

# THE PROBLEM OF THE COSMIC CONSTANT

I am a detective in search of a criminal—the cosmical constant. ... I think I have enough evidence to justify an arrest.

Arthur Eddington (1931)

The cosmological constant has hovered in the background of cosmological theory ever since Einstein first put it forward, causing worry to some and solace to others.

Roger Penrose (2004)

The cosmological constant was a vacuum energy (the energy of empty space) that kept gravity from pulling the universe in on itself.

Eric Linder (2005)

Today I'm back in 1917. Einstein's tuning up GR. In his head he wanders round the universe trying out assumptions at its edges, checking consequences, killing anything that will not fly. He still thinks of the universe as having no beginning. He still pictures it as in a static state. His equation's giving him a headache. It describes a universe that is unstable. Gravity may drag it down in a Big Crunch. So he figures that it needs adjusting. He adds an extra term, the famous fudge, a kind of universal antigravity. This is what he calls the Cosmological Constant, represented by the symbol lambda:  $\Lambda$ . He sizes it to cancel gravitational attraction of the universe's mass. Bye-bye Big Crunch. Hullo to a pile of problems.

Einstein himself sets off the further fuss a few years later, after Hubble shows the cosmos *isn't* static. It's expanding. He reverses his position, saying lambda is his 'biggest blunder'. It's not only that it's fudge. It's fudge that, it seems to him, is not necessary. Having fathered it he tries to kill it off.

Well, as it turns out, it's not  $\Lambda$  that's the blunder. The blunder is his change of mind. Or so it seems . . .

It's hard to concentrate on Einstein's problem. My fictional detective's on my mind. When he speaks his voice gives me an eerie feeling. When he's silent I am waiting, partly bracing for the feeling, partly wishing that his voice would come back soon. Does he know what Einstein did? I've come to see that vacillation as the center of the storm. It tears down shores, exposes rocks and fashions beachheads for the physics that's to come. It leaves cosmology adrift amid a plethora of perils. There are books about them. What they say is: No one knows what's going on.

The latest version of the  $\Lambda$  story says that it may be Dark Energy. Or vice versa—as if one label for the unexplained explains another. But its central problem's simple: Stillborn but of late reincarnated, it has ever been a number seeking an idea. It's a cosmic rebel looking for a cosmic cause. Such as:

Mass-energy density of the vacuum?

A number that's adjusted so the universe is flat?

A constant varying with time?

Dark energy?

It's an enigma. Discarded some eighty years ago, it now seems central to our understanding. It's in almost all of the equations of cosmology. It may be the universe's most important number. The latest data say that it is very small but real. That it tunes the contents of the cosmos to fantastical precision just to keep it balanced on its razor edge does not make sense to me.

So the clue from  $\Lambda$  is: It is, but then what *is* it?