# Strings and things

## Language is stretched to its limits in an effort to describe mathematics.

**Jon Turney**

"Common metaphors are the best because they are the only true ones," said Argentinian poet Jorge Luis Borges. If, along with physicist Steven Weinberg, you dream of a final theory, maybe superstrings will be the answer. But how are you going to explain them? Well, says Weinberg in *Dreams of a Final Theory* (Pantheon, 1994), "these strings can be visualized as tiny one-dimensional rips in the smooth fabric of space". But what does the fabric of space look like, and how does it get torn? Mixing metaphors like this (maybe the strings represent the fabric of space unravelling) betrays the strain new theory places on everyday language.

Science wants to be precise, unambiguous, logical and universal. Natural language is none of these things: hence scientists' addiction to mathematics. But if they cannot manage with words alone, neither can they do without them. Words lend coherence, build understandable narratives, explain what the mathematics is about.

In physics, especially, the struggle to fathom what underlies appearances is always twofold. First, there is a search for a formalism that offers some kind of fit with reality. Then there's a groping for a description in words which makes sense of the formalism.

And it is through words that the wider culture begins to make sense of what the scientists are trying to say. It may pick up on turns of phrase or key metaphors from professional discourse: big bang, black hole. But these are invariably enriched and elaborated in new ways as popular accounts of new theories proliferate.

Popular-science authors gradually build up a stock of explanations. While literary writers worth reading strive for freshness of expression, science writers are happy to reuse others' tried and tested analogies. Deploying a genuinely new one requires a great deal of thought. Is it really fit for the purpose? So run-of-the-mill science books tend to use what are now the conventional non-mathematical explanations of quantum mechanics, say, or of Einsteinian space–time.

Right now, superstrings offer a fascinating demonstration of how hard it is to convey what the mathematics might be telling us before the conventional explanation has had time to bed down. Physics has coined the term as a shorthand for a new mathematical entity. But how to go beyond the early, rather tentative, attempts, such as Weinberg's, to elucidate?

In a way, superstring theory says there is only one thing to describe. The whole point of the theory is that the Universe contains just one fundamental kind of entity, which can manifest itself as all the particles and forces of conventional theory. But we want a non-mathematical sense of what kind of thing it is. Where to start? From its name we know that superstring theory will involve string-like entities. But what kind of string? A ball of garden twine, perhaps? A puppet string? A bow string? No: a violin string, vibrating under tension and generating harmonies.

But no sooner are we dusting off our intuitions about violin strings than the image undergoes violent alteration. For these strings can never be bowed or plucked. They are almost inconceivably small, $10^{20}$ times smaller than an atomic nucleus. For Brian Greene — whose extended account of string theory in *The Elegant Universe* (Jonathan Cape, 2000) won last year's British science book prize — strings appear as "tiny, one-dimensional filaments somewhat like infinitely thin rubber bands". Nor are these strings stretched between fixed points like those in a musical instrument because, again like rubber bands, they are looped around.

Now forget the rubber. Each loop is not made of any ordinary material. They are "minute loops of energy", says John Horgan in *The End of Science* (Addison-Wesley, 1996). "A string is just a loop drawn in space", offers Lee Smolin, in *Three Roads to Quantum Gravity* (Weidenfeld & Nicolson, 2001). It is not made of material at all. It is what material is. As for elementary particles, there is no real content to the question, what are strings made of? They just are. Rather ask what they can do.

The main thing they can do is vibrate, oscillate or resonate — vibration is the most popular term, and harks back once more to violin strings. They generate tones by resonating at frequencies that allow a whole number of waves to occupy the length of the string. Then, as Horgan puts it, particles with different masses and force charges arise from vibrations of elementary strings "just as vibrations of violin strings give rise to different notes".

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Superstring: shorthand for a mathematical entity.

So far, the macro-metaphor is working well. The physicists' strings may be vanishingly small, looped, and under fantastically high tension. But they still seem string-like.

Then, however, comes another property that doesn't fit the word 'string' at all. For individual strings can merge or divide. A particle collision is now described as the merger of two strings to produce a third. This string travels a bit, and then releases the energy derived from the two initial strings by dissociating into two strings that travel onward. This is getting harder to picture, even when accompanied with diagrams that conform to Smolin's suggestion that "when a string moves in time it makes a tube rather than a line". But the notion of collision and merger remains completely unexpected from the macro-analogy which the term string most commonly invites.

At the moment, though, it is difficult to see where else a writer eschewing mathematics could turn for an intelligible way of approaching these strange objects. You can hardly begin with 11-dimensional membranes and supersymmetry, which is where the development of the theory eventually takes you. But as long as there are writers, such as Greene, who agree with Ernest Rutherford — that if you cannot explain some result in physics in simple, non-technical terms, then you do not fully understand its origin, meaning or implications — they will keep trying to stretch our intuitions about strings into new shapes. ■

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