JOUAL 2009 Workshop

***** Just One Universal Algorithm *****

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Emergent properties of discretized wave equations

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Emergent properties of discretized wave equations

- The great abyss
- Emergent chaotic like behavior from discretization
- Constraints on a discrete theory including the wave equation
- Speculation to cross the great abyss
- EPR and Bell's Inequality
- Conclusions

The great abyss

- Planck time $\approx 5.392 \times 10^{-44}$ seconds
- Planck distance $\approx 1.616 \times 10^{-35}$ meters
- Smallest measured time $\approx 10^{-18}$ seconds
- Electron microscope resolution $\approx 5 \times 10^{-11}$ meters

Emergent chaotic like behavior from discretization

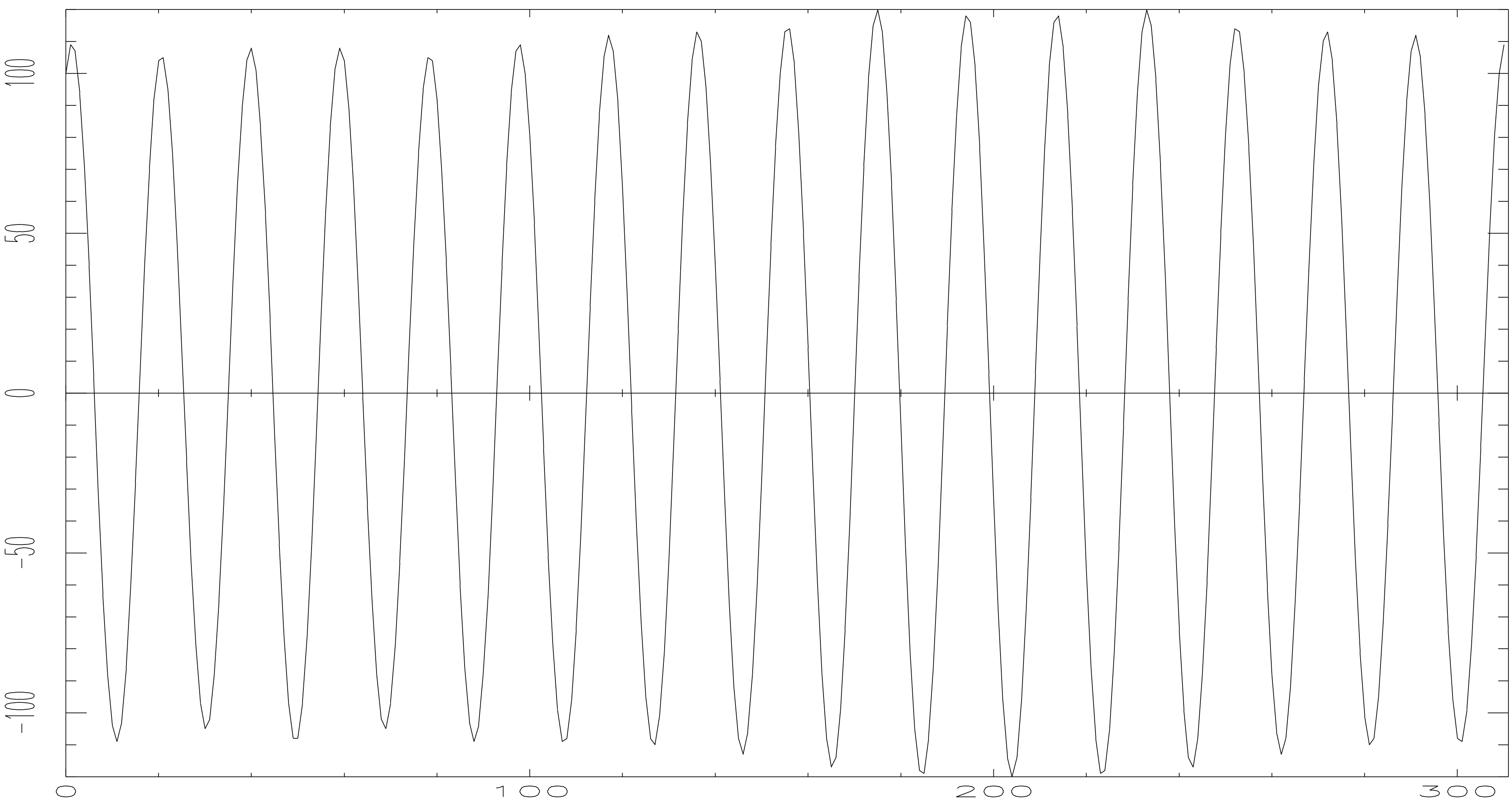
- Simple time symmetric, discrete, scalar finite difference equation: $f_{t+1} = T(nf_t/d) - f_{t-1}$
- *T* is truncation to 0 (nonlinear operation)
- n and d are integers
- The differential equation: $\frac{d^2 f}{dt^2} = (n/d - 2) f(t)$
- A differential equation solution for 2 > n/d > -2:

$$f(t) = f_0 \cos(t\sqrt{2 - n/d} + \theta_0)$$

- The solution to the discrete finite difference equation is more complex

Discretized finite difference equation solution until it repeats

$$f_0 = 100, f_1 = 109, n = 19, d = 10$$



Discretized finite difference equation sequence length until repetition

N = 19, d = 10

	f_1												
f_0	100	101	102	103	104	105	106	107	108	109	110	111	112
100	154	269	154	154	269	328	328	328	289	309	174	116	116
101	269	77	250	328	250	289	328	77	309	116	309	174	174
102	154	250	154	289	328	309	250	77	77	58	174	289	77
103	154	328	289	77	328	328	328	328	77	309	116	289	289
104	269	250	328	328	77	309	289	250	309	309	289	174	174
105	328	289	309	328	309	328	77	77	289	58	289	77	309
106	328	328	250	328	289	77	116	77	77	116	116	174	77
107	328	77	77	328	250	77	77	58	289	309	174	289	309
108	289	309	77	77	309	289	77	289	309	309	309	289	174
109	309	116	58	309	309	58	116	309	309	289	174	174	289
110	174	309	174	116	289	289	116	174	309	174	250	116	77
111	116	174	289	289	174	77	174	289	289	174	116	174	174

Longer sequences with the same peak magnitude are stronger attractors

The universal wave equation

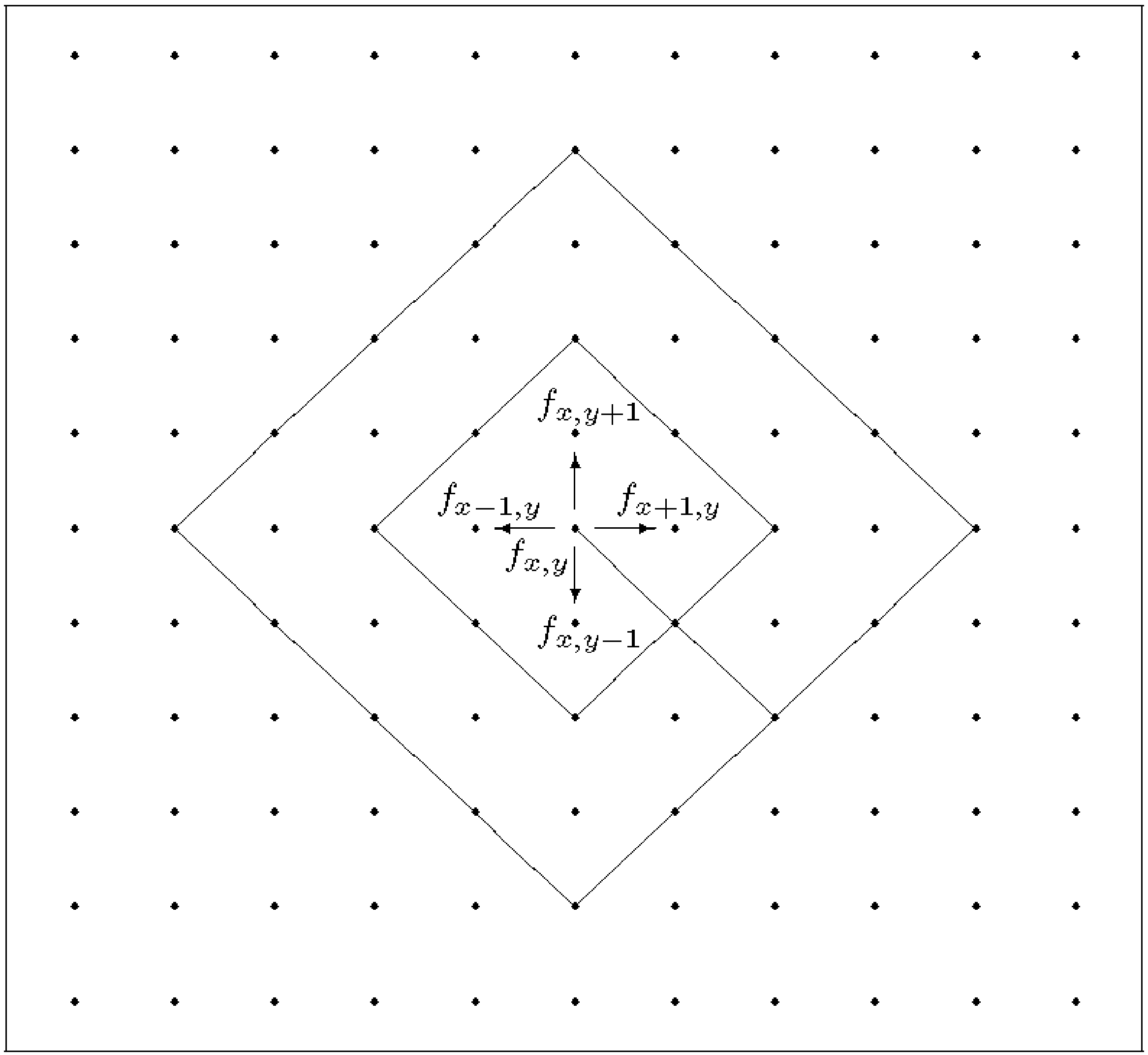
- Is the solution to Maxwell's equations
- Is the relativistic Schrödinger equation for a single massless particle
- Is :

$$\frac{\partial^2 f}{\partial t^2} = v^2 \nabla^2 f$$

Constraints on a digital theory of everything

- Time and space must be discrete
- Functions in space-time must be discrete
- Wave equation must be approximated to extraordinary accuracy
- Isotropic space must be approximated to similar accuracy

FDE nearest neighbor propagation on a rectangular grid



A finite difference approximation to the wave equation on a rectangular grid

$$d = v^2(f_{i+1,j,k,t} + f_{i-1,j,k,t} + f_{i,j+1,k,t} + f_{i,j-1,k,t} + f_{i,j,k+1,t} + f_{i,j,k-1,t} - 6f_{i,j,k,t})$$

$$f_{i,j,k,t+1} = d - f_{i,j,k,t-1} + 2f_{i,j,k,t}$$

To discretize round or truncate *d* – this preserves time symmetry

Could a discretized finite difference approximation to the wave equation be a theory of everything?

Fate of an initial disturbance

- The continuous equations both diffuse to ever smaller values over an ever larger volume
- A discrete time reversible model must:
  - Loop in place repeating a sequence of states
  - Separate into structures that move apart
  - Diverge filling ever more space with nonzero values

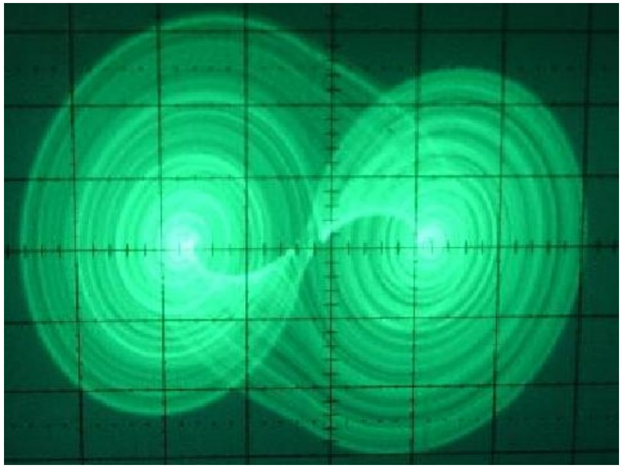
Emergent properties of the discretized wave equation

- Quantization – dispersion has a finite limit
- Chaotic like behavior – nonlinear discretization
- Special relativity – everything is electrodynamic

Can speculation bridge the abyss?

- Particles – dynamically stable attractor like structures
- Quantum uncertainty – transformation focal point
- Pseudo random behavior

Speculation – particles stable dynamic attractor like structures

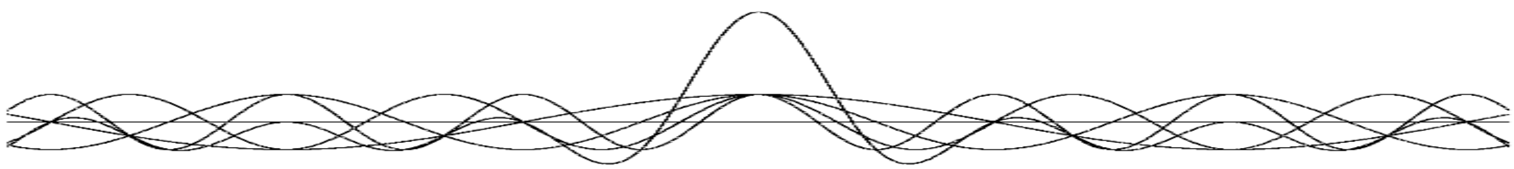


- Perturbed chaotic attractors can transform state
- Particle interactions are chaotic like transformations
- The quantum mechanical wave function is a statistical average of a physical function in space-time
- Einstein's hidden variables are information stored holographic like over an extended region

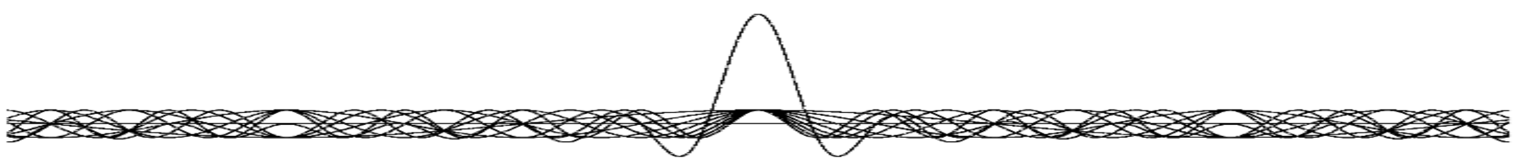
Particle interactions

- Particle interactions have a focal point in physical space and in state space
- Initial conditions determine the focal point shape
- QM predictions are limited by this shape
- At the Planck scales exact predictions are possible
- A classical wave cannot have exact frequency and position, but it is deterministic

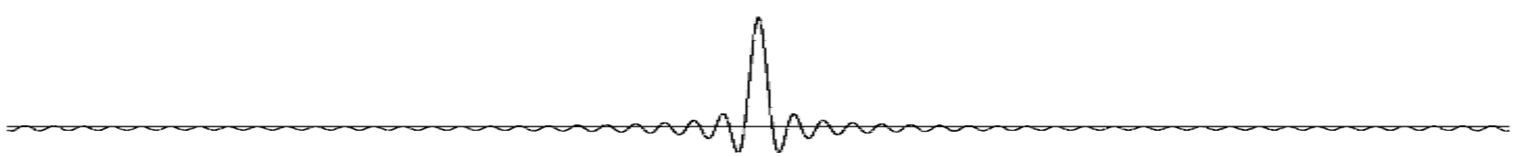
A deterministic classical wave cannot have an exact frequency and location



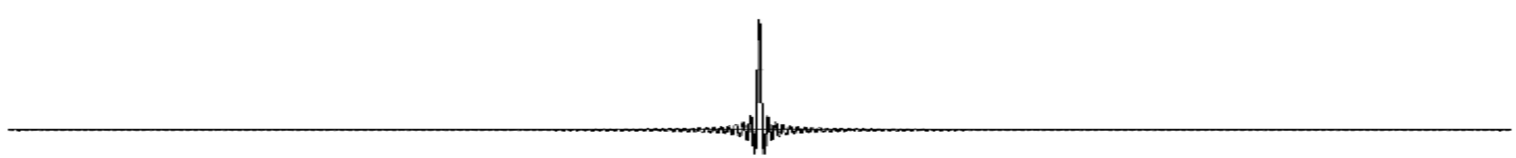
4 sine waves and their sum.



8 sine waves and their sum.



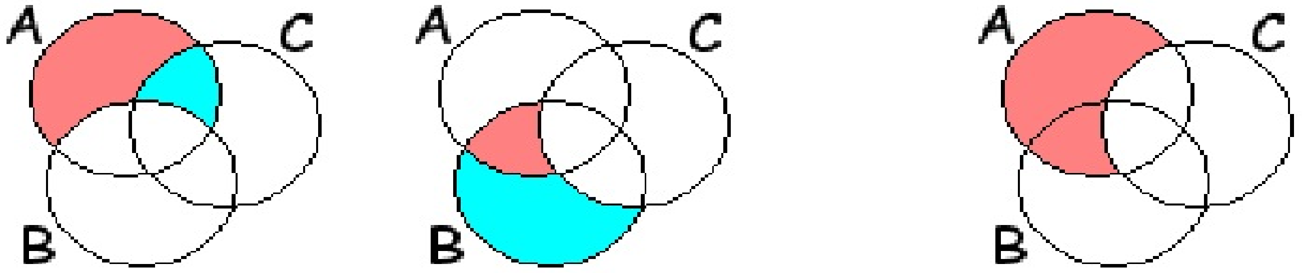
The sum of 32 sine waves.



The sum of 128 sine waves.

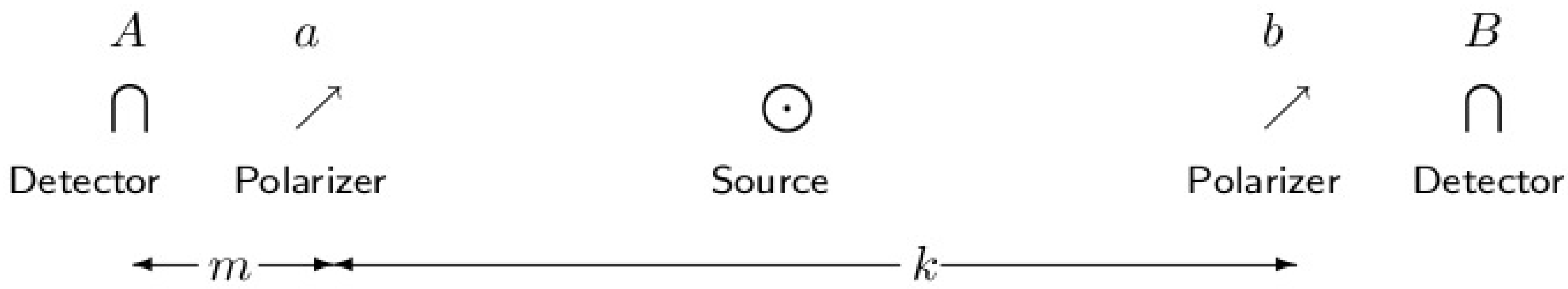
Bell's Inequality

$$P(A \,\&\, [\text{not } B]) \;+\; P(B \,\&\, [\text{not } C]) \;\geq\; P(A \,\&\, [\text{not } C])$$



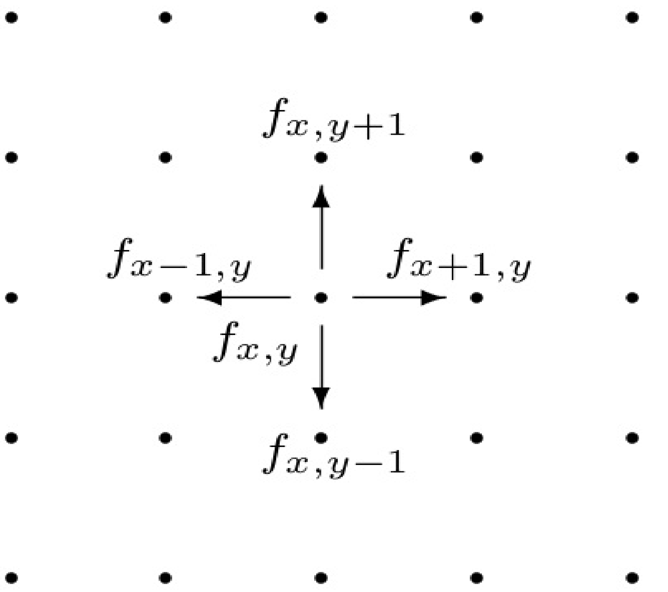
- QM predicts Bell's Inequality is violated
- This makes QM a non-local theory
- These predictions come from absolute conservation laws and statistical laws of observation (EPR)
- The conservation laws are enforced by instantaneous influence with no limit on distance
- The mathematics of QM is local in configuration space, but the predictions are nonlocal in physical space

Superluminal influence in QM



- Requires 2 adjustable instruments and 2 detectors
- The influence can go from a to B or b to A
  - Same predictions in all relativistic frames of reference
  - No superluminal signal can be transmitted
- Experiments consistent with QM
- Experiments have loopholes

Locality



- Strongest simplifying assumption in physics
- Non-local discrete topologies are complex
- Any point can be connected to any other
- A separate set of spatial dimensions for ***every particle*** in some formulations of QM
- Could there be a simple model that explains how the conservation laws are enforced?

Loopholes in Existing Experiments

- Delayed determinism – Franson
- Inefficient detectors – allows a local explanation
- Local but superluminal dynamics

Converging to a Stable State

- May start but not complete
- Must be consistent with conservation laws
- Is reversible – delayed determinism
- Like water seeking its level
- All allowed paths (loopholes) may be taken

A recent Bell experiment assuming gravitationally induced collapse

- Spatial separation: 18 km (60μs)
- Detection triggered mass movement in ~ 7.1μs
- Quantum efficiency: 10 % (possible loophole)
- Dead time (after detection) ~ 10μs
- Illustrates the challenge the solution proposed here faces

Conclusions

- A discrete approximation to the wave equation on a regular grid will be nonlinear and superluminal
- This may lead to dynamically stable states (particles) that transform like chaotic attractors (quantum collapse)
- Quantum collapse may be a physical process with a superluminal, local space-time structure
- If true, this structure should be observable in some tests of Bell's inequality