The Paradigm Discourses

"Outsmarted"

Which came first, the present or the past?

"Damn, you won again. How are you doing this? I invented this game."

Logic smiled, "Come on, Paradigm, this is supposed to be your strong suit."

Curiosity laughed, politely, but Paradigm was feeling the embarrassment. Softly, "You actually look embarrassed." Paradigm, mustering a grin, "Well, fortunately, there is only one of me, if there were two, one of us would certainly collapse in a puff of shame." Paradigm was pleased that at least he still had enough presence of mind to pull off a joke.

Reason, "Nice *one* Paradigm, alluding to superposition," Curiosity rolled her eyes, but apparently only she and Paradigm caught Reason's pun, "but the question remains, from you if I remember the start of this conversation; how are you letting Logic beat you in a game you invented?"

"I don't know – yet."

Dogma had been observing Paradigm's succession of defeats with a little bit of guilty pleasure, an unflattering indulgence that he recognized, but in truth he found quantum tic-tac-toe rather intriguing. It was a clever way of investigating superposition, and he appreciated the pedagogy it offered. But he was also aghast, it wasn't real physics; it was just a game. It pretended to sport superposition, but in fact all the superpositions were unweighted, not the complex weights of quantum mechanics, not even real weights. And only one basis, so it couldn't support conjugate bases, thus no uncertainty principle either. It was artificially quantum; incomplete. It struck him at that moment that here was another example of Paradigm ignoring some aspect of reality, in what was undoubtedly a deliberate strategy in line with his ignoring conjecture. He sighed; trouble was it might be the right strategy. Somehow, despite all the simplifications, all the ways it was incomplete, what emerged from it was an objective measurement process; one free from the problem of interpretation: problems quantum mechanics had not yet solved. How, being less, could it also simultaneously be more? Perhaps the Realm was offering up a hint.

Theory and Experiment stumbled through the door. One less familiar with them might make the mistaken assumption they were drunk.

"We heard you all have a new game."

"We are here to learn, master, dominate, and take names."

Understanding pointed at the group, "Ask them."

As they made their way over, a bit clumsily, Curiosity rose. She enjoyed the tutoring role and these two made good students, might as well volunteer.

"Have a seat," she said. "This game is a variation on the venerable children's game of classical tic-tac-toe. But instead of marking just one square, each player is to mark two squares; every move

is in a superposition of two squares. The pair of moves is indicated with ‘spooky-marks’. You’re not in both squares, more like half-n-half; call it the square root of a move.”

Experiment, “Ah, this will be child’s play.”

Paradigm shook his head, not in disapproval; all puns should be acknowledged, as a matter of competitive curtesy.

Curiosity ignored it. She drew a large tic-tac-toe board on the white board but doubled up each of the two vertical and two horizontal lines that define the nine squares of the board. Then she numbered every square, left to right, and top to bottom. Next she placed two X’s, one in square 1, the other in square 2, each X subscripted with the number 1. “Let this be X’s first move, a pair of *spooky-marks*. To keep track of the spooky-marks, which ones belong to which pair, they are subscripted with the number of the move. X gets the odd numbers; O gets the even numbers.”

Theory and Experiment nodded.

She continued, “Now what it means in physics to be in two places at once is a bit muddled, but in quantum tic-tac-toe, the interpretation of superposition is easy, obvious, and unique; there are now *two* games of classical tic-tac-toe in play at once.” She held up two fingers. “Call them the classical ensemble.”

Now she added two small tic-tac-toe boards below the quantum board, each with only single lines to delineate the squares. “In one classical game, X’s first move was in square 1,” she so marked the first classical board, “and in the second classical game, X’s first move was in square 2.” She so marked. “Clear?”

Everyone nodded.

Experiment, not making it a question, “It will be the same for O, won’t it.”

Theory, “Yes, but now there will be four games in the classical ensemble.”

Curiosity, “In general yes, unless one of her spooky marks shares a square with X.” She added spooky-marks for O into squares 2 & 5 to demo the exception, duplicated the two classical games so there were now four and duplicated X’s first move in them as well. Then she added marks for O in the classical ensemble; in one of the four classical games, square 2 had two marks, one X and one O. She looked at her students.

Theory, “That can’t be right, it is not allowed in classical tic-tac-toe to have two marks in the same square.” Curiosity, “It certainly isn’t.” Then she waited while they worked it out.

Experiment, “We have to throw that game out.” Curiosity circled it with a flourish and drew a diagonal line through it signifying its ejection from the classical ensemble.

Paradigm emphasizing, “You mean we have to throw a reality away.” He raised his eyebrows.

Theory looked at Paradigm, “If this is a metaphor for the realm,” he paused, “then that’s an audacious metaphor. Realities, at least what we think of as classical realities, would be popping into and out of existence moment to moment.”

Reason, “I think my head hurts.”

Mathematics came over for just a moment. Looking at the board he observed, “*Hmm*, only 3 possible classical games. Looks to me like the states of X & O aren’t separable anymore; that should mean they are entangled.” Nods all around.

Curiosity, regaining control of the session, “Now look what happens if X’s second move is a pair of spooky-marks in squares 5 and 1.” Working together they updated the white board. The three classical games from move 2 were doubled, to six. X’s second move added an ‘x’ to square 5 for three of the games, and to square 1 for the other three. But this resulted in four of the six classical games having a square with *two* moves in it: four illegal classical games. Throwing those out left the classical ensemble with only two valid games.

She continued, “What we have now is a cyclic entanglement. Follow.

“If X’s first move were to collapse into square 1, then his second move must collapse into square 5, and that forces O’s first move to collapse into square 2, which forces X’s first move to collapse into square 1; which was our beginning assumption.

“On the other hand,” she couldn’t help looking at Dogma, “if X’s first move were to collapse into square 2, then O’s first move must collapse into square 5 and that forces X’s second move to collapse into square 1, which forces X’s first move to collapse into square 2; which was the beginning assumption this time.

“Only two possibilities; both self-consistent.” Logic interjected, “I see it; it’s an analog to the pesky logic question Paradigm tortured us with in the game of 13, ‘This statement is true’.”

Curiosity pressed on, “To balance the game strategically, the rules specify that the player who did not create the cyclic entanglement gets to choose the collapse. In this case that is O. Now in this particular situation, her first move can end up in either the center square (5) or the edge square (2). Generally, she would choose square 5 as it is a more powerful location, so the other game is now eliminated from the classical ensemble, but by collapse not by contradiction,” she crossed out the game with O in square 2, “leaving only this one classical game.

This is a new type of move; a *collapse* move, in contrast to the conventional *place* move.”

For a while everyone just mentally worked through the example. Then Curiosity dropped the bombshell. “Question. *When* was the cause of X’s first move being in square 2 rather than in square 1?”

Theory was first, “You’ve got to be kidding me; the collapse occurred as part of move 3; that’s after move 1.”

Experiment said, “But that decided where move 1 was?” He looked at Theory.

“Yep, I can’t come to any other conclusion.” He looked at Paradigm, then added almost in awe, “The present has influenced the past.”

Dogma closed his eyes and shook his head in silent frustration.

Curiosity, “So far so good, but not quite complete. The cause is extended in time. It includes the first move of the game when X placed spooky-marks in squares 1 and 2, but it also includes the third move of the game, when O chose the collapse that placed her move in square 5 and X’s first move in square 2. It is also extended in space; three squares are involved in where the first moves end up.

“Collapse of move one is nonlocal.”

She waited a few more moments, giving her students time to digest this new perspective on games, and to ponder the metaphors it offered about the realm. Then she continued, “Now all the

rest you can figure out for yourselves, there are a couple of additional surprises, but they all follow from these basics. I expect they'll be obvious to you. What I want to do is summarize the implications.

"To wit; superposition led to entanglement, which grew into a cyclic entanglement, which led to an objective measurement process, where causality is distributed in time and space, where the present can affect the past without temporal paradox, where the interpretation is that a quantum reality implies a coherent set of simultaneous classical realities that grow by superposition, shrink by contradiction, and are pruned by collapse."

"Oh, I've been an idiot." Paradigm almost cringed, the light bulb finally going off. "That's how Logic has been beating me; he has been attacking my past, *sigh*. You've been using entanglement to eliminate realities by contradiction; choosing to prune all the classical games where I had an advantage. As long as you can preserve two games where you win, my position becomes hopeless." He looked at his adversary.

"I congratulate you. As a gentleman, I solute you; as a gamer, I concede defeat. Nicely played, nicely deduced, and very, very devious. I did not see that coming."

Logic, with a Robin Hood laugh, "Darn, it only took you one week, I was hoping to keep this advantage for months."

From the other side of the room, "YES!" boomed Proof. He and Mathematics turned from Understanding's computation engine. "We just proved that X has a winning strategy. It took a brute force approach, but he can always eke out a win by at least half a point."

Reason, "I'll be damned, here we have one more example of where what is impossible in a classical reality becomes possible in a quantum reality. Well done gentlemen."

Paradigm, addressing Mathematics and Proof, "Clearly, I'm not going to play against either of you two either."

The rest of the evening was pleasant while uneventful. Dogma eventually got over his angst, having to admit, if only to himself, that the darn game was unique, clever, and held enough surprises to while away a whole evening.

But Reason was pondering, mentally puttering, offering his subconscious the opportunity to impune some answer to the only question he was keeping at the conscience level, 'what else might be possible in a quantum reality that is impossible in a classical reality?'

