

## Does God Play Dice? - New Developments & New Physics

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## Overview

- Einstein & the question of randomness in Nature
- Unexpected behavior of random devices
- Link Theory: a new approach to the core of Physics
- Link Physics project, theory collaboration
- New experiments on the nature of randomness
- Implications & Applications

## 2005 - World Year of Physics

1905 – the miracle year:

- *Quantum nature of light*
- *Dimension of molecules*
- *Brownian motion*
- *Special relativity*
- *Mass-energy equivalence*

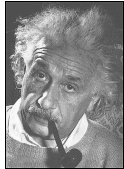


## Classical vs Quantum

- Classical Newtonian Physics
  - Deterministic, predictable in principle
  - Randomness only apparent (2<sup>nd</sup> law of Thermo)
- Quantum Mechanics
  - Non-deterministic, statistical in principle
  - Uncertainty principle (Heisenberg)

*Can these two disparate views be unified?*

## Is Nature Probabilistic?



*"[QM] yields much, but it hardly brings us closer to the Old One's secrets. I, in any case, am convinced that He does not play dice."*

– A. Einstein, letter to Max Born, 1924

*"Not only does God definitely play dice, but He sometimes confuses us by throwing them where they can't be seen."*

– S. Hawking, 1995



## Randomness in Nature

- Macroscopic – apparent, derivative
  - chaos, sensitive/dynamical systems
  - disorder/entropy, thermal, 2<sup>nd</sup> law of thermo
- Microscopic – fundamental
  - radioactive decay
  - quantum tunneling
  - zero-point fluctuations

## Applications of Randomness

- Fair distribution of risk or reward (lottery)
- Cryptography, coding, compression, security
- Sampling, polling, data reduction
- System testing (verification) and measurement
- Communications (routing, timing, ethernet)
- Algorithms (approximation, simulation)
- Strategy, tactics (games, military)

## Applications of Randomness...



### Random is the New Order

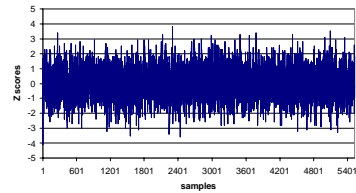
Welcome to a life less orderly. ... iPod shuffle rejects routine by serving up your favorite songs in a different order every time. ... Daily gridlock feels less mundane when you don't know what song will play next. iPod shuffle adds musical spontaneity to your life. Lose control. Love it. -- Apple iPod ad copy 4/05

## Electronic Randomness



RNG

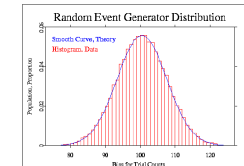
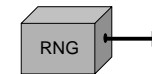
→ ... 0 1 1 0 1 0 0 1 0 0 0 1 1 1 ...



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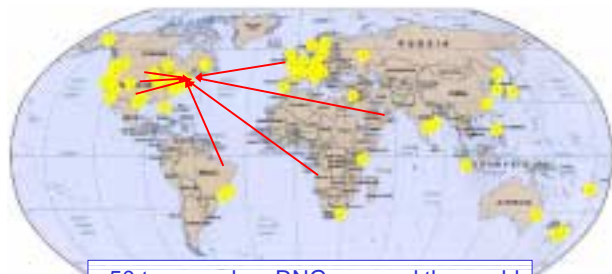
## Uninfluenceable, Unpredictable



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## Global Consciousness Project

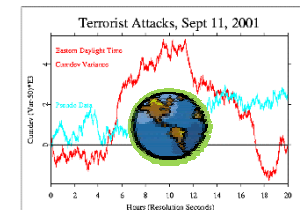


>50 true-random RNGs around the world  
 200 bits / sec / RNG → 864 Mbits / day  
<http://noosphere.princeton.edu>

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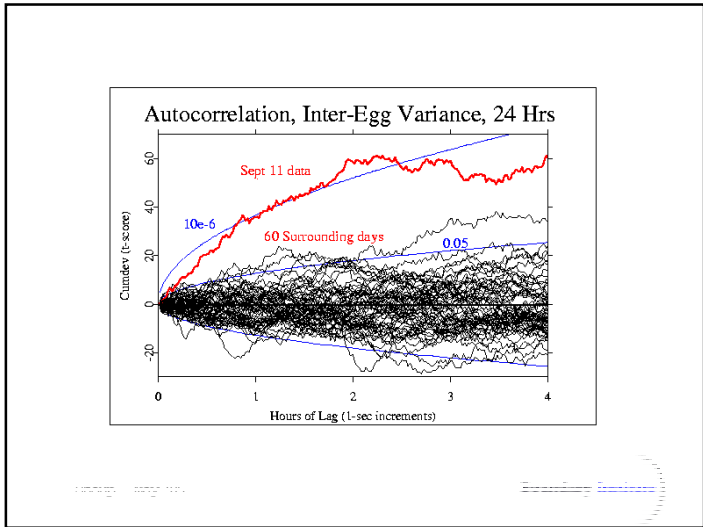
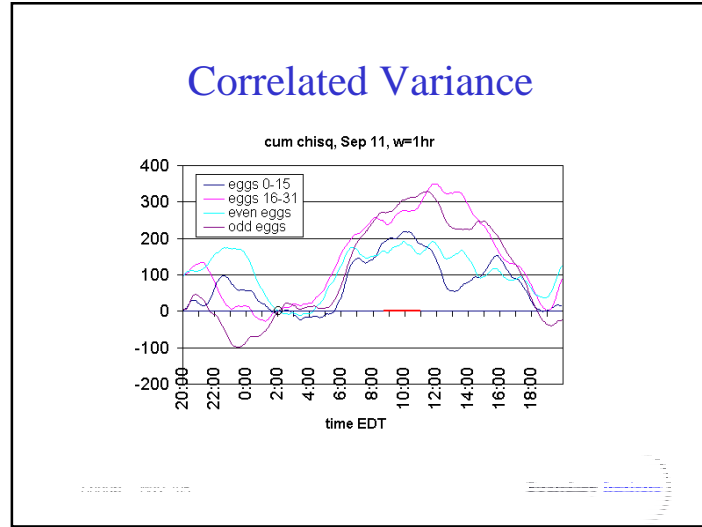
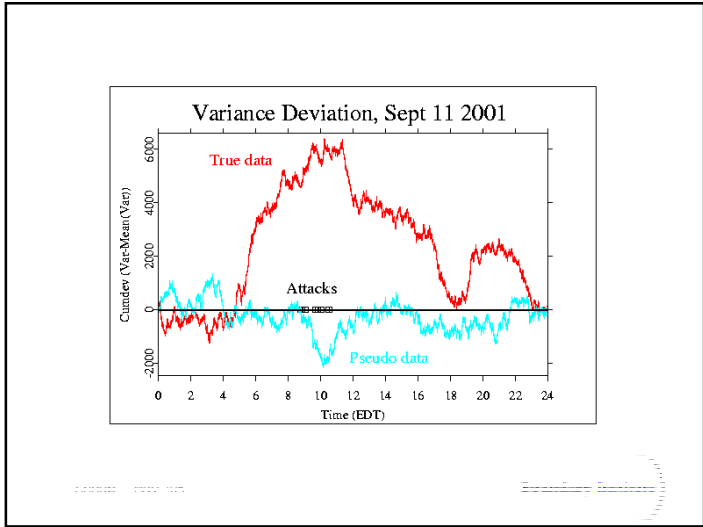
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## Anomalous Behavior in the GCP network of Random Generators on September 11, 2001



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FOUNDATIONS OF PHYSICS LETTERS  
Vol. 15, no. 6, December 2002

STATISTICS

### CORRELATIONS OF CONTINUOUS RANDOM DATA WITH MAJOR WORLD EVENTS

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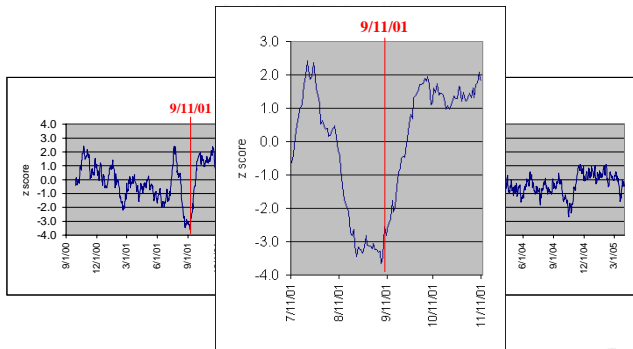
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Received 18 July 2002, revised 4 October 2002

The detection of correlations and physical systems is most often discussed in theoretical terms, usually with reference to the systems, initial and boundary conditions of quantum theory. Low and future in a growing literature regarding experiments that measure the statistical correlations of random data. How do these correlations arise?

## Card Guessing

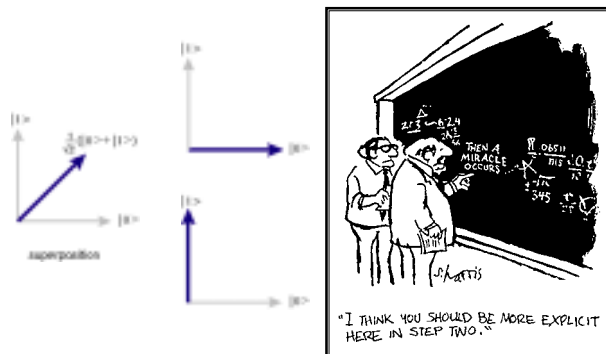


## What is the evidence telling us?

- Science is all about *the data* – the evidence.
- Do not discard data without a *really* good reason ... *especially* data you don't like.
- Something is wrong with our assumptions about cause and effect, and randomness.

"I like to keep an open mind, but not so open my brains fall out."  
 -- Arthur Sulzberger, Chairman, New York Times

## Quantum Measurement

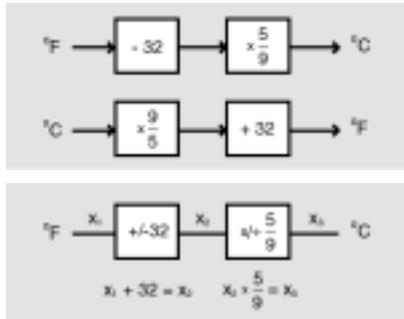


## Link Theory

- Theory of composite *Relations*, joint constraints
- *Case counts*, restrictions on set of *possibilities*
- Bi-directional, *symmetrical*, timeless
- Single paradigm: logic, arithmetic, statistics, Qcomp, ...
- Show how *core laws of QM* are just *mathematics*
  - Predict quantum probabilities, explain the uncertainty principle

The image contains several mathematical expressions and diagrams. On the left, there is a 3D coordinate system with axes labeled  $|0\rangle$ ,  $|1\rangle$ , and  $|2\rangle$ . In the center, there is a matrix equation: 
$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$
 Below this, there are more equations involving matrices and vectors, and a diagram showing a vector being transformed by a matrix.

## Function vs Relation



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## Relation Examples

- Moore's Law – cause or effect?
- Math & Physics – equations ( $F = ma$ )
  - not mapping/inverse mapping
- Comp Science – relational database
  - not assignment, not an algorithm or procedure

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## NOT, AND, OR as Relations

$x$	$y$	$z$
$\sim$		

$x$	$y$	$z$
$\wedge$		

$x$	$y$	$z$
$\vee$		

$x$	$y$	$z$
0	0	0
0	1	1
1	0	1
1	1	0

$x$	$y$	$z$	$n_z$
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

$x$	$y$	$z$	$n_z$
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

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## Case Counts & Domains

all  $I$ s : independent, uncorrelated  
 one  $I$  : selector, state, classical  
 more than one  $I$  : logic, relation, superposition  
 one or more  $>I$  : statistics, multisets, don't cares  
 both + and - : quantum realm, interference

$x$	$y$	$n_x$	$n_y$	$n_z$	$n_1$	$n_2$
0	0	1	0	0	1	1
0	1	1	0	1	2	1
1	0	1	0	0	2	-1
1	1	1	1	1	1	1

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## The Link Physics Project



**H. Pierre Noyes**  
*Emeritus Professor, Stanford Linear Accelerator Center  
Former head of SLAC Theory Group*



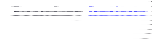
**Thomas Etter**  
*Boundary Institute*



**James Lindesay**  
*Professor of Physics, Howard University  
Director, HU Computational Physics Laboratory  
Visiting Professor, SLAC*

[www.linkphysics.org](http://www.linkphysics.org)

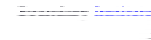
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## Link Physics

- Goal: Unification of 3 views of physics
  - classical (Newton, Maxwell, Einstein)
  - Markovian statistical
  - quantum mechanical
- Link Theory – more general, encompasses
- Examine the core laws of QM
- Address implications

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## Open Problems

- Particle physics: origin of coupling constants, mass ratios, etc
- Cosmology: dark matter & energy, inflation, coherence of background radiation, etc
- Relativity and Quantum Mechanics
- String Theory? Quantum Gravity?

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## Eternal Triangle Effect

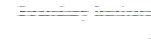


Classical Determinism

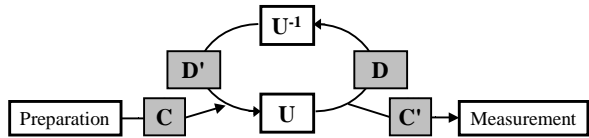


Quantum Mechanical Irreversibility  
+  
Statistical Prediction

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## Quantum Measurement



U - any unitary matrix (Schrödinger evolution)  
 C - causal density matrix of the preparation  
 C' - causal density matrix of the measurement  
 D, D' - quantum density matrix of a broken link

*Classical and Quantum states are represented in the same algebra*

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## Next Steps

- Theory: Link Physics Project
  - Conceptual unification of physical measurement
  - New paradigm for all of physics
- Experiment: randomness, analysis
  - Markov chain of RNGs
  - RetroComm optical RNG

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## Markov Chain Experiment

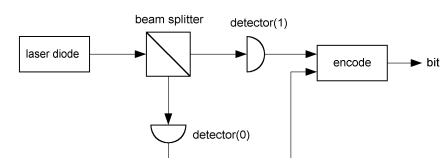


- Chain of randomizers
- Backward propagation of influence?
- Current, many users on-line

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## RetroComm experiment



- Goal: unequivocal demonstration of influence on an optical RNG
- Supermajority & other codings, analysis
- Single subject in the lab, many on-line

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## Relevance - Science

- Potential answers to big questions
  - Particle physics, cosmology, more...
- Better understanding of quantum realm, causality, time, etc.
  - Randomness seen in a new light
- Keys to understanding many perplexing anomalies & phenomena
- New view of the Scientific Method & experimental protocols
- New tools for engineering, investigating, understanding the world
- Applications: semiconductors, quantum computing, communications, medical imaging, ...

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## Relevance - Society

- Deeper connection between Science and human experience
- Psychological mindset, guiding principles

Functional/unidirectional cause-and-effect

⇒ usage, control, manipulation, consumption

OR

Relational/bidirectional influence

⇒ co-existence, cooperation, symbiosis, mutuality

*... Which of these is a better model for Science in the 21<sup>st</sup> Century?*

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