

Outliers of exponentiated power-law variates
could determine entire subjective histories

Lutz Polley

Institut für Physik
Universität Oldenburg

Please note: Many Worlds are **implicit** in the Theory of Decoherence.

Here challenged **equivalence**, not existence, of Many Worlds

Observer splitting (in many words, 2 equations, 1 picture)

Some order statistics (textbook matter)

An argument for Exponentiation (physics, non-speculative)

How One's World might emerge from a Final Draw (speculative)

Selecting from well-known concepts (just for credits):

- Equation of evolution strictly linear, like in the theory of decoherence, no collapse of wavefunction
- Fundamental role of observer (interacting with environment)
- Observer's wavefunction splits into many "worlds" or "minds"
- Decoherent **histories**
- Backward causation (*not* backward evolution)

Novel ingredients:

- Observer's branches vastly **inequivalent**
- Fundamental role of **outliers**, order statistics
- Experiential "states" lifted to "subsystems" of **dimension** > 1

Observer's history (as in Theory of Decoherence)

In each act of observation, system-observer splits into branches:

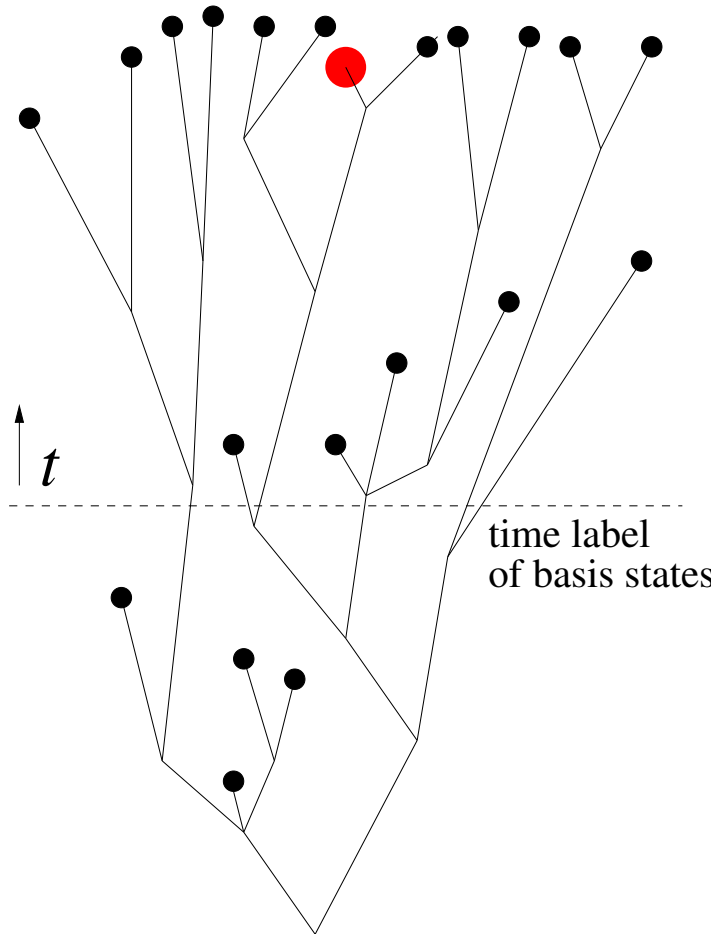
$$\begin{aligned} & \left(\alpha |\text{spin up}\rangle + \beta |\text{spin down}\rangle \right) |\text{ready}\rangle \\ & \quad \downarrow \\ & \alpha |\text{spin up}\rangle |\text{up observed}\rangle + \beta |\text{spin down}\rangle |\text{down observed}\rangle \end{aligned}$$

Branches are **decoherent** — $|\text{up observed}\rangle$ and $|\text{down observed}\rangle$ differ by so many degrees of freedom that non-zero matrix elements between them cannot exist

Static picture (Heisenberg picture): State vector is “timeless”, but time appears in labels of basis states.

$$|\psi\rangle = \sum_{l_1} \psi(l_1) |l_1, t_1\rangle = \sum_{l_2} \psi(l_2) |l_2, t_2\rangle = \dots$$

The scenario proposed (invoking Heisenberg picture)



Observer's world lines split into de-coherent branches

End points (●) form ensemble with exponentiated power-law distribution of "experiential dimension"

Extremal draw carries nearly all of "experiential dimension"

Subjective history (path to origin) uniquely determined

Power-law distributions

Probability for an event of size k

$$P(k) \propto k^{-\gamma} \quad k = 0, 1, 2, \dots$$

Standard generating mechanism:

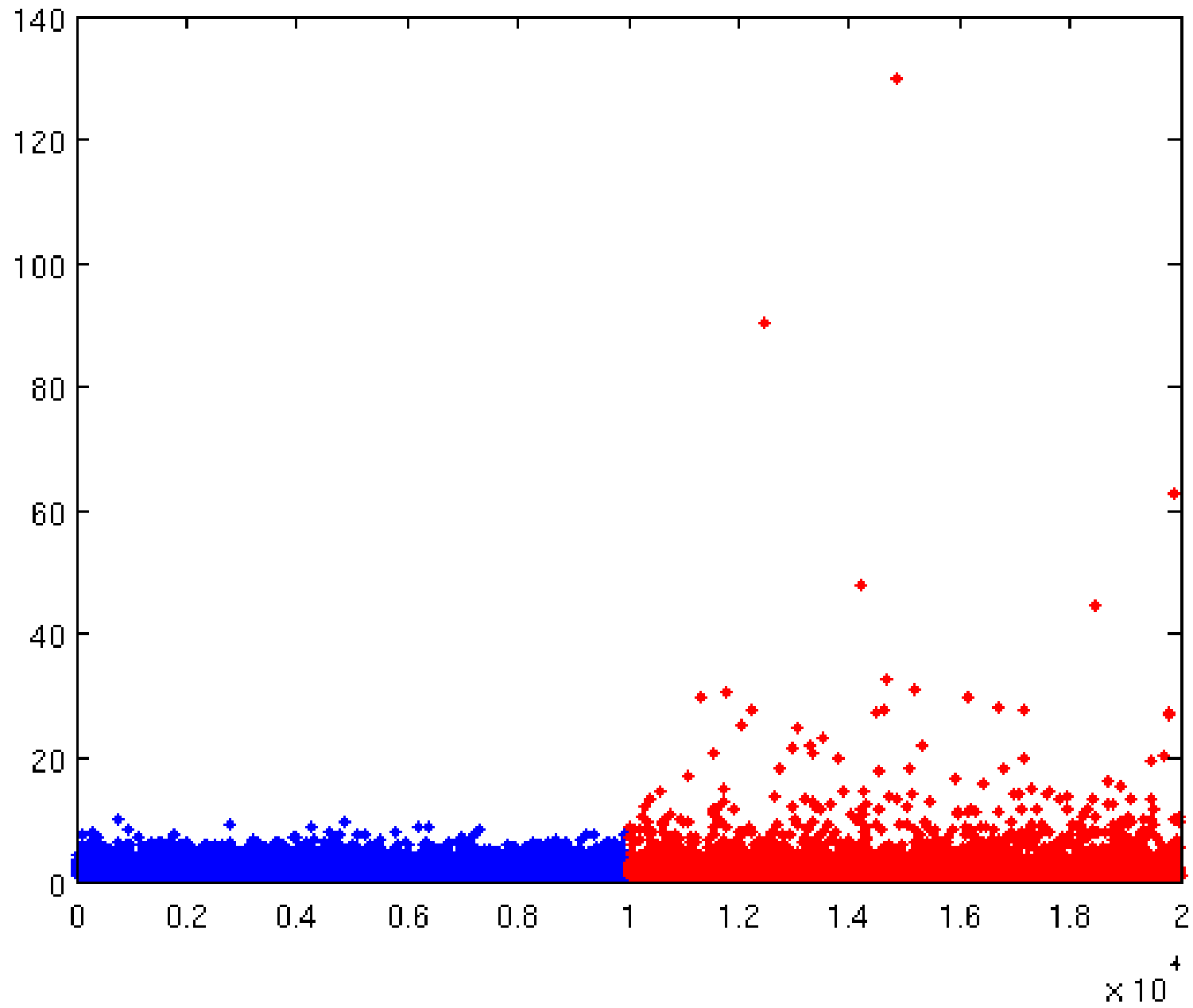
Chain reactions, supercritical, growing like $e^{\alpha t}$, terminated at random times with exponential distribution, $e^{-\beta t}$ (constant probability per time for termination)

$$\gamma = 1 + \frac{\beta}{\alpha}$$

W.J. Reed, B.D. Hughes, *From gene families and genera to incomes and internet file sizes: Why power laws are so common in nature*, Phys. Rev. E **66** (2002) 067103

M.V. Simkin, V.P. Roychowdhury, *Re-inventing Willis*, arXiv:physics/0601192

10000 draws from exponential (blue) and Pareto (red) distributions with mean 2



The extremal draw:

Statistics of outliers of power-law distributions

Power-law distribution / maximum-stable variant (Fréchet 1927):
cumulative distribution function and probability density are

$$F(x) = e^{-x^{-\alpha}} \quad (x > 0) \quad \frac{dF}{dx} = \alpha x^{-\alpha-1} e^{-x^{-\alpha}} \sim \alpha x^{-\alpha-1}$$

Consider ensemble of size $N \rightarrow \infty$ of Fréchet-distributed \mathbf{X} .

Statistics of **difference** of extreme and next-to-extreme value is
(in the notation of Embrechts (1997) corollary 4.2.13)

$$\mathbf{X}_{1,N} - \mathbf{X}_{2,N} = N^{1/\alpha} \mathbf{Y} \quad \mathbf{Y} \text{ a random variable independent of } N$$

N.B.: For normally, even log-normally distributed \mathbf{X} , difference $\xrightarrow{N \rightarrow \infty} \text{const.}$

H. A. David, *Order statistics* (Wiley, New York, 1981)

P. Embrechts et al., *Modelling extremal events* (Springer, Berlin, 1997)

An exponentiated outlier takes almost all.

Assume (for the moment) dimension of subspaces at ends of branches is distributed like 2^X .

Assume there are N branches.

Fraction of dimension *outside* the leading branch is smaller than

$$N \times 2^{X_{2,N}} / 2^{X_{1,N}} = 2^{-Z} \quad \text{where} \quad Z = N^{1/\alpha} - \log_2 N$$

But is there a **reason for exponentiation?**

Exponentiation

related to *Labelling Problem* in quantum theory of observer's mind: Mental states cannot be distinguished simply by labels as in Dirac notation, since labels are void without reading.

M. J. Donald, *On Many-Minds Interpretations*, quant-ph/9703008.

Any bit of experience must *participate in process* of cognition, constitute subsystem with dimension ≥ 2 (else, bit is “frozen”).

Examples:

Information stored in a neuron is available by firing and resting.

Black grain in a photograph is visible by ability to absorb light.

Hence, **dimension of “experiential Hilbert space”** processing X bits of information / experience / awareness should be 2^X .

Now for some speculation . . .

What could be the nature of the Final Draw?

It could be a grand linking event — linking many previous experiences, *preserved in superpositions*, to form one whole connected experience.

Potential problems

Dimension cannot be the ultimate clue.

There always exist infinitely many remote possibilities (branches) “ruled out” only by exceedingly small amplitudes (like macroscopic tunnel amplitudes). Ultimate clue must be **amplitudes**.