THE VACUUM CATASTROPHE

The problem is that once we identify the cosmological constant with vacuum energy, nobody has any idea why it should be zero or even small.

Leonard Susskind (2006)

This gives an answer about 120 orders of magnitude higher than the upper limits on [the vacuum energy] set by cosmological observations. This is probably the worst theoretical prediction in the history of physics! Nobody knows how to make sense out of this result.

Michael Hobson et al. (2006)

I discover later that he seems to think about it—*if* a nothing thinking nothing's thinking—without effort.

I think about it now. But writing these five words, even thinking about writing them, as I *really* was, gives the lie to this. So I try to think of nothing without much success. It seems that nothing is more difficult to think about than nothing.

So difficult that for two thousand years post-Greek-era thinkers don't think of it. The whole idea of nothing's seen as paradoxical. It needs Newton to revive it. He ignores the paradoxes. He constructs his theory on the firm foundation of the void. And he thus jump-starts the question: What exactly is the void?

Barrow writes the book on it: *The Book of Nothing*. He explores all sorts of nothings. But his main concern's the sort that physics likes to call 'the vacuum', the void by another name. So, what is it? He mentions Maxwell's definition: 'The vacuum is that which is left in a vessel after we have removed everything which we can remove from it.' He says QM has much to say on empty vessels. Getting all the air out of the vessel's not the problem. It's *a* problem but that problem is mundane. The best vacuum in a science lab has many atoms in each liter. Even deepest space contains an atom or two in a cubic yard. But aside from practical impossibility, getting all the atoms out is not *the* problem. Getting out the energy's the problem. How do we know? Well, QM says that nothing is a something that is full of energy. QM is right so often this is hard to doubt. Even Seinfeld, once he gets it, says that nothing may be something.

Without QM the vacuum is just empty. QM sees it seething with activity that cannot be removed. Every point in space—and QM's space has an infinity of points—behaves as though it vibrates every which way it can go. QM says that each vibration has an energy that can't be cut below a minimum amount. So any

little vacuum has infinite energy. It's a difficulty I'll inflict on him some time. There is a way—a hokey way it's true, but one that's used routinely and is known to work—to get rid of this infinity. And once it's gone what's left? Well, what's left does not agree with what's observed.

The problem isn't that there is a disagreement. Physics deals with disagreements every day. Further work can often fix them. But not this one. The *Vacuum Catastrophe* is a disagreement that's so big it boggles the imagination. QM predicts an energy that is 10^{120} times larger than what physics measures. As Barrow notes, 'You can't get much more wrong than that.'

The value of the vacuum energy brings other problems in its wake. Like: Why *is* it so tiny? And: As it's so nearly zero why not exactly zero? The catastrophe's an open sore upon the body theoretic. The Problem is: Why is theory so wrong?

Thinking this, I idly wonder: What if nothing isn't nothing? What if Seinfeld's right? Which brings me to a tougher question: What is space?