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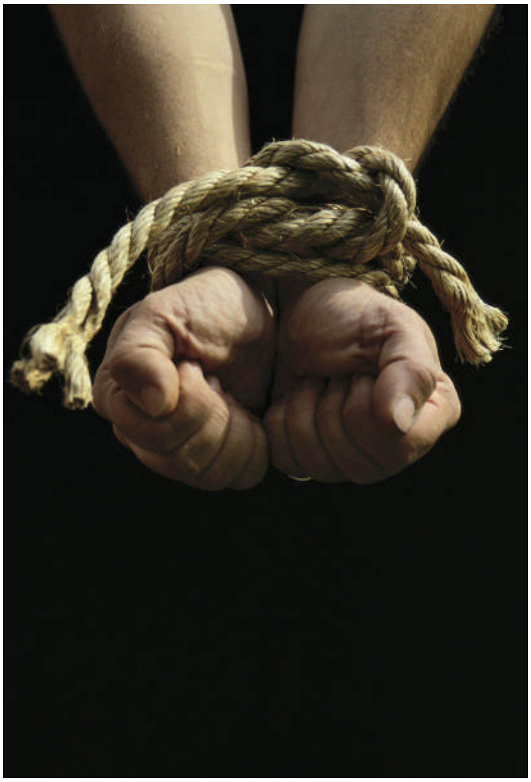
Tied up with string?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Much to the delight of the mainstream media, there's a battle royal going on in physics. Over recent months, a fair bit of mud has been slung in the theoretical physics community over the issue of string theory: has it failed to deliver as a 'theory of everything', and should we still be pursuing it?

The fracas was provoked by the publication of two books, whose full titles clearly signal the authors' stance — Peter Woit's *Not Even Wrong: The Failure of String Theory and the Continuing Challenge to Unify the Laws of Physics*, and *The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next* by Lee Smolin (the latter reviewed in this journal last month: *Nature Phys.* **2,** 649; 2006). Woit and Smolin make valid points. String theory is far from being the all-encompassing solution that might once have been promised. It has absorbed substantial manpower in the theory community, leaving little to expend on alternative approaches. There is even a perceived risk that the pursuit of string theory could undermine the very principle of science.

In face of the accusation of failing to live up to expectations, string theory is guilty as charged. But those 'expectations' deserve to be questioned. The quest for a theory of everything has great allure, and can sway the popular imagination just as much as that of a physicist. Then there is string theory's simple central, and oft-repeated, concept — that the spectrum of subatomic particles can be imagined as strings vibrating at different frequencies, like the notes played on a violin. No wonder then, that such a (seemingly) graspable yet tantalizing notion should have enjoyed wide attention.

The reality of string theory is vastly different. True, it could offer a framework for the unification of quantum mechanics and gravity. But the deeper physicists have delved into string theory, the more complicated its mathematics has become, and the more remote from physical reality. Some critics find this unacceptable, and have cited the popperian philosophy that what defines 'science' is falsifiability: string theory has yet to make a falsifiable prediction, and so should not be considered science.

To anyone drawn to intellectual endeavour, as physicists are, this could seem an unnecessary shackle, and, in the case of string theory, it is premature. String theory poses one of the greatest challenges in modern physics. It is a mere two decades since work began in earnest — surely no one expected the ultimate framework of physical understanding to be built in that time? — and we have barely scratched the surface. The mathematical exploration becomes ever more complex, and has thrown up disquieting features such as the famous 'landscape' of 10^{500} solutions, or possible universes. But at the same time there are ideas emerging that may have some relevance, for example, in the physics of black holes, as discussed by Leonard Susskind in this journal last month (*Nature Phys.* **2,** 665–677; 2006).

But is too much effort being directed into string theory? Woit and Smolin's claim that it is unduly dominating theoretical physics research deserves inspection. String theory is bound to attract young researchers, by its very nature and because there is so much work to do. But to take the stance of encouraging the free exploration of the possibilities of string theory means also encouraging the free exploration of other possibilities — loop quantum gravity, for example. In that spirit, this issue of *Nature Physics* includes a News & Views article by Abhay Ashtekar (p725), reporting on the latest developments in this alternative theory.

Arrogance in science is inexcusable and contrary to the spirit of progress. It is not time to call 'time' on string theory — but neither is there yet reason to dismiss alternatives.