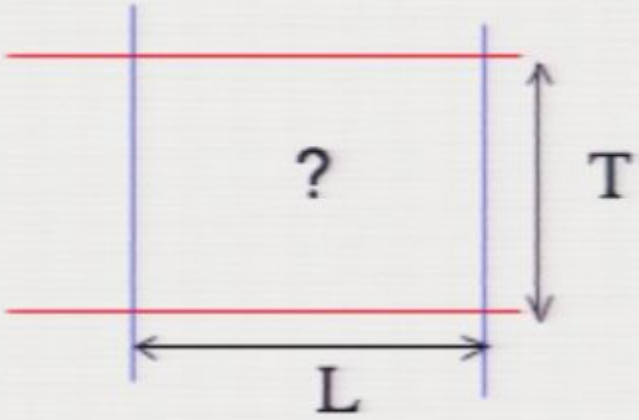

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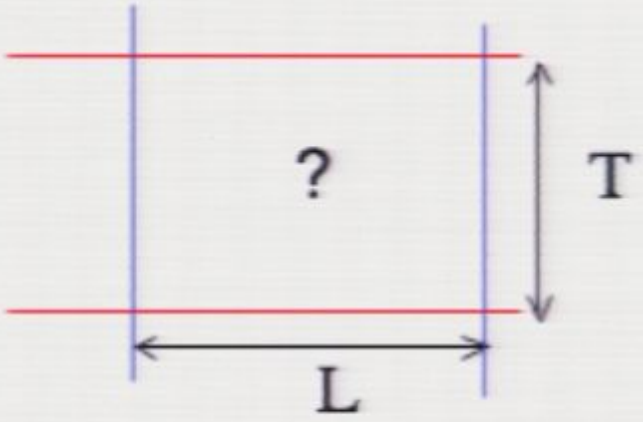

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For any values of T & L, "frequency tower" mostly disappears!
(Solutions almost always correspond to single-valued energy)

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Consequence: Preferred hypersurfaces for BCs $(e.g.\ \dot{x} = 0)$

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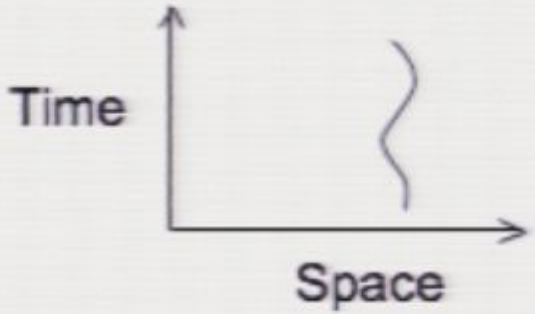

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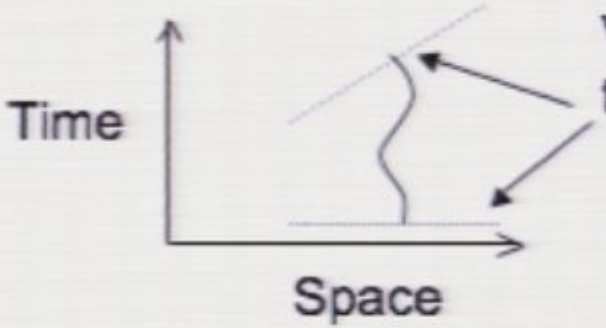

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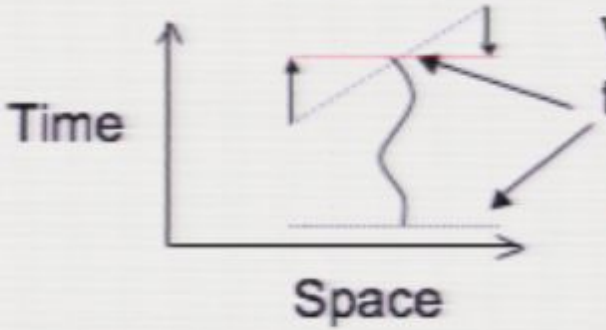

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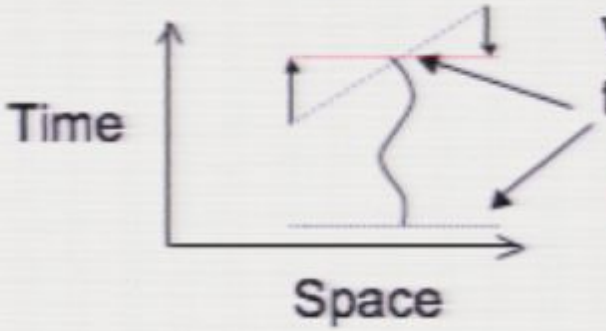

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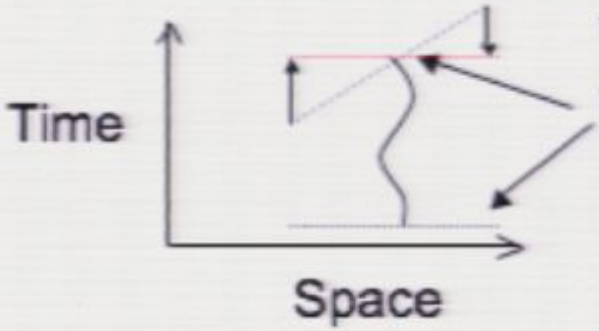

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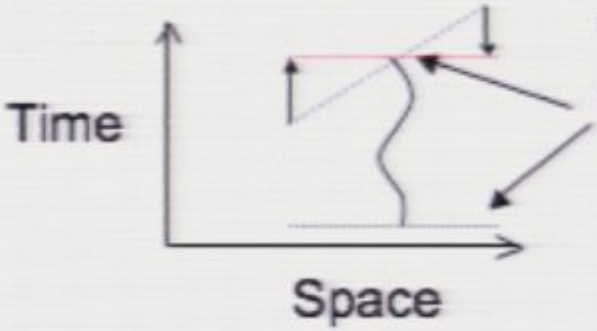

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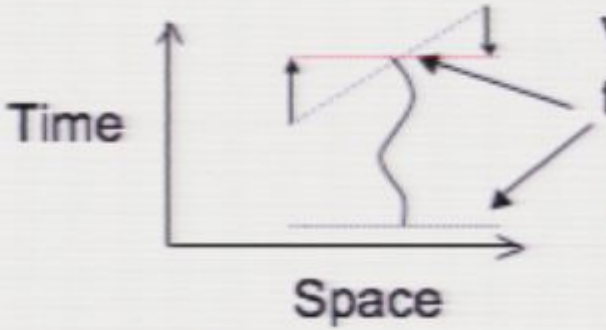

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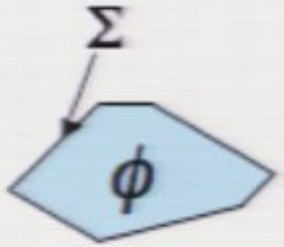

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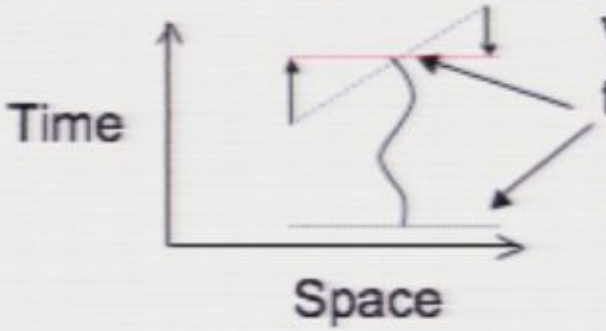

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("Natural boundary conditions" in Courant and Hilbert)

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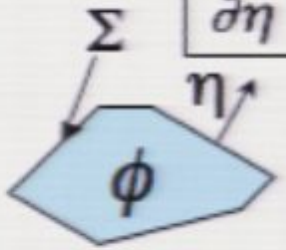

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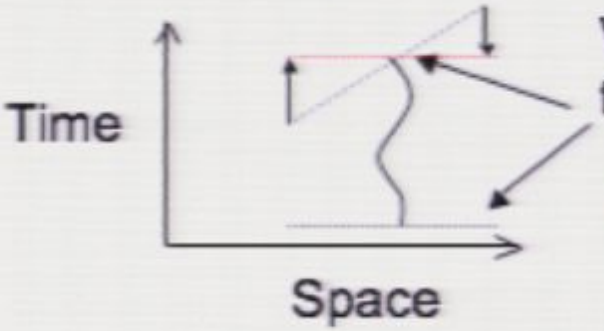

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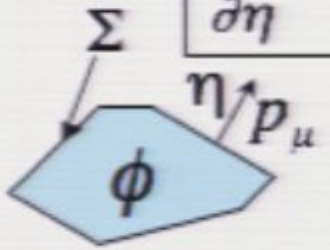

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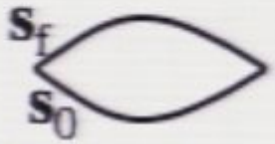

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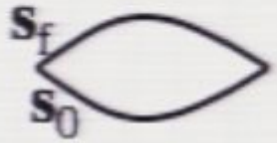

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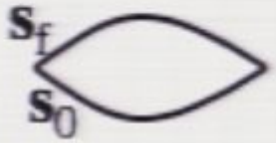

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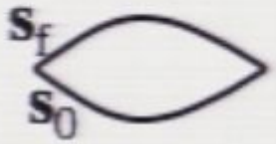

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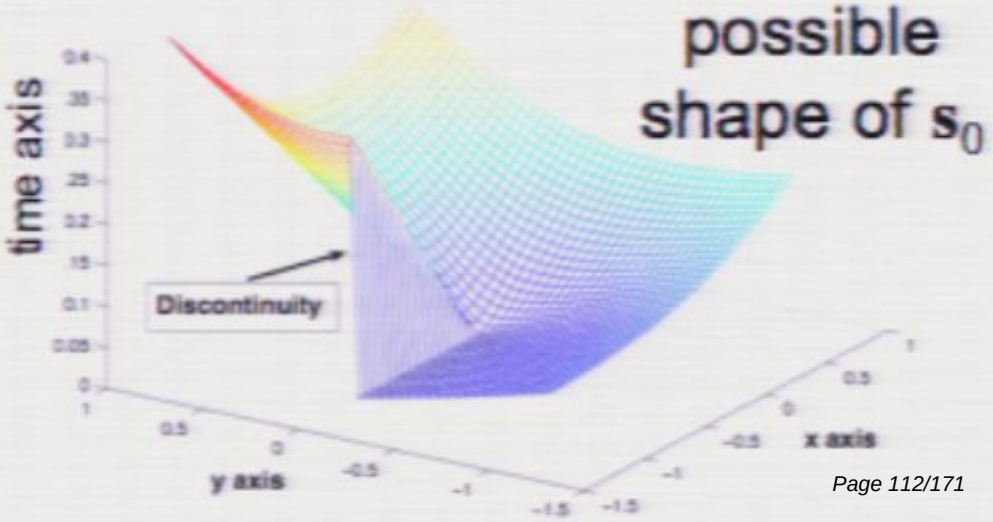

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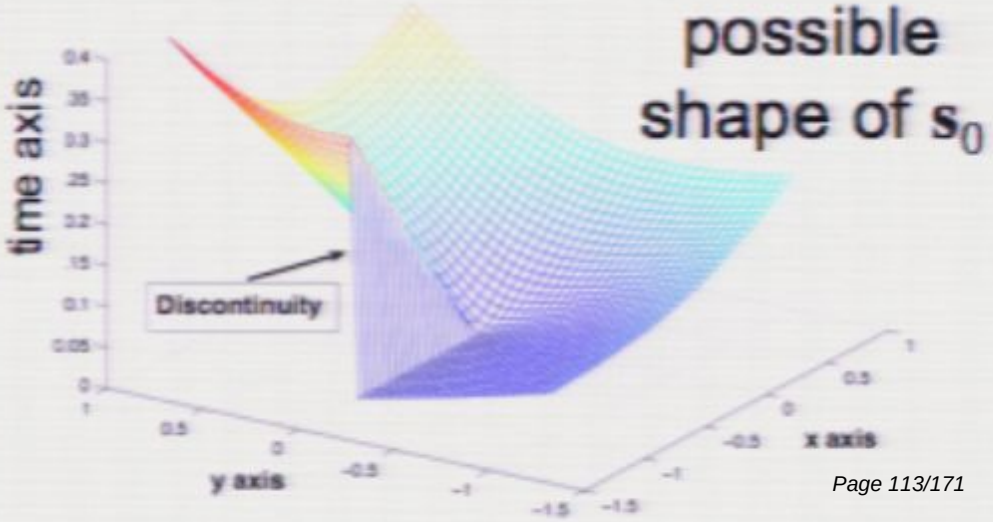

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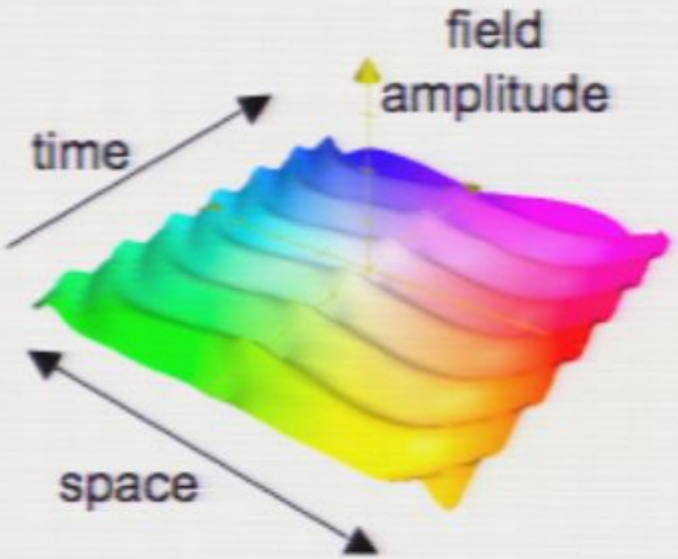

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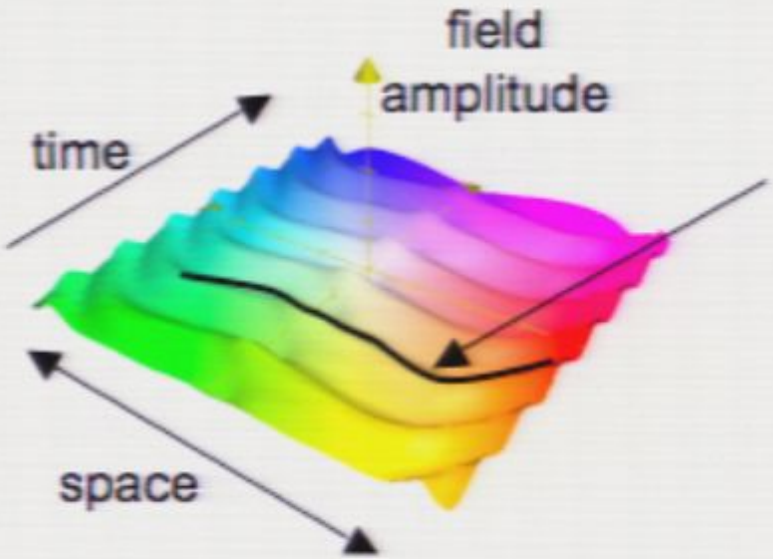

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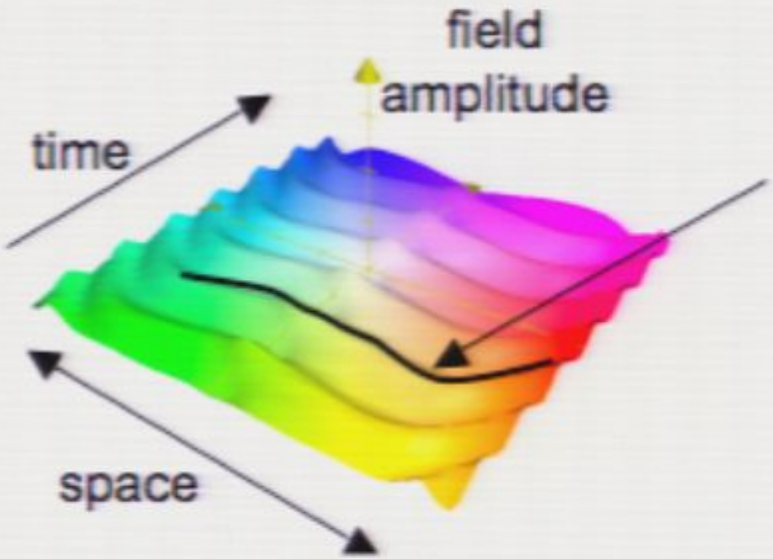

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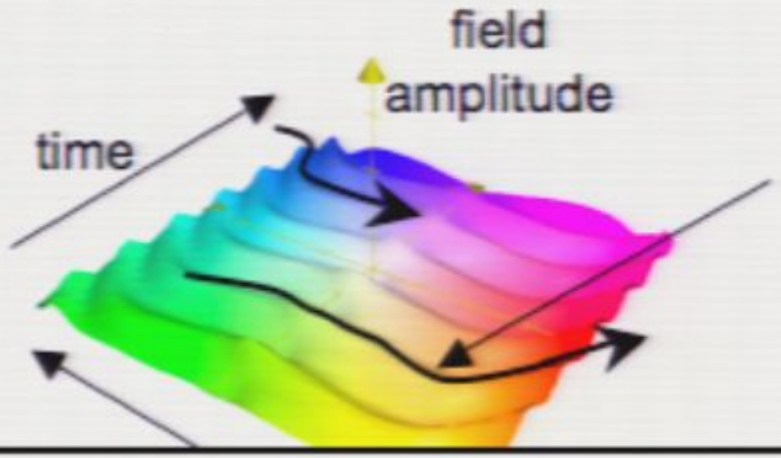

Corkscrew-shaped hypersurfaces are restricted to periods near $n\pi/\omega_0$!

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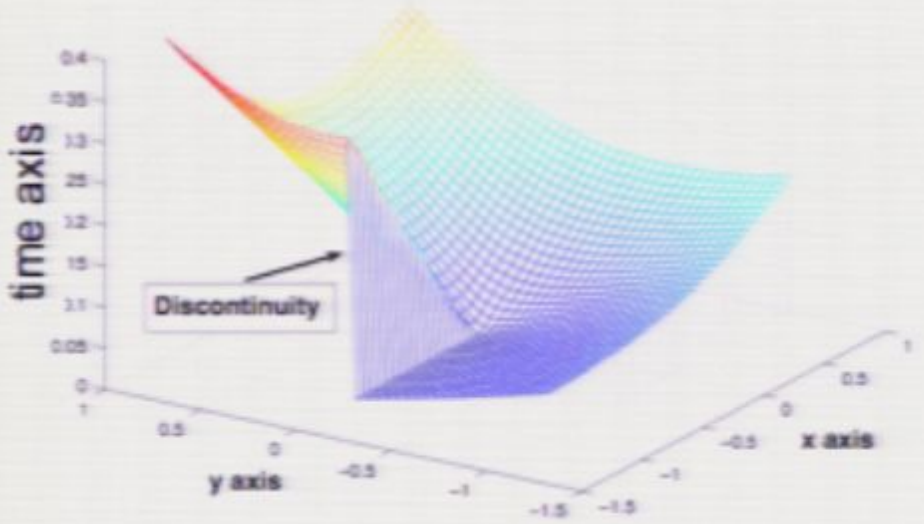

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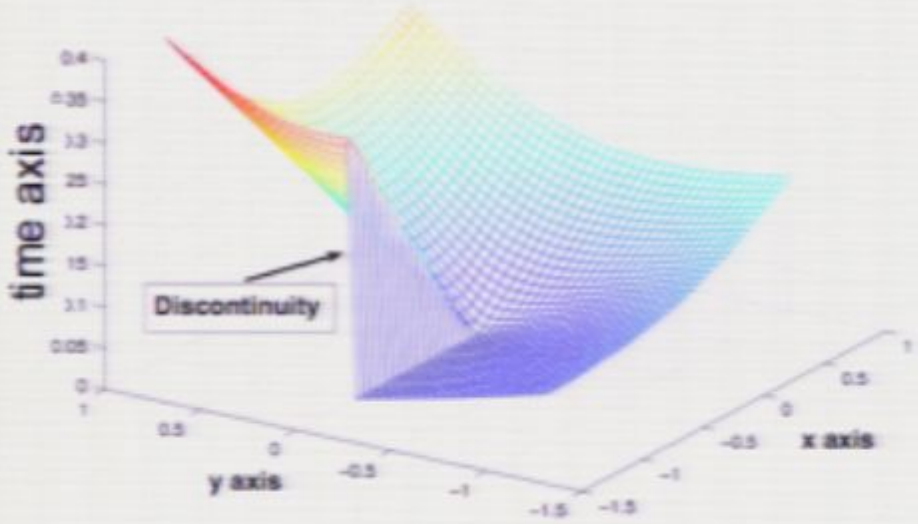

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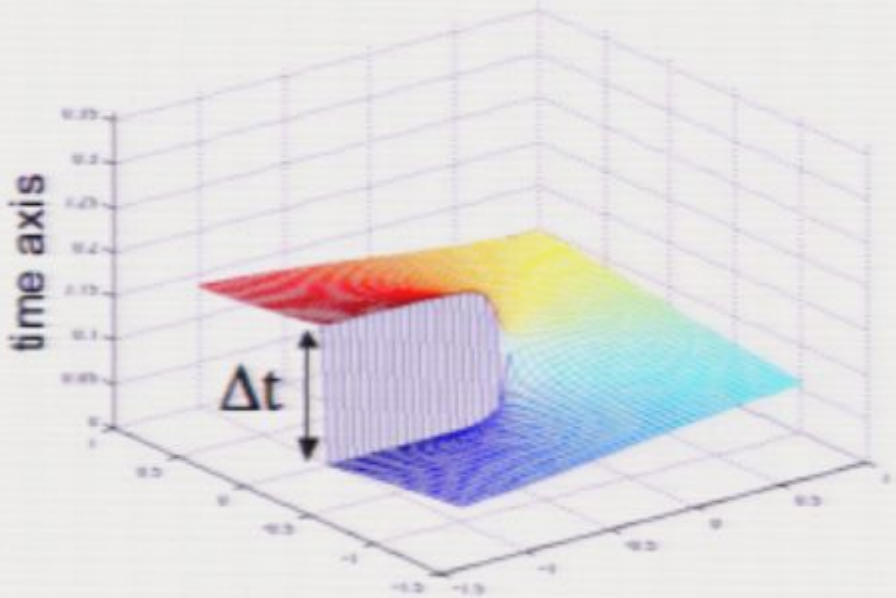

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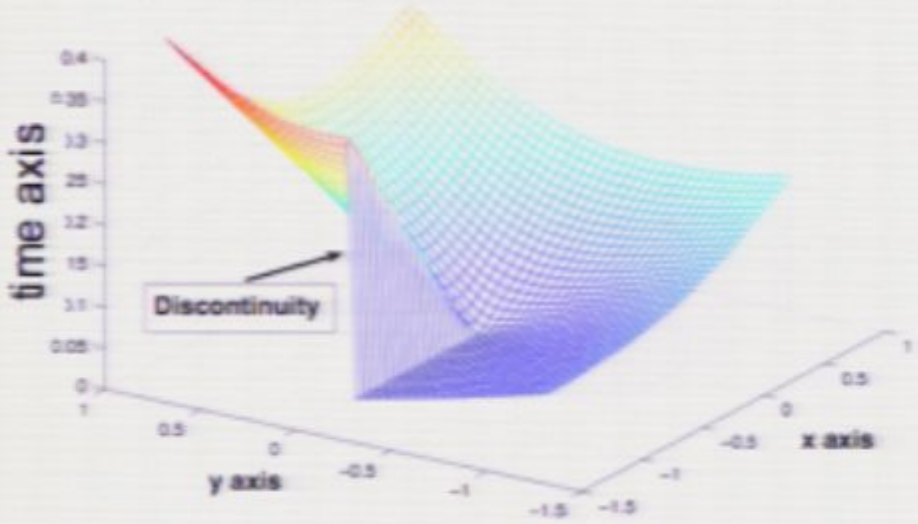

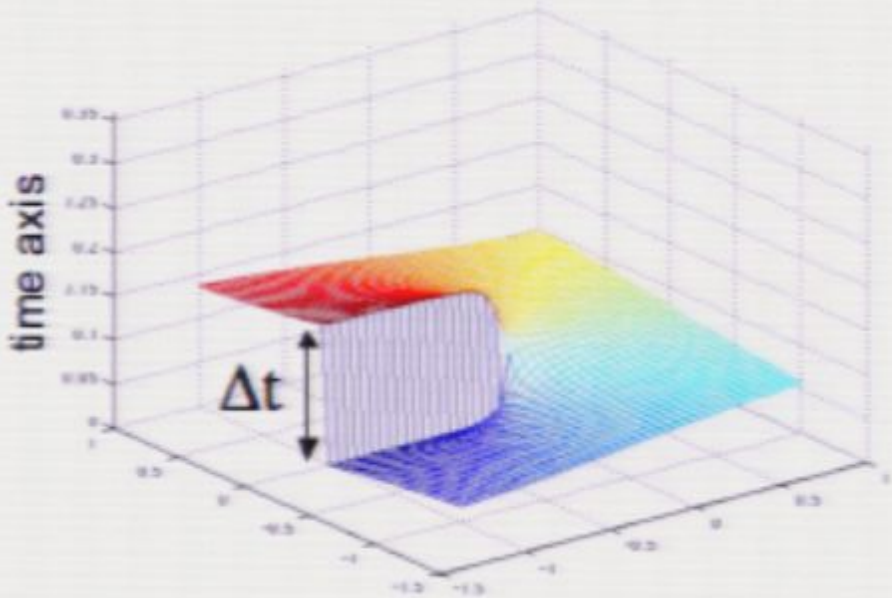

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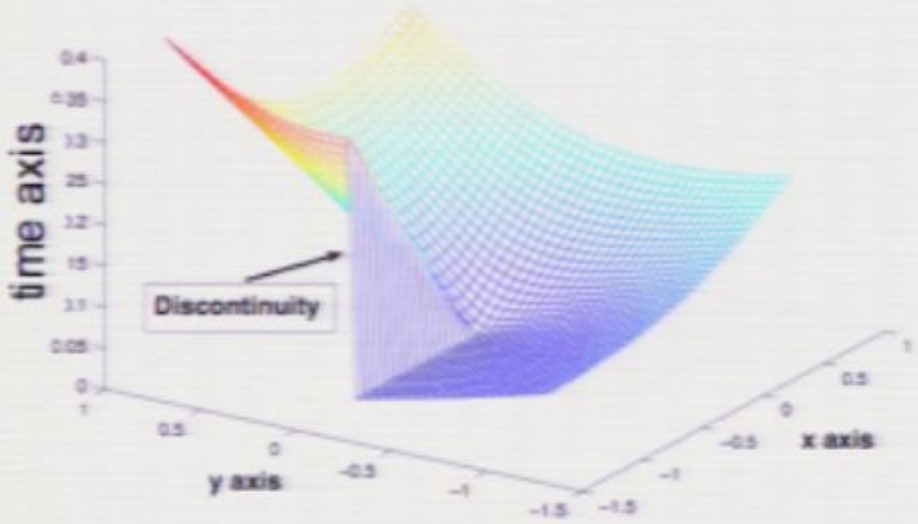

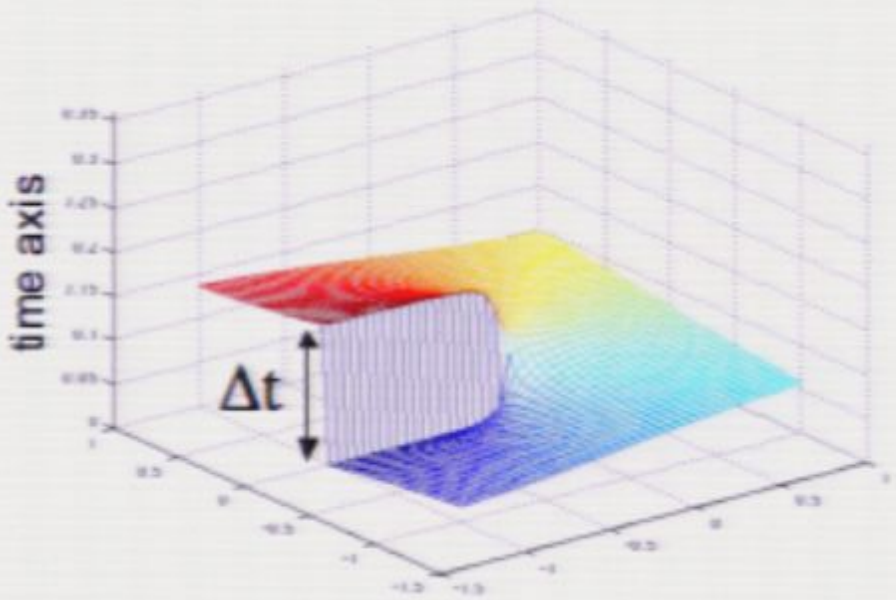

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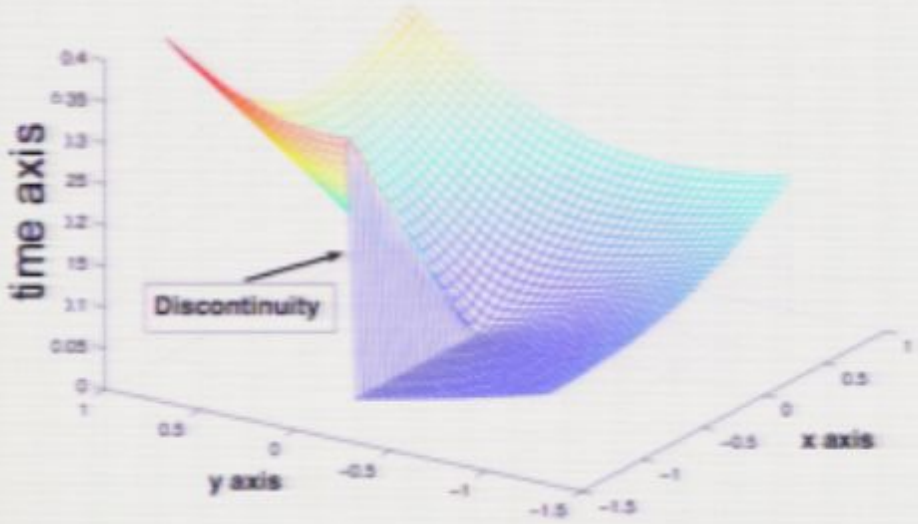

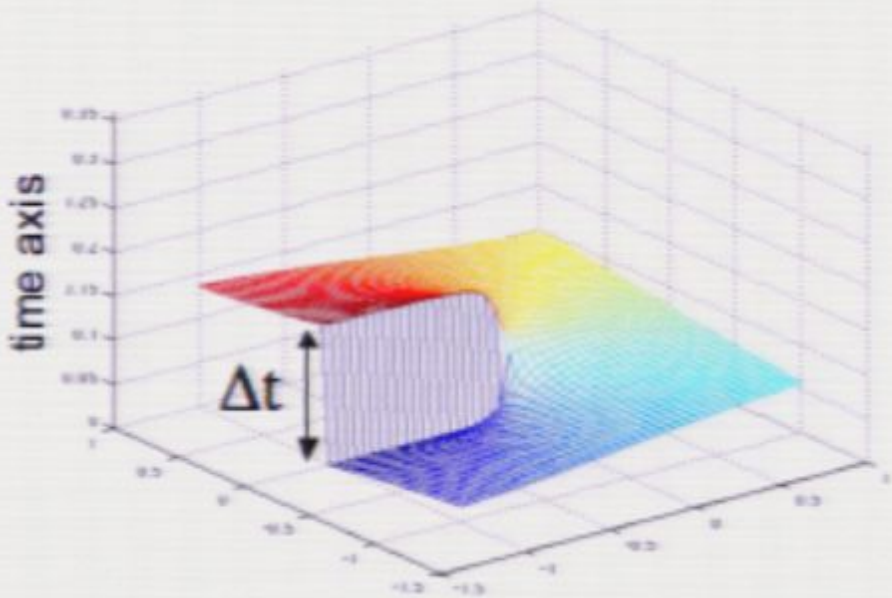

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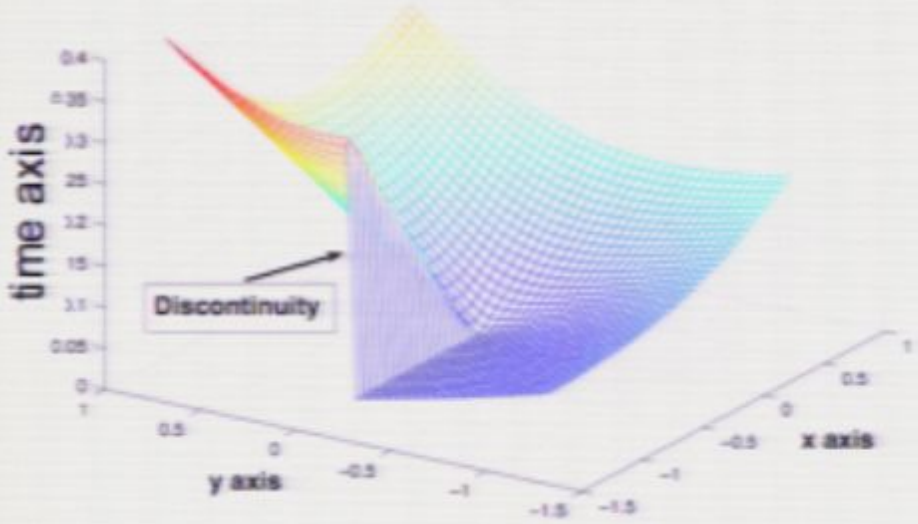

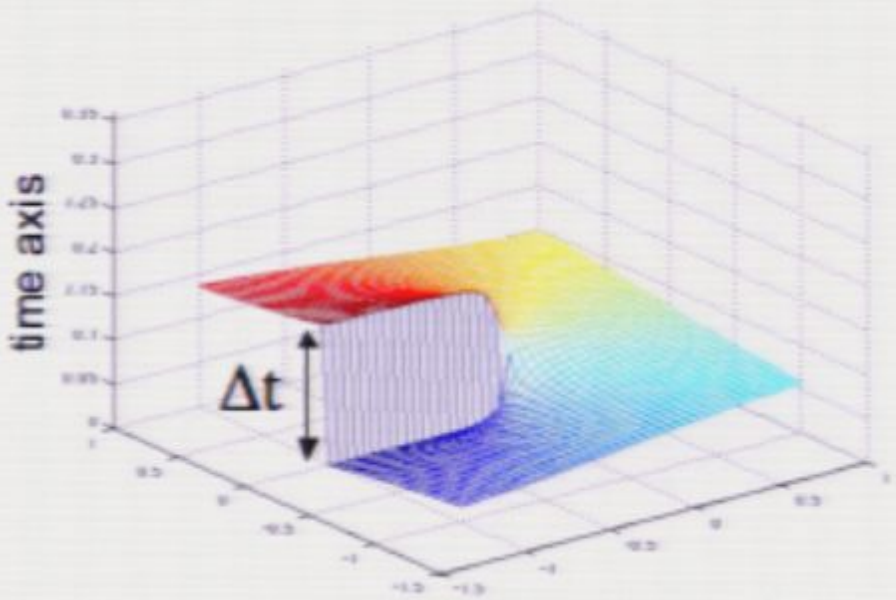

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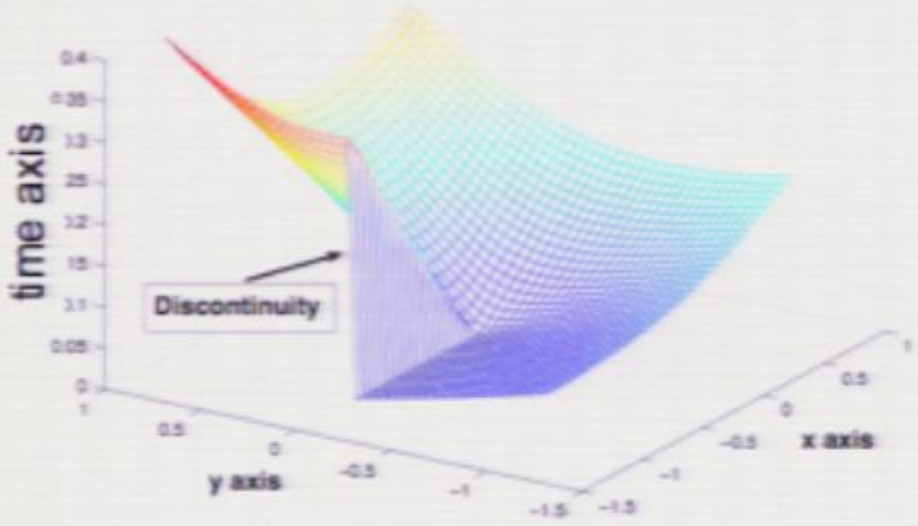

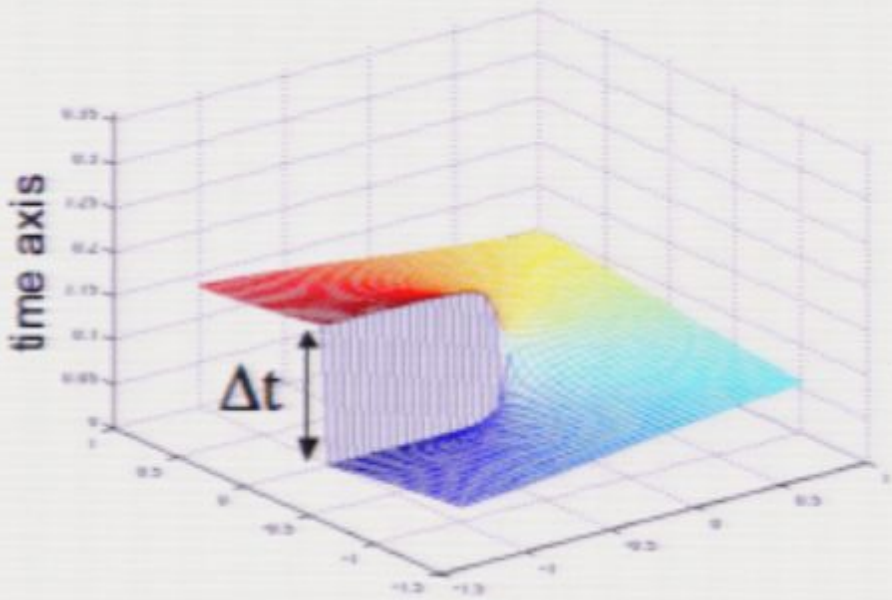

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(Hebeker and March-Russell hep-ph/0107039, Csaki et. al. hep-ph/0305237, Dolce 0903.3680)

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Bohr-Sommerfeld quantization analog (quantized energies?)

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Remember: these are purely classical fields!

(No need for operators?)

Probability in a Block Universe

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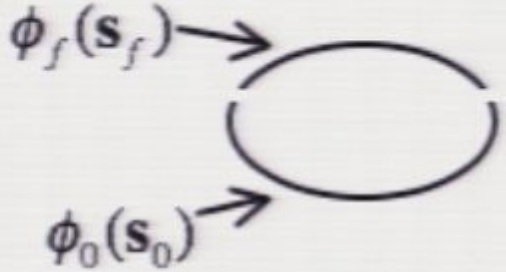

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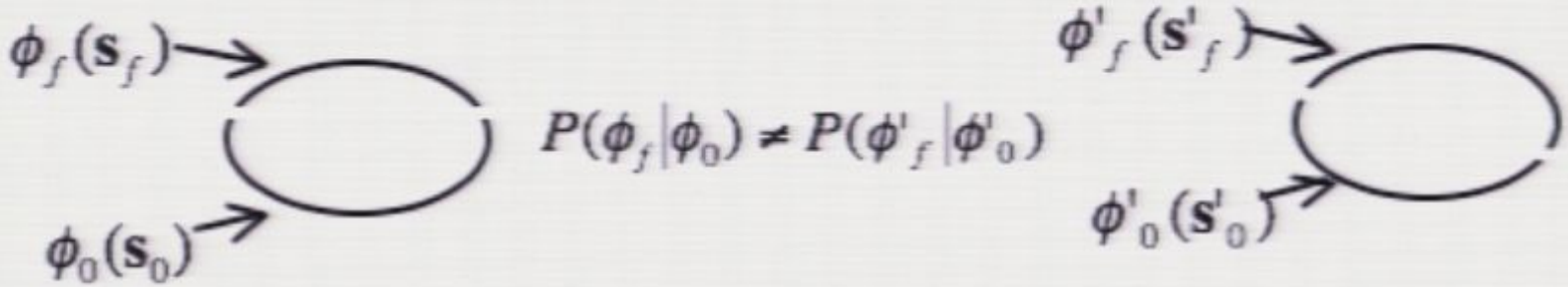

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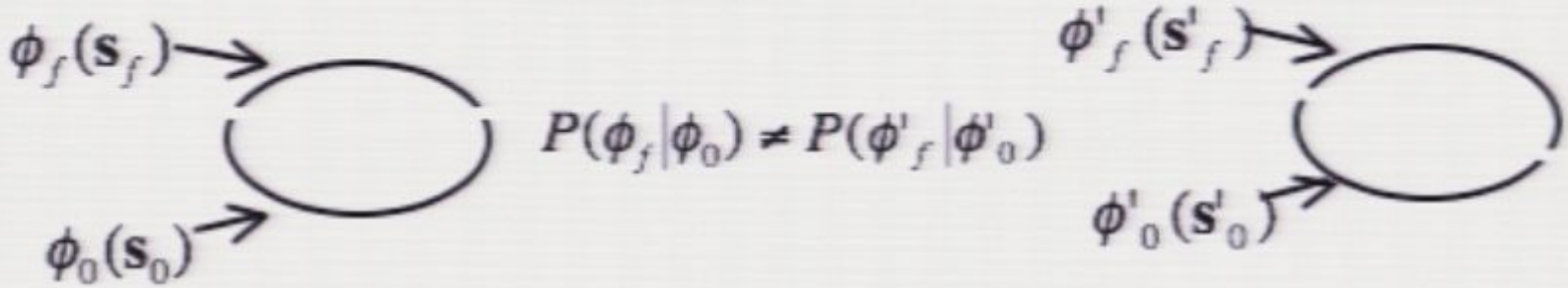

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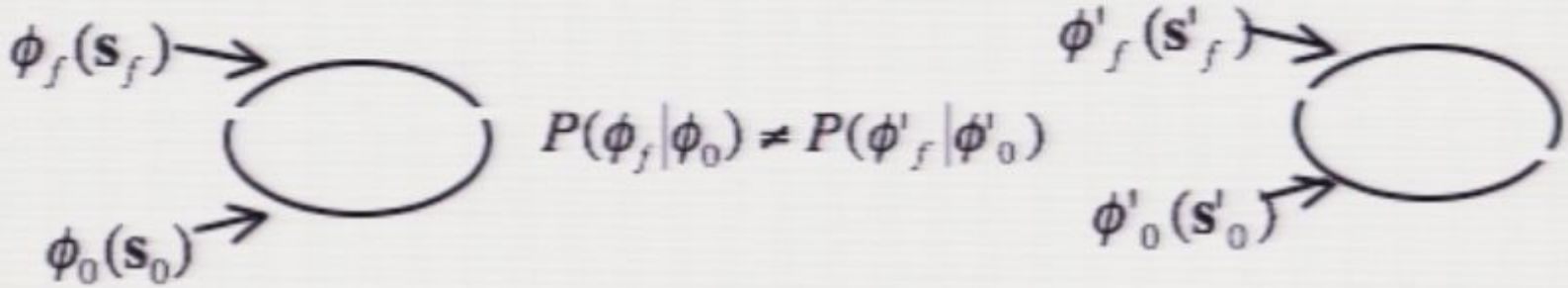

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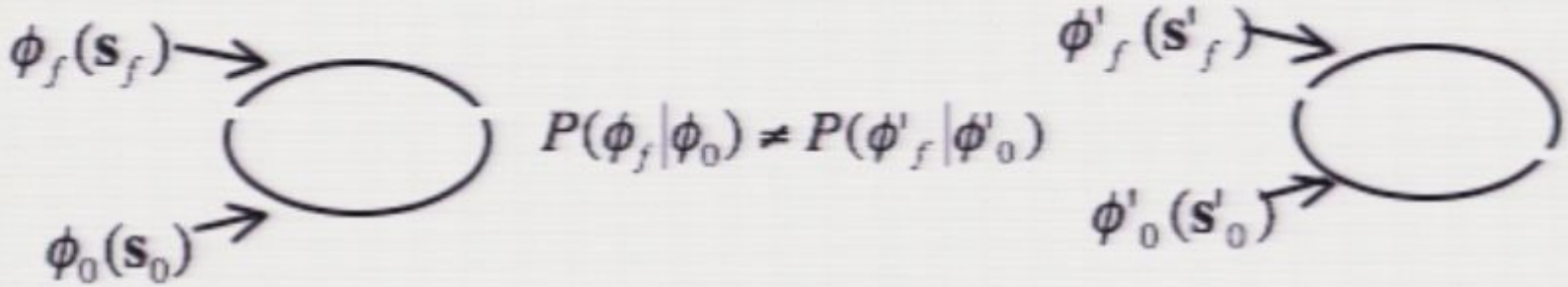

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Lagrangian Schema & Scalar Field (w/ one conjecture):

- Quantization of classical fields
- Counter-intuitive "contextuality"
  (Hidden variables constrained by future BCs)
- Single-valued outcomes if measured (E,L_z)

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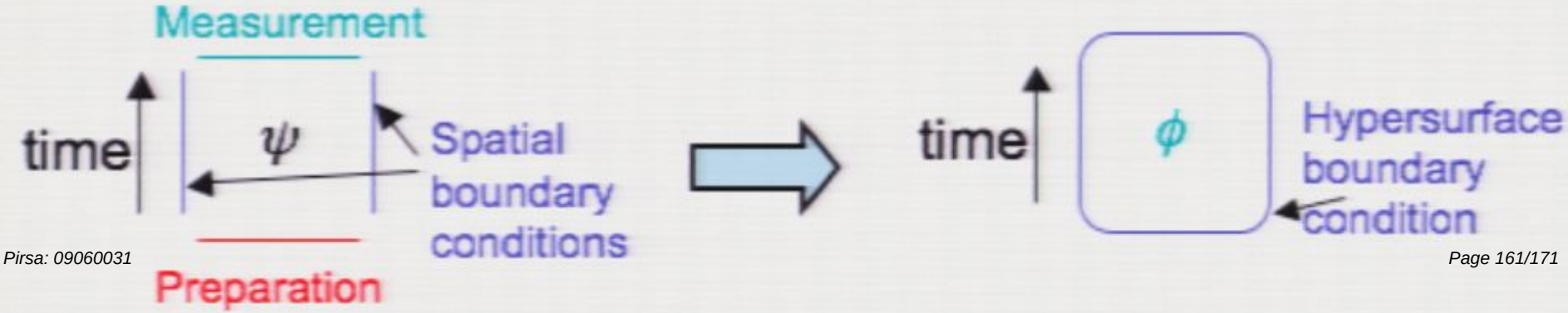

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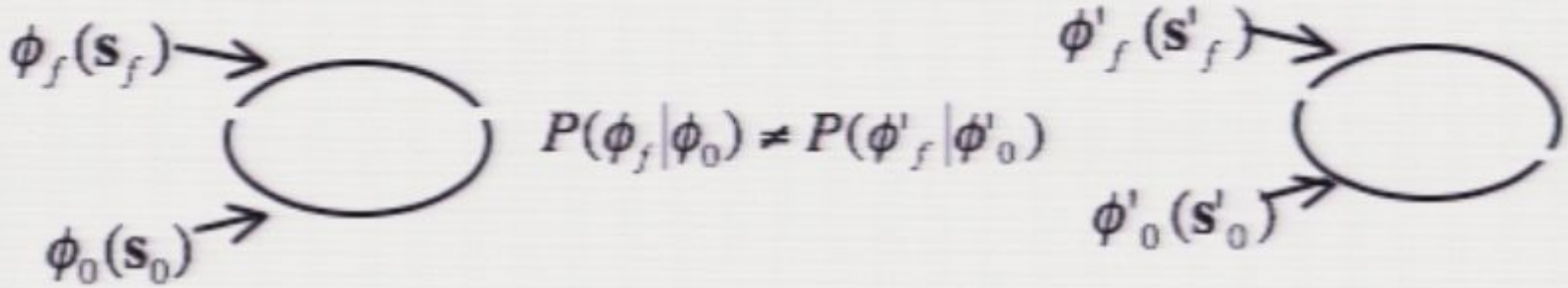

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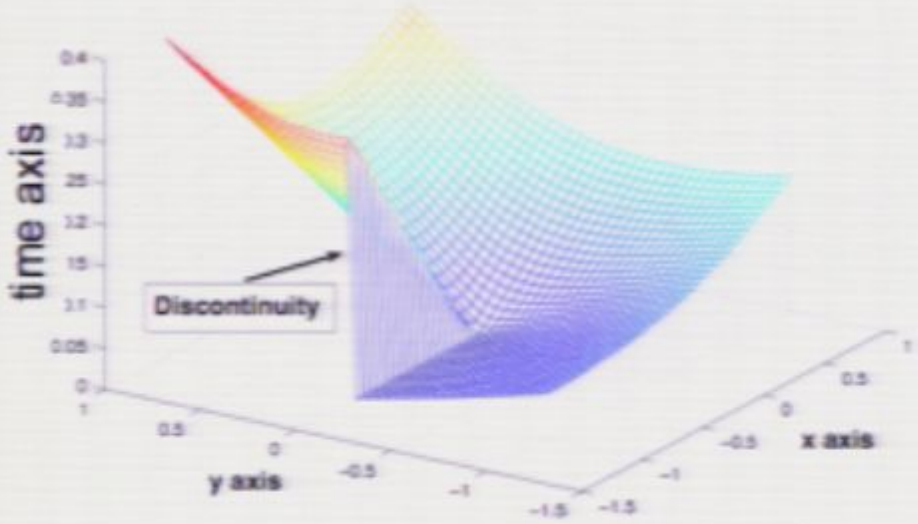

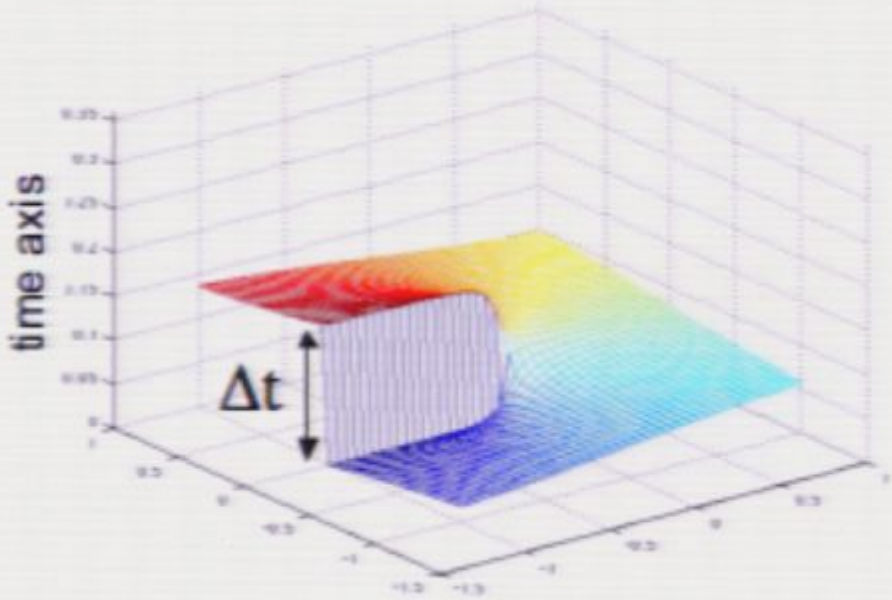

No solution where $\frac{\partial\phi}{\partial t} \approx \frac{\partial\phi}{\partial \eta} = 0$

Possible solution, so long as $\Delta t \approx n\pi/\omega_0$

$$\Delta t = \oint \frac{dt}{d\ell} d\ell = \oint \frac{v_g}{c^2} d\ell \approx n\frac{\pi}{\omega_0} \longrightarrow \boxed{m\oint v_g d\ell \approx \frac{n}{2}h}$$

If $\int T_{00} d^3\mathbf{s}_0 \approx \int T_{00} d^3x = E_{tot}$, and if you can build s_0 out of line integrals w/ constant T_{00}, $\boxed{L_z \approx n\frac{\hbar}{2}\frac{E_{tot}}{mc^2}}$

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Quantum Cosmology

- Measurement BCs -> Cosmological BCs