

UNTANGLING ENTANGLEMENT

Many are the thoughts that come to me
In my lonely musing;
And they drift so strange and swift
There's no time for choosing
Which to follow; for to leave
Any, seems a losing.

Christopher Cranch (1844)

GWENDOLEN. Do you allude to me, Miss Cardew, as an
entanglement? You are presumptuous.

Oscar Wilde (1895)

The essential physical significance of the law of motion is therefore simply that *all 'interactions' are manifestations of EPR-entanglement and nothing but EPR-entanglement*. What might seem a mere change of terminology here is actually a radical shift of physical viewpoint, comparable to the abandonment of gravitational 'force' in general relativity.

Antony Valentini (1996)

Most physicists will always have some kind of mental picture to complement the mathematical tools.

Nicolas Gisin (2002)

For me it is the end—or should be; it's a dance with danger, last track of the disco mix. She phones to say she's off to Quetta. Guilt by destination. Though I've never been there, I have been to northern Pakistan where Quetta's reputation is well known. It was of old a fort astride the land route to south Asia. It's deep within the tribal areas amid the Chiltan and the Koh-i-Murdar mountains, now said to be a city of a million—no one, least of all the Pakistani government, is sure—awash in intrigues in a half a dozen languages.

Cosmology in Quetta? Just in case, I waste the twenty seconds that it takes to check. My instinct is: Get out of Dodge. Having told me of her plans, she just assumes that I will book her travel. I'm not sure, maybe she is right—I can't leave yet, or I don't want to. If I took the book what would she do? One thing's for sure now; when I do leave I'm not leaving it behind.

Her travel's easy. Nothing will have *my* name on it. Hers, she says, is Gretl Hannemeier for this trip. Where does she get her passports? Always German. She

dictates the details of another credit card. My gut tells me what I am doing now could be a hazard to my health. She wants two hours in Frankfurt so I book Lufthansa via Denver to Dubai. First class it is ten thousand more than Delta through Atlanta. This makes Frankfurt an expensive stop but she gets three hours on the ground. And one day in Dubai.

It's the Quetta leg that sets the schedule. PIA flies twice a week, Tuesdays and Sundays, from Dubai, City of Money, into Quetta, City, so it seems, of Schemes. She wants a day there. She gets two nights in a suite at the Serena.

Back to study with a sense that somewhere out of sight a clock is counting down.

The eye-opener of the Beginning is Entanglement. I remind him how particles become entangled when they interact so that some quantum property of each is tied up with the other. At the moment of the interaction QM can describe them as a single quantum system. Typical might be two particles that have a common origin. Let's say they start out as a Something that has zero spin. QM says this Something is a quantum system. Its ψ describes all future states including its decay into two particles. The particles created from it can each have non-zero spin; their spins must then be opposite and equal so they total zero. And, here is the kicker: QM treats them as a single state regardless of how far apart they travel. Experiments confirm QM's description.

So, I ask myself, rhetorically, what is more entangling than one Fleck turning into two? And then again, repeating till they number staggeringly many, every one of them in mutual Entanglement with every other one. It looks reasonable when I write it. But the words conceal the fact that I don't know. The more I read about Entanglement the less I seem to understand. It is a quantum thing. As always QM only gives the odds. So it says nothing about what is going on. Or, more precisely, it says nothing's going on, don't bother asking. My misfortune is: I ask. What, then, is Entanglement? Nobody knows. Fleck images keep moving in my mind until I'm dizzy.

"Are you forgetting Windows?"

I have mixed emotions when I hear him. A slight startle and a feeling of intrusion, a turning of my inward eye as if I might be looking for his help, relief I haven't been abandoned and, though it seems silly, slight resentment that he's back again. The resentment's more insistent when, as now, he's condescending.

I try to damp it down and focus on the question. What do Windows have to do with Flecks entangling? As I ask myself, the answer becomes obvious. We did this already. Windows tie together two dimensions of adjacent Flecks. It dawns on me that this may hold a hidden meaning. I reach for the thought; it slides away. Second reach and it comes clear to me, it's serendipity: Think Links.

There are *two* ways to look at the relationship between two next-door Flecks. One is as the interface between two volume quanta. He calls this a Window; each one, having two dimensions, is an area, so area is quantized too. But the other way to think of the relationship is interlinking two dimensions of one 6-D Fleck with two dimensions from the next. The picture that goes with this way, misleading though it may be, is a ribbon. The relationship may mean more than the picture: It's a Link. Thinking of the two—the Window, a 2-D boundary *between*—and the Link, a 2-D ribbon running *through*—I think: Could they be complementary? It looks like two ways to look at the same thing. And it seems that each way does exclude the other. Could they both be needed for complete description? Could it be Complementarity is woven in the fabric of the universe at its most basic level?

How did I get here? Entanglement. He says to think about the Windows. I think what I need to think about is Links. Do two of six dimensions of each Fleck Link two of a next-neighbor Fleck's dimensions?

"It's a Rule. Two make a *Thread*."

Well, now he says so. I suppose that it's the sort of thing that would be in the Rules. It fits the Primal Principle. Given there are Flecks and nothing in between them, having two of their dimensions line up seems the simplest way that they could get along. There would have to be some kind of rule. When Move 1 makes two Flecks it makes two Windows, each with two dimensions. It seems simpler to align dimensions through the Window than to leave them all awry. And they must be the *same* dimensions in both Links so no dimension ever ends. As the Big Fizz unfolds . . . I close my eyes and see . . . a rat's nest to end rats' nests, a fantastic fabric made of 2-D Linky Threads through 3-D Flecky space. I see it and I'm sold. This is what the world is made of: Flecks that Fizzion making tangled Links.

Tangles, tangled Linky ribbons woven with those curled dimensions. With Move 1, two form a ribbon ring. Before Move 1 that unformed ribbon curls within the Manifold. After Move 1 it turns into the second Fleck. At mind's edge I see a half a twist turn one way in one Window and the other in the other. As I mind-plunge through a Window it becomes a B-T twist. *This* is what he's twisting: Links! Links make B-T's ribbons and his ribbons are Frank's Threads. Threads make tangles and the tangles twist the Links. My thoughts wander: What would B-T do if he knew what he's twisting? Is the twisted ribbon the foundation of Entanglement? If there were a quantum theory for the Manifold, would it say that daughter Flecks remain entangled in a single quantum state? How could it not be so? When the first two Fizzion, four granddaughter Flecks entangle. And so on.

Another thing: The ring cannot be broken so a twist made any-where must match a counter-twist some-where; at every Move the UC makes it so. Is this why

what is done to one is done to all? The Beginning echoes what some say, that everything's entangled. A universe entire! Am I forgetting? This should get a check against the Spooky Action Problem.

Does he see all this? Is this what he means by saying Moves make a non-local universe? All I can say is, his laconic claim that it's a Rule sounds much like prior knowledge. Does he really know the Rules? It seems there are not many. Certainly not many for the making of a universe with all its messy mass. Which thought brings back the issue of Fleck mass.

I keep thinking that each Fleck must have its own mass—the energy it costs to make it. It is not ordinary mass. It's far too tiny. It must be much less than the mass of any particle. And it must be the same for every Fleck, for the reason we worked out for volume: There is no reason any one of them would have more mass than any other.

“There is.”

What does he mean? There *is* a reason? If Flecks are the same why would it take more energy to make one than another?

I await his explanation. My pulse murmurs in the silence. I conjure up a thinking-blocking program in a non-existent language:

100 Check for voice

110 If no voice then go to 100

A moment later I insert another line:

105 If this is the tenth time round then Stop

I count. It stops. No voice. His silence says there *is* a reason. It also says that it's for me to figure out.

I try to think what could be different. They have equal volume. They make the same space. But they aren't all made at the same time. What difference does that make? Well, the universe is bigger when the later ones are made. So what? A sudden silly image of a bottle of Bohemia. The bubbles at the bottom of an opened bottle make the level in the bottle rise. It lifts the beer. Just so, each new Fleck makes the universe a little bigger, lifting it a tiny distance on its shoulders as it were. In physics terms, it's doing work. Work equals energy. And energy's another word for mass.

An early Fleck must lift a denser universe than does a later one. Denser means more gravity. An early Fleck must push a little harder. So it does more work. Which is more energy. More mass. He's right: New space is getting easier. My concept of a constant Fleck mass might be wrong.