STRINGS AND THINGS

It's only make believe.

Conway Twitty (1958)

Imagine that I give you a chair, while explaining that the legs are still missing, and that the seat, back and armrest will perhaps be delivered soon; whatever I did give you, can I still call it a chair?

Gerard 't Hooft (1996)

String theorists like everyone else are trying to make the best of a very difficult moment in the history of physics.

Stephen Weinberg (1992)

String theory offers an improvement by showing how … infinite extremes might be avoided; nevertheless, no one has any insight on the question of how things actually did begin.

Brian Greene (1999)

A growing number of theoretical physicists … see the present situation as a crisis that requires us to re-examine the assumptions behind our so-far unsuccessful theories.

Lee Smolin (2006)

Many physicists have spent their whole careers working on [string theory], and some would argue that this is why a theory that should have been thrown out long ago still has currency: there is too much invested in it.

Brian Clegg (2009)

[Evidence of extra dimensions] would alter our whole notion of what reality is.

Max Tegmark (2010)

We're into strings. Looking back, I never thought he'd make it so far. I wonder what it is that's working. He may find strings hard to swallow. So I feed him little bits. Right away there is a small advantage: It seems that he's already heard of strings. Of course that's not the same as grasping the *idea*. He has no idea what the string idea is. But it's a start. And the idea is simple: Things are made of strings. That is: Things are made of atoms. They in turn are made of particles. And the particles are strings. Or so they say.

Well, that's the simple version. It turns out there are dozens, maybe thousands, of string theories. They start in the '60s. Off and on they are the flavor of

the month for many years. Now Google says string+theory gets 9 million hits. Bing goes 130 million better. Either way the number must go up by more than one a minute. I say this shows how strings have hordes of physicists just beavering away. Strings are purely theoretical. Once again he wants what he imagines are real clues.

I know exactly what a *fictional* detective would do here. He'd see strings as strange things. He'd be attracted to their strangeness. He'd poke around them, soak them up. There's got to be something to learn here that a good detective needs to grasp.

The story of string theory is a story of industrial development. The best bets for bridging the divide prove unproductive. So most physicists crunch numbers with QM. At least it is a steady job. But in the grand tradition some seek new directions. By the 1970s some work on strings. That's what they call them. Why? Well, in 1968 then-Japanese about-to-be-American Yoichiro Nambu works on math of interacting particles. He shows it's like a formula for thin vibrating things. Hence strings. His theory is soon replaced by others, many others, some quite different but the label sticks; they all are strings.

So what are strings really? Well, the cynic in me sees this as a new-lamp story: 'New lamps for old, bright shiny gold.' Procol Harum talks to me.

It goes like this: Physicists have problems with their particles. With zero size they are pure points in space. I'll have to tell him soon how points give physics indigestion. Solution: Stretch the points to give them size! But wait. They can't stretch in space. Not in the three dimensions where they're pointy. So summon the dimension genie, and conjure up another one. Or six. Or even twenty-three. In three plus one is four or maybe more dimensions, particles have room to stretch. So, no longer pointy, they at least have length. Any length will do—no matter that it's little—and the zero woes are toast. But they can't stretch much! Someone will want to check them out. So new dimensions should be small. So small there is no way to see them. Well, what is a lamp for if not a genie; and what's a genie for if not to manage wish lists? Presto! Or should that be abracadabra? New dimensions that, unlike the sisters who had mercy, have departed and are gone, conveniently hid forever from our eyes.

The cynic might not be quite right but would not be entirely wrong. Strings trade in the old pointy problem for a new one: Where do their dimensions come from? Well, at least it's new. And the accepted answer—if anything about them can be said to be accepted—is that they started out large like the other three but curled up tightly long ago. Nothing's known about the curling process but it gets a moniker: The extra dimensions are said to be *Compactified*. Ugly.

Just because these dimensions are too tiny to be seen doesn't mean there's no

way to determine they exist. For example, Musser says, 'If the LHC produced subatomic black holes, they would be immediate proof of extra dimensions, because gravity in ordinary 3-D space is simply too weak to create holes of this size.' And, in fact, physicists are working on this stuff. The cynical view (okay, I overstate it in the hope that he will get it) is far from a unanimous opinion. Though no one has seen a string or ever hopes to, many study them. They slave away, mainly because of the math that seems to come with strings.

It's a roller-coaster ride. In the early '80s the first wave of string theory is all but dead aborning, awash it seems in ugly inconsistencies. Green and Schwarz toil through painstaking calculations and show to the astonishment of all that all the problems—anomalies as they are called—neatly cancel. Their success redraws the research map. Pariah becomes paragon. Greene says that the number of string theorists goes from two to thousands almost overnight. But there are snags; one is the math.

Physicists prefer math off-the-shelf. Pure mathematicians invent new tools for fun. No one expects these new tools to be useful. They may have no relation to the real world. It is as if a workforce forges wrenches, sets of wrenches, just because they feel so fine and fit their carry-case so well, with no regard to whether nuts and bolts will be invented. Not to laugh. Half of the human species is said (by the other half) to shop for wrenches on this basis. Physicists, then, working on some nutty problem, could often find the right tool ready if not always close to hand. Think Einstein and the tensor calculus. String-theory math turns out to be different. It isn't on the shelf. String theorists invent it when they need it. By all accounts they fall in love. String physicists become mathematicians. They become the best—maybe the only—experts in string math.

String theory is pure math with no link to experiment. For this reason Smolin, though he has years of string research under his belt, is leery of its dominance. He questions whether it's real physics. Georgi, no stranger to strange theories himself, goes further. He is said to call this kind of stuff 'recreational mathematical theology.'

Why does this matter? Why should my study buddy care? Well, it redraws our map again. Stringland on the edge of physics is Albania in Europe in the '60s. There's not a lot of commerce back and forth. Its people don't speak English. They don't even do the math that others do. They do string math. They draw weird diagrams. They make all the particles and forces, the mystery of motion, even gravity, with wiggly bits of string. They unite two kinds of particles—those that get together, those that don't—in so-called supersymmetry. Even Smolin says that 'supersymmetric string theories are deeply elegant objects.' Does all this mean anything? No one knows. Can Frank ignore it and move on? Not on my say-

so. A bookie watching money moving would say strings may be the odds-on favorite to be *the* theory.