

THE PROBLEM OF DARK ENERGY

Jack: I have lost both my parents.

Lady Bracknell: To lose one parent, Mr. Worthing, may be regarded as a misfortune; to lose both looks like carelessness.

Oscar Wilde (1865)

We now believe that the universe is dominated by a completely unpredicted dark energy.

Charles Bennett (2005)

The new concept of dark energy— ... needed to explain the discovery of the accelerating expansion of the universe—has changed our understanding of the nature of matter and energy.

John Moffat (2008)

We know even less about dark energy. It seems to be spread out perfectly evenly, with the same density everywhere and everywhen, as if it were an intrinsic property of space-time.

Frank Wilczek (2008)

He hasn't noticed I've said nothing of the problem of what matter is. He could ask so many questions, like: Where did it come from? What's it made of? Why's it packaged into particles? Why do they form atoms that form all we see? Aren't there enough questions to make this a Problem?

Well, matter's problems are not on my list. Physics has a theory of matter. It answers lots of questions. It describes in detail all the particles that make up matter and the forces holding them together and apart. Beginning in the '50s, this theory grows apace. By the '70s it's so establishment it has a boring name. He should remember this at least: the Standard Model. Aka the Standard Muddle.

For a while the matter problem was: The universe is mostly *not* made out of what we see. What we can see is not enough to explain why it behaves the way it does. The solution is to say that what we see is just a small part of what's there. The rest of it—about 95.5% of everything—is made of something else. Some of it behaves like matter. We can't see it so, with bold originality, it's called Dark Matter. It is said to be 'the greatest challenge facing modern cosmology.' The Standard Model and big particle accelerators are in hot pursuit.

How do the cosmologists know that it is matter? Well, they can see the

gravity of galaxies makes it hang together in their 'hoods. In turn *its* gravity is what sucks in ordinary matter to make galaxies. It's now reckoned to be 22.7% of the mass-energy of the universe. Lost, one might say, and still not really found. No one knows what it is made of. But I can see no way to tell him that this is a clue.

Yet by subtraction it does leave a clue! The total matter that behaves like mass amounts to only 27% of what the numbers tell them must be there. In other words they've lost another 73%. To call this carelessness would be Wildely witty but for cosmologists this is a problem. A *big* problem. It's as big as problems get.

How do they know this? Well, after the Big Bang the universe kept on expanding but its rate of expansion slowed down. This was what they'd expect. If a ball is thrown straight up, gravity will slow it to a stop and bring it down. The gravity of the whole universe should pull on the whole universe. GR says that, if there's enough mass, gravity should bring expansion to a stop and put it in reverse. But recent measurements show in the last few billion years expansion has stopped slowing down. Indeed, as he has seen, it's speeding up. Cosmologists produce an explanation like a rabbit from a hat. It's an adjustment to the number Einstein called his biggest blunder. Suddenly his biggest blunder may have been his brightest insight. For GR to match the acceleration (of which Einstein never knew) 73% of everything must be some form of energy astronomers can't detect. So this problem's fixed with yet another fudge-factor. It's called Dark Energy, a term for what they know they do not know: It's not mass, and they can't see it. It is as if this energy's spread evenly throughout the universe.

What would my detective think? He'd say: As if?—maybe it *is*. Now there's a revolutionary thought. This same thought is revolutionizing physical cosmology. Speculative candidates abound. My list shows fifty plus and counting. If one of them is real it could get listed in what once was called *The Guinness Book of Records*. It is the biggest item in the universe. It's more than half of all there is.

Even the idea that Dark Energy *is* energy is up for grabs. The reason it's called energy instead of matter is it doesn't clump with gravity like mass. In other words it behaves more like photons or, as Wilczek says, 'as if it were an intrinsic property of space-time.'

So what's the Problem? Well, although it's seven-tenths of all that's in the universe, we don't know what it is. As in no idea! Well, maybe as in too many of them but we have no notion which of them is right. Talk about carelessness. Could it even be that they all miss the mark? And that, I think—and think my Frank might think inside my silence—*that* is an idea.