Ferryman Puzzle

Problem Description: A ferryman has to get a rabbit, a bag of carrots and a fox across the river. He can only take one at a time. (Assumptions: The fox will not eat the rabbit, and the rabbit will not eat the carrots, when the ferryman is present. Neither will the fox or the rabbit run away.)
Narrative solution

• Takes the rabbit across, comes back empty.
• Takes the carrots over, comes back with rabbit.
• Takes the fox over, comes back empty.
• Takes the rabbit over.
### Graphed solution

(M) = ferryman  R = rabbit  C = carrots  F = fox  7 iterations (2 null)  5 states (2 mirror symmetric)

<table>
<thead>
<tr>
<th>State</th>
<th>Left riverbank</th>
<th>Right riverbank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(M)</td>
<td>R (M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(M) RCF</td>
</tr>
<tr>
<td>2</td>
<td>R (M)</td>
<td>Null (M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CF(M)</td>
</tr>
<tr>
<td>3</td>
<td>RC (M)</td>
<td>R (M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F (M)</td>
</tr>
<tr>
<td>4</td>
<td>CF (M)</td>
<td>F (M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R (M)</td>
</tr>
<tr>
<td>5</td>
<td>(M) RCF</td>
<td>R (M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(M)</td>
</tr>
</tbody>
</table>
Observations

• Ferryman (M) can exist in any of 16 initial positions
• R vector fluctuates between left and right bank
• F & C are fixed vectors, to left bank only
• 16 possible initial conditions result in 4 unique states.
• If we can observe only 1 side of the riverbank in any complete state, probabilities for the other side are bounded by rotation through 4 pi and thus precisely calculable.
## Probability Table for Graph

<table>
<thead>
<tr>
<th>P</th>
<th>State</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>RCF + $\Psi(R)$</td>
</tr>
<tr>
<td>1.0</td>
<td>1</td>
<td>R</td>
<td>CF</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>$\Psi(R) + C$</td>
<td>F + $\Psi(R)$</td>
</tr>
<tr>
<td>1.0</td>
<td>3</td>
<td>CF</td>
<td>R</td>
</tr>
<tr>
<td>0.5</td>
<td>4</td>
<td>$\Psi(R) + RCF$</td>
<td>0</td>
</tr>
</tbody>
</table>
The observer’s (quantum operator’s, ferryman’s) initial position can be anywhere, left or right. Christian’s topological framework, however, is orientable. In the context of our example, this is equivalent to R crossing the river first. Therefore: the state 1, R ↔ CF probability is 100%. How does this relate to Bell’s theorem?
Bell-Aspect & Quantum Nonlocality

Bell-Aspect results ignore probabilities for states 1, 2 and 3 and assigns to them the value of nonlocality, i.e., $\Psi_{total}$. Bell-Aspect operators are commutative on the interval $(-\infty, +\infty)$, i.e., indeterminate and independent of the time of measure. Joy Christian’s time-dependent model is deterministic, with definite probabilities on the interval $[0,1]$.
The Importance of Orientability

Quantum nonlocality means that we cannot know whether the observer (quantum operator) is on the “left” or “right” until after observation.

Nor does it matter, because the quantum mechanical system assumes non-orientability, i.e., the framework assigns equally likely probabilities to outcomes not observed.
Statistical Inference from Orientable Initial Condition

In Joy Christian’s locally realistic framework, the statistical inference of state 2 (table) is clear: the probability of finding CR or RF on the same side of an oriented surface is zero, though if one observes either C or F alone, one knows that the opposite orientation includes $\Psi(R)$, the wave function of $R$, which is a fluctuating variable (sign reversible).
Buridan’s Principle

This situation is made clear by what mathematician Leslie Lamport has formulated as Buridan’s Principle:

“A discrete decision based upon an input having a continuous range of values cannot be made within a bounded length of time.” (Lamport, L. “Buridan’s Principle” research.microsoft.com/enus/um/people/lamport/pubs/buridan.pdf 1984)

If one doubts this principle, one should read Lamport’s treatment of the Stern-Gerlach experiment in the cited reference, from which Lamport tests the validity of the principle against Buridan’s Law of Measurement.
“If \( x < y < z \), then any measurement performed in a bounded length of time that has a nonzero probability of yielding a value in a neighborhood of \( x \) and a nonzero probability in a neighborhood of \( z \) must also have a nonzero probability of yielding a value in a neighborhood of \( y \).”
Is the value greater or less than y?

A counterexample must necessarily answer Lamport’s poignant yes-no question.

Lamport concludes with pinpoint certainty, “There does not seem to be a quantum-mechanical theory of measurement from which one can derive Buridan’s Law of Measurement.”

Indeed, the only such measurement theories are classical, including EPR and Bell’s own inequality.
Bell’s Inequality

Bell’s theorem forbids quantum mechanical derivation of Buridan’s law of measurement by violation of the inequality:

\[ 1 + C(a,c) \geq |C(a,b) - C(b,c)| \]

where particle pair correlations depend on the three variables \( a, b, c \) which are particle detector settings (cf. R, C, F in our example).
Bell, CHSH & Hidden Variables

T H Ray 1 Dec 2011

We don’t have to discuss the stronger CHSH (Clauser, Horne, Shimony, Holt) inequality to make our point, because the same conclusion holds:

Bell-Aspect and CHSH experimental results both violate the given inequalities, and (therefore) no local hidden variable theory can be both local and realistic.
How topological initial condition affects the dice

In neither Bell’s inequality nor CHSH, does topological orientation play a role. The results are probabilistic (rolls of the dice) and follow quantum mechanical predictions precisely, even though the parameters are all classical.

Consider (R)abbit, (C)arrot and (F)ox in our example. We know that state 2 (table) has zero probability of being observed – how? – because the presence of C or F alone would inform us that our observation is oriented left or right. We would never observe (in a bounded length of time) the fox alone or the carrot alone, because the wave function $\Psi(R)$ is unitary.
Deduction of States by $4\pi$ Rotation

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Just as Joy Christian claims, we can infer simultaneous observer position (left or right) and state of motion (fixed or oscillating) \textit{only} by rotation of the system through $4\pi$ revolutions. I.e., even without a “collapse” of $\Psi(R)$ —the fluctuating variable wave function of state 2 (table)—we know the bound states of C and F, the fixed variables. After a series of observations that disregard the indeterminate wave state, we deduce the orientation of determined values, $\lambda_{lh}$ or $\lambda_{rh}$. These lambdas are reversible by sign change, as \textbf{must} be the case in a classical system of time reverse symmetry—however, when we in a bounded length of time know that we can fix the operator in a LH or a RH orientation, we find by the observed pattern of alternating fixed variables that we can know deterministically the instantaneous state of the system.

\textit{The hidden variable is hidden only by our perception of quantum unitarity, which is an illusion in the context of a continuous function model.}
Only the Wave Function is Unitary

As Joy Christian has discovered—the unitary wave function does not imply discontinuous (i.e., probabilistic) pair correlations.

Pair correlations are a function of an oriented initial condition (the “rabbit” must cross first), and a topology that guarantees continuous functions.
The fact that we cannot determine in a bounded length of time, the position of $R$—whatever particle lies in the wave function of the fluctuating variable—is a verifying aspect of Christian’s framework, because it represents dynamic evolution of the system in a finite space, which makes the framework fully relativistic. In other words, while general relativity is conventionally considered a model finite in time and unbounded in space, when we reverse the convention—to one finite in space and unbounded in time—not only do we not damage the theory, we benefit by natural extension to a stronger unifying theory which eliminates singularities.
The End of Quantum Nonlocality

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The foregoing is all that need be said about Joy Christian’s counterexample to Bell’s theorem. A locally real deterministic theory based on classical Bell and EPR parameters is both possible and tractable to physical experiment.

A time dependent, singularity-free fully relativistic theory, however, goes far beyond subsuming Bell-Aspect results into a local realistic measure scheme.

It implies metric continuation for infinite time over the measure space of the manifold, as a direct consequence of the limit of the physical space $S^7$. This feature fundamentally connects the Christian framework to the physical phenomenology of the Ricci flow—necessarily true if the metric which guarantees quantum pair correlation is Ricci-flat.

That is, given a metric $g$ on a Riemann manifold $M$, $g$ is Ricci-flat if $R_{ij} = 0$ at every point.

$S^3$
The Beginning of “Topological Correctness”

One of the more contentious Joy Christian claims, is that Bell’s Theorem is disproved because of a “topological error.” Aside from the fact that a mathematical theorem cannot in principle be disproved, one can only be “topologically correct” in a continuous function model. Assuming nonlocal, discontinuous functions (see table) one recovers Bell-Aspect results with the predicted probability. The theorem stands.

On the other hand, a stronger topology-based framework—as Christian explains in his publications—obviates any probabilistic theory of how nature works. If the topological space is finite, it is as if we are rolling real valued dice with perfect information. I.e., even though measurement in a bounded time interval (see Lamport) prevents us from predicting the result of any individual throw, information on the instantaneous state of a system is completely determined.
The Reciprocal of Infinity

Riemannian Metric on $S^3$ equator = Ricci metric tensor on $S^2$. (Finite space, unbounded time.)

\[ \frac{1}{r^2} \rightarrow S^3 \rightarrow \{+1, -1, i\}^2 \rightarrow g \]

How so?
Reciprocal of Infinity, Cont’d

Curvature on the plane, $\kappa = \frac{1}{r}$, is flat.

The compactification of the plane to the complex (Riemannian) sphere—which is a 2-dimensional object with one simple point at infinity—leads to the definition

$$\frac{1}{0} \equiv \infty$$
Reciprocal of Infinity, Cont’d

As the Thurston-Hamilton research into geometric flows demonstrates, and culminating in Perelman’s proof of the Poincaré Conjecture, time flows are always away from infinity; i.e., when Perelman applies the mathematics of Ricci flow with surgery on $S^3$, geometric uniformization demands that every singularity is extinguished in finite time.
Reciprocal of Infinity, Cont’d

The definition of the point at infinity, then, allows us to speak of an unsigned—and therefore hidden—variable that exists for infinite time on the interval \([0, \infty)\). Because infinity is not a number, there is no distinction between \(+\infty\) and \(-\infty\) except in relation to a real number. (Therefore, the source of “topological incorrectness” in Bell-Aspect results on the interval \((-\infty, +\infty)\).)
To be proved

Lemma:

*Time dependent measures of quantum pair correlations on the 3 manifold implies geometric unformization.*

(Ricci metric for Christian framework follows.)