The Paradigm Discourses

"What are Friends For?"

The kisses of an enemy are deceitful, but the wounds of a friend are faithful.
– Old Testament

Critique

"Alright, everyone, quiet down." In short order, Understanding had everyone's attention. "This has been a good exercise, nicely done all around. Inventive, but not fanciful. I was particularly impressed with the high quality of your critiques and the improvements they led to. Now what I want to do is leverage these skills you just displayed to our problem at hand – QTP.

"Paradigm, you accepted point on this…endeavor, project, quest, or whatever we're going to call it. Either way you're on defense."

Imaginary Truthvalues

Logic

Understanding pulled a piece of paper from his pocket, unfolded it, and looked at the list. "Logic, you're up first."

Logic stood, took a deep breath, and dove in. "Paradigm, I love your imaginary truthvalues, and I see their analogy with conjugate basis sets, but I don't see how to map them onto a basis, they are in something less than a vector space. There are no lemmas, much less postulates. You've identified only a pair of mono operators, NOT and BUF, but no binary operators nor their truth tables. It's not formalized, just a raw idea; they need explicit specification, and they need to be turned into a formal system. It isn't clear how to specify equality, or transitivity, nor what's commutative, or distributive." Proof nodded in hearty agreement. "They suggest that paradox is a solvable problem, no longer a conundrum, but they need more work, a lot more."

Paradigm, "Point taken, ahem, perhaps I should say points taken. Seemed to me we could develop them ad hoc as needed but you make a good case that they are not terribly useful in their current form. Thank you."

Semi-Entanglement

Mathematics

Understanding said, "Mathematics, what do you have for us?"

Mathematics stood, slowly, looking first at the floor. "In the current literature, all references to entanglement are pretty much just EPR pairs. The quantum tic-tac-toe equivalent is a pair of moves with both spooky-marks overlapping in both squares, but when overlapping is in only one square, you still call that an entanglement." He looked up at Paradigm. "A separable bipartite system with two particles has four terms in their psi equation, EPR pairs have two terms; yours have *three*. It would be more accurate to describe them as *semi-entanglements*; halfway between

separable and full, saturated EPR style entanglements. It's not clear that such states can even be achieved in physical systems, and I've never seen an operator, a linear quantum mechanical operator, that could generate such a state. We need to confirm that such states, states of semi-entanglement, are possible and achievable." He paused, but then sat back down without adding anything else.

Paradigm, "You're right, and I like the name you've suggested, semi-entanglements. But I'm content to stay hypothetical at this point. If we can show an FTL protocol with semi-entanglements then we either have a protocol, or if FTL is impossible, we have a proof by contradiction that semi-entanglements are impossible. In the latter case we lose QTP, but in either case we advance knowledge. Thanks for the observation, and we'll use the new term from now on."

Pruning by Contradiction

Proof

Understanding, continuing down his list, "Proof, what do you have?"

Proof went over to the whiteboard. He drew four classical tic-tac-toe boards. "Separable." He crossed one off, then a quick nod at Mathematics, "Semi-entangled." Then he pointed first at one of the remaining three boards, then another, "Which one you eliminate now either gives you a cyclic entanglement or collapses one move leaving the other two in a superposition." He put the marker down. "How do you define contradiction? Is this the same as the Pauli exclusion principle? Does it therefore apply only to leptons? Photons are a better medium for communication, but they are bosons. Can you recast quantum tic-tac-toe to use a different pruning mechanism than contradiction, maybe one where the moves want to be in the same square; that would be bosonic like behavior and better suited to photons." He returned to his seat.

Paradigm was silent for several seconds. "Good points, you got me thinking about the bosonic equivalent, might need a different game than quantum tic-tac-toe, though." It was very quiet, and frankly subdued in the room.

Symmetric Spacetime Intervals

Experiment

Experiment was summoned next.

Experiment stood but asked Theory for assistance. They positioned themselves on opposite sides of the room, making Paradigm turn his head from one to the other. "Who measures first? The math works out the same. Maybe there is no direct causality. Maybe, it's only nonlocality. Maybe, it's like the interferometer, or your classical ensemble, both measurements cause collapse, one in one classical reality, one in the other. A distinction that can't be verified, isn't one that can be specified. It's like causality itself has been put into a superposition. It reminds me of the glued boxes; without a working FTL protocol, the SSI isn't testable, isn't falsifiable. You are trying to think out of two boxes at once. That's a tall order, with many more ways to be wrong. Speculative, clever, but not actually a scientific hypothesis. It cannot stand on its own. Sorry."

Paradigm, “Now damn it, the SSI is the one thing we have down pat. It provided a way to tell left from right and it’s a clean mathematical derivation.” He looked at Mathematics, “You double checked it.” Mathematics, “Yes, but it used the relativistic Doppler equation, valid for photons, but is it valid for leptons?”

Theory chimed in, “Probably not, the slope of the SSI you derived for photons turned out to depend on their center of mass. For distributed sublight particles, the center of mass is not a relativistic invariant.”

Experiment, “I’d forgotten about that,” turning back to Paradigm, “but Theory is right. However, I have two more disturbing questions; if one photon of an EPR pair encounters a mirror, does the symmetric interval follow the optical path or the physical path? If it is the physical path, then the encounter and response events shift, dramatically.

“But it is my second question that might be devastating.” He paused, looked at Understanding, then back to Paradigm. “What about entanglement swapping? Here you have another pair of photons that are now EPR entangled, but they have no creation event. How do you specify a symmetric interval between them?”

Paradigm’s response was muted but considered. “Good questions, good observations, but I think each of those objections can be handled in the lab, we just have to ask the Realm a clear, precise question, and she’ll tell us.”

“Perhaps, but without FTL, you don’t have a way to ask such questions. We’ve a chicken and egg problem.” Experiment and Theory returned to their seats.

Decoherence

Theory

Understanding, in measured tones, “Theory, your turn.”

Theory stayed seated, “Love the use of self-reference, but your model is incomplete without considering decoherence.”

Paradigm, “Uh, ok.”

Quantum Tic-Tac-Toe

Curiosity

In one fluid movement Curiosity stood maintaining eye contact with Paradigm from start to finish. “In your cute little game, quantum tic-tac-toe, you achieve entanglement, sorry, semi-entanglement, by contradiction. Moves cannot be in the same squares, but that implies lepton like behavior, yet somehow, we all ended up with an FTL protocol that utilized photons, boson like behavior. Entanglement in that scheme relies on indistinguishability, but in QT3, the moves are all regarded as *distinguishable*, they are labeled with the number of the move. The FTL scheme from that metaphor entails creating, extending, or connecting semi-entanglements.” She glanced at Mathematics, “Should we now call those demi-entanglements?

"Furthermore, this must be done on spacelike separated parts of the growing entanglement. I'd like to see the math, and even more, I'd like to see the physical setup that can achieve even one of these three transformations in the system state. That scheme achieved FTL by growing entanglements until they were cyclic, but the indistinguishable scheme requires that FTL be possible by measurement. Didn't Eberhard prove that impossible?

"It seems we have two ideas, incompatible, that don't do much to inform on the other. Have we confused metaphors?"

Paradigm looked at her, she perhaps more than any other team member was someone whom he had counted on for unconditional support. He took a moment to gather his thoughts, but the basket came up empty. All he could muster was, "Thanks for the feedback."

Indistinguishable Particles and Reduction of the Hilbert Space

Reason

Reason stood, slowly. He glanced at Paradigm, then at Curiosity. Returning to address Paradigm, "Your proposed FTL schemes only work if EPR entangled photons from different EPR pairs can be regarded as indistinguishable. Don't they have to be in the same state? But such photons are not in a pure state, they are in a mixed state, their polarization value depends on the state of their companion particle. Is it possible, that to reduce the Hilbert space, it is the mixed states that have to indistinguishable? If they both start out in the anti-symmetric Bell state, flipping one turns that mixed state into the symmetric Bell state. Are the mixed states not now distinguishable? Your scheme can still work, just let the idle state represent the 0-bit, but your SNR goes down, and thus your packet size must go up, and with current technology, I don't think you can complete a packet fast enough to maintain a spacelike interval."

He looked at his feet and dug his shoes into the carpet. Looking up, he fixed Paradigm with a sad look, "But the real concern is that the companion photons are spatially separated, and thus distinguishable. Each is entangled with one, and only one, of the pair of photons we are trying to make indistinguishable. Entanglement is very selective, even though the companion pairs are spacelike separated, might they not make the cross pairs distinguishable? This all be itself might destroy any possibility of treating them like indistinguishable particles, and that breaks all your FTL protocols, completely, no hope for a statistical reprieve.

"Sorry pal, but there are too many questions to be confident yet that you've pulled off what the current orthodoxy," he glanced in Dogma's direction, "regard as impossible."

QTP

Dogma

Understanding, after a deep breath, "And the last of our critics, Dogma."

Dogma had been looking forward to this, but suddenly it felt much less victorious. He too stood. "Together, we all built a clever demo of QTP, but the pieces never actually jelled. QT3 suggested one approach, but in the randomness of creative problem solving, we ended up

somewhere else, without quite noticing. We have an FTL protocol, several in fact, one of which might work, but probably won't, but we don't have a specification of QTP. Solving the measurement problem was the quest, which seemed like it would require spacelike causality, so FTL was just a potential side-effect. We might have seduced ourselves.

"Perhaps spacelike correlations will be sufficient, but without a spacelike cause, how does one generate a causality paradox? Without paradox for a background, how does indeterminacy form a foreground? Without indeterminacy defining a unique basis, you don't have a measurement mechanism. If entanglement requires some third kind of causality, we haven't found it yet.

"I like the idea of self-reference in time leading to nonlocal destructive interference, that's clever, but if collapse is going to be driven by paradox, driven to find a basis of indeterminacy, then the indistinguishability protocol fails to achieve this. The paradox created by that protocol consists of two spacelike causes, each of which requires a classical measurement. They don't even have to be measured in the same basis. Resolution is by philosophical argument, 'Nature can avoid one, if she merely does this, that or the other thing,' Declaring that all paradoxes are 'conditional' begs the question, unless the conditionality can be quantified. What's missing is collapse, specifically self-collapse, in a basis that avoids paradox. We haven't elevated QTP to the level of a hypothesis quite yet, it remains merely a provocative idea.

"Between these deficiencies, and those reported by my esteemed colleagues; I fear these ideas might not be salvageable. At the very least they require a lot more work, and more rigorous work at that."

After an embarrassing pause, he added, with an apologetic shrug, "QED."

Paradigm

All was quiet, pin dropping quiet.

Paradigm was channeling a Greek sculpture, not moving at all; frozen in time. He noticed his own state, but the observation wasn't enough to trigger movement. For a while longer, Paradigm remained silent, silent and still; his thoughts churning. This was a much longer list than he'd anticipated. Everyone on the team had a critique; these were his friends? He also felt a bit embarrassed; phrased this way, he wasn't even close. QTP? An acronym for a fanciful concept, but too ambiguous to rise even to the level of a hypothesis. In its current form, vague, incomplete, and far from testable. Damn. Humility was a virtue he preferred to admire from a safe distance.

He rose, regally, "Thank you all for your comments." He paused, bit his lip and unconsciously ran his hand through his hair. "I'm goanna go for a walk." And with that he unceremoniously exited.

Understanding

Understanding, with gentle compassion, addressed the remaining members, "Seems to me, that what we have done is assemble several pieces from different jigsaw puzzles. They form an interesting picture, a suggestive picture, but they don't actually go together. We have a choice; we

can abandon this project in favor of something else, or we can accept the challenge of finishing the other puzzles and see what kind of picture they present as a completed set.

"I propose that this is a decision each of us should make, individually, and without a deadline. Meeting adjourned, stay as long as you like."

Compassion

Curiosity wandered over to Dogma, "I was watching you. Yesterday, I would have predicted that you would have enjoyed tonight, maybe taken a little victory lap." She paused, eyed him close, "But tonight I don't think that."

Dogma looked back at her, "I'm a little surprised myself; I had the same expectation." He twisted his lapel, "This felt awkward, a little sad, maybe even a little mean. Turns out I don't actually like dashing hopes." He forced a wry smile.

"What are you going to choose: continue or abandon?"

Dogma, "I don't know yet. Understanding said there was no deadline. I think I'm going to procrastinate. Goodnight Curiosity, see you next week."

One by one, they all left; Curiosity watched them go. She approached Understanding, to give her regards, but he spoke first, "Last one to leave tonight, I see." She nodded. "Yep, I'm in a thoughtful mood."

Understanding did something unexpected, he did a fast spin on one foot, turned all the way around, 360 degrees, gracefully, like a dance move. "Why did you do that?" she inquired. He responded, "Life has a funny way of working out, of surprising us. My prediction; everyone is going to choose to continue." Curiosity smiled, "That would be grand. Goodnight, boss."

And that was that.

