TWIST N SHOUT

Tweedledum and Tweedledee Agreed to have a battle….

English nursery rhyme (ca. 1700)

So passed a day in the life of a P.I.

Raymond Chandler (1953)

Ideally, physicists would prefer a single entity. … All of the known particles would arise from this fundamental entity behaving in different ways, like different notes played on a bugle.

Robert Oerter (2006)

The significance of this model is its extreme economy.

Sundance Bilson-Thompson (2008)

I'm looking for something kind of twisted.

Amanda Seyfried (2010)

All morning I work in a Frank-free zone. I'm surfing and it is my lucky day. First I check out quantum+gravity and find myself once more at the P.I. in Waterloo, full of physicists who do this stuff we only dabble in. And so I check it out. There's faculty, like Smolin; lots of post-docs. One from Adelaide where I once spent two weeks. Absently I click and there is Sundance Bilson-Thompson's smiling face. Author of some arXiv papers, one with Smolin as co-author and it has embedded links. One click finds an '08 paper by the post-doc with the catchy name. Its title isn't catchy: Composite preons? *Could* be catchy though as, idly downloading the PDF, I wonder what it is about.

Well, what it is about is braids and twists; braided twists like hair. What Bilson-Thompson braids instead of hair is not exactly clear. Some kind of ribbon, though what *that* may be he doesn't say. To me it seems a serious omission. What he braids the ribbons into he *does* say: They're Standard-Model sub-atomic particles. The simplest braid of all turns out to be the photon. I print the PDF and go straight to his diagrams. Extreme economy is what he says about his braids. The diagrams look simple, like a game for kids, but soon they seem so subtle that my head spins.

The twisty braids make every kind of particle but one. Missing is the graviton—a particle that some imagine must exist. Disciples say that it transmits the force of gravity. Frank won't be surprised that it is missing; his Beginning seems to say there *is* no force of gravity.

Twist images turn thought in chance directions: The whole world was ex-

plored by cord. For centuries it causes ships to stop and go. Thick twisted ropes for mooring or for rigging. Thin twisted thread for weaving sails. Cord is strands of feeble fiber—hemp, jute, cotton or whatever—made strong by twist, the magic factor. But it's more than merely practical: It's like rotation. I have always felt that it is fundamental. I can't wait to hear what he will make of this. It's getting late when he makes an appearance.

"Where's the notes?" is all he has to say.

This may not be the time to mention grammar so I turn the thought aside and write. I feel him waiting.

Bilson-Thompson tries another round of atom cutting. Interest in the preon—it's a postulated sub-sub-sub-atomic particle—has faded since the 1980s. B-T picks the preon up and cuts it one more level down. He shows how the quarks and leptons (such as the electron) can be elegantly made from simple braids of things that he calls helons, or composite preons. Each helon's made from *Tweedles*, four cuts smaller than the atom. A Tweedle's like a ribbon. It has two ways to be. It can have a half-twist clockwise (it's a 'dum') or half-twist anticlockwise ('dee'). It's no coincidence that Carroll's Tweedledum is said to be the mirror twin of Tweedledee.

So B-T says these Tweedles are the basic pieces by whose combinations all the matter that we see—quarks and photons, atoms, molecules like Teflon, frogs and physicists, the galaxies, the cosmos—is explained. The combinations all start with a simple rule: Two Tweedles hook up end to end. They make three kinds of helons:

> Two dums → the H_+ helon (a full twist clockwise)
>
> Two dees → H_- (a full twist anticlockwise)
>
> A dum and dee or vice versa → H_0 (no net twist at all)

In this Looking-Glass world, twist creates electric charge. Well, actually, it *is* the charge. Twist makes my desktop make my world go round. The battery that's in my laptop's belly has Tweedledums and Tweedledees and all they want is battle. Well, it's not that simple but that isn't Bilson-Thompson's fault. After all he's at the sub-sub-sub-sub-basement level trying to sort out the mess the standard muddle left upstairs—six quarks, six leptons, the photon and three other bosons, not to mention possibly the Higgs. But charge *is* simple: Tweedles have one-third the smallest charge observed on isolated particles: namely $\pm e/3$.

B-T says that all the Standard Model particles are made with simple braids of helons. And by simple he means *very* simple. Braiding has two rules: All braids have three helons; and the H_+ and H_- helons never braid together. Every braid that can be made is up for grabs. He checks all combinations and finds the famil-

iar family of the sub-sub-sub-atomic particles. Familiar to physicists, that is.

It's like a deck of cards: Four suits, three face cards, nine numbers, aces high or low—even with no Joker one can play ten kinds of Poker, not to mention Bridge or Solitaire or Crib. B-T's Tweedle twosomes braid in threesomes into literally everything. It all comes down to twist this way or that. Just two choices and no chance of making more. It's hard to see the cutting getting any deeper. It's the one thing my guy *didn't* see in the Beginning. Fundamental particles; he should have known the makings of them *must* be there.

I close my eyes and try to see the seething sea of Flecks. At any given Tock each Fleck may have a Tweedle or may not. Everything results from this. I'm a puff of twinned and braided Tweedles that the UC moves around. And what is he?

"Hmm." He has been quiet. Does he know what twists and braids might be?

"Two threes are six."

Three threes are nine, my mind responds unthinking.

"What if twists and braids cross Windows?"

I hear him but he doesn't have my whole attention. I'm wrestling Windows to get Flecks into a stack. I keep flashing on a beeswax kind of structure. It's no good, I know. I try instead to think of Flecks as foam. His question filters through. I'm stacking Flecks or trying while he's peeking in their Windows? Is he out ahead of me again? The penny drops. The Flecks are six-dimensional. Each Window is an area, 2-D. So every Fleck must share these two dimensions with a neighbor. What do we do with this?

"Absolutely nothing."

Nothing? Why do nothing?

"You said leave physics to the physicists."

I'm not sure I said exactly *that*. I want to go with my idea. I've begun to think of it as mine. If Bilson-Thompson's Tweedles are the building blocks of particles and if their twists involve the Windows between Flecks, the Beginning says there's nothing tinier than that. With apologies to Truman, Bilson-Thompson could declare: The cut stops here. The Greeks will cheer. No-cut is a great idea. But for about a hundred years it has been looking lost.

"It's more fundamental."

What could be more fundamental than the a-tom?

"Remember the great problems? What's the third one?"

So I have to look it up. It's Smolin. He asks whether all the particles and forces are 'manifestations of a single, fundamental entity.' And, yes, I see he's saying that the answer is maybe they are, maybe the Tweedle is the fundamental entity. It's a revelation. Since Mendeleev, atoms have had many entities; the Standard

Model starts with seventeen. B-T now says there's only *one*. While Tweedles are B-T's invention, Smolin has his fingerprints all over. For some reason, it's this thought that brings it home to me: Twist may be everything we see. How beautiful this universe in its simplicity! Flecks and Windows, twists and Tocks. Fallout from the Fizzion.

I'm bone-tired. It has been another heady day. I hustle for the train. I realize that all my speculations about particles *in* Flecks were wrong. Walking, out of breath, I recollect an article I read on knots. Knots of the sort that sailors make in string. The name that comes to mind is Jones. I have an urgent urge to find him. Fifty minutes later, dumping takeout on the table, I log on and look him up. Vaughan Jones is a Newzie. He does knotty math. What I am after is what he calls closure. Think of any ordinary knot in any piece of string. No matter what knot, nor what sailor ties it, it can be undone. Unless, that is, the string is endless, so its loop is closed. B-T's braids are tangles in three bits of string. If the strings are open then the tangle's temporary. But if they're closed the tangle is a knot. It may move along the strings but unless it should come upon its opposite—its mirror image—it can run but it cannot untangle. Jones is in the business of closing braids. B-T and Jones and Frank between them show me how to solve a problem that I didn't list: Why do physicists find charge in quantum pieces? It's the twists betwixt space quanta.

I chew on cold burritos while I doodle on some paper:

1 hydrogen atom

2 subatomic particles: 1 proton, 1 electron

4 elementary particles: 3 quarks, 1 electron

12 helons

24 tweedles

It must be true, I think a little later, easing out the door onto the beach. The Tweedle takes us right down to the Fleck scale. There's no lower place to go. Pink Floyd may have made it first but B-T's looks to me to be the final cut. *There's* a Nobel waiting for experimental confirmation!