

# THE DISAPPEARING UNIVERSE

Some people's universe consists of only a few streets.

Georges Simenon (1951)

Thus galaxies with distances greater than [about 14 billion light years] are receding from us with velocities greater than the speed of light.

Tamara Davis & Charles Lineweaver (2001)

One hundred billion planets in the Milky Way? Just thinking about it can drive you crazy.

Anderson Cooper (2012)

I wait until he's had some coffee. Then I tell him. Most—maybe almost all—of the universe has disappeared. He takes it very well. I don't tell him that the latest data suggest right now every *second* he is losing something like a million planets, not to mention stars.

My reading tells me there are physicists who don't agree. Even Feynman seems to have dismissed it. In sorting out the tangle in 2003, Davis and Lineweaver call it 'expanding confusion'. Behind their humor they are serious. They say, 'Superluminal recession is a fundamental part of the general relativistic description of the expanding universe.'

Some might see these as fighting words. I pass them to him after D&L convince me they are right. Why does it matter? Well, it matters for the quest. Few things are known or even claimed about the universe entire. He can't afford to be confused about the few.

It starts with Einstein and SR. Well, actually, it starts with something they don't say though many people seem to think they do. They *don't* say that nothing can go faster than the speed of light. Not exactly. And he's slowly coming round to understanding that *exact's* the thing that makes the physics world go round. In this case, exact makes a world of difference. More! A large part of the universe.

Over-simply: There are galaxies whose color spectrum says that they are leaving us at 99% of  $c$ , the speed of light. So they were leaving that fast when the light we now see left them many billion years ago. Now they must be leaving faster. Faster, Hubble's Law avers, than  $c$ .

Some see this as conflicting with SR. Others say it can be explained away using 'corrections'. Still others can't accept that space expands.

Luckily for me it's simpler than it seems. It goes like this: SR is all about

*Inertial Frames* and the observers that go with them. It works but only has a local meaning. SR does not work well with cosmology. When Einstein dreams it up he is twelve years away from thinking of the universe. He is thinking about rods and clocks and railway trains and beams of light. In *this* context he does say that ‘the velocity  $c$  plays the part of a limiting velocity, which can neither be reached nor exceeded by any real body.’

He doesn’t say that an Inertial Frame extends in an expanding universe. Why not? Well, first he has no notion it’s expanding. And second, if he had, he’d know that an Inertial Frame does *not* extend across a universe that is expanding. That is, SR works only in a piece of space so small that its expansion can be neglected.

GR brings a new twist to this. GR governs the expanding universe. It assumes the cosmos looks the same to all observers in all directions everywhere. Frank says he remembers this. Some kind of principle. Well, he needs to see that it’s a substitute for instantaneous observers who report from outposts of the universe. There are none, so the substitute’s a necessary evil. It gives Einstein a way to solve GR’s equations on a universal scale. Of course this don’t jibe with the foundations of SR. Tao Kiang says,

Once the shadows of [SR] are cast away, the ... broad features of our universe emerge easily enough. The difficulty has not been the mathematics, but the psychology.

There is a lesson for him here. He thinks a fact’s a fact. Asked to interpret it, he’d be like Luther: It interprets itself. But that was theology. In physics the interpretation of a fact depends upon the theory that is used to think about it. For example, Eddington says: ‘Astronomical measurements are, without exception, measurements of phenomena occurring in a terrestrial observatory or station; it is only by theory that they are translated into knowledge of a universe outside.’ As was his wont Churchill is pithier. He says, or is said to say, ‘These, Gentlemen, are the opinions upon which I base my facts.’

The upshot is, the fact that distant galaxies are fleeing faster than the speed of light is not a problem for SR. It falls within the purview of GR. And GR says not only it is fine; it is expected.

Now he is through the meat, he can turn to potatoes. A detective might assume that all the evidence must be inside a sphere—the light horizon—that contains what we can see. But it’s not so simple. One reason is that what we see is what *was* there when starlight from the light horizon set out on its way. The expansion of the universe continued since that time. Far stars are now much further from us. Another reason is that over time a photon that was *then* outside the light horizon may have moved inside. But this is mere detail—a few

extra billion billion billions of cubic light years that we might in theory get to see some day. The bottom line, I have to tell him, is that there *is* a boundary. Space outside it moves away from us at more than twice light-speed. We can't see anything outside it. It's lost to us. If, as many physicists believe, the expansion won't slow down it's gone forever.

Of course he's not concerned about some photons showing up here twenty billion years from now. He's offended that the universe is disappearing. Much of it is leaving faster than a beam of light. What bugs him most is this: Almost the entire universe has always been leaving faster than light-speed! His crime scene (as it were) isn't just disturbed, it's mostly disappeared. Before the days of Interpol the crime equivalent is Poirot finding that the culprit made it to the Folkestone ferry.

It's gone forever. There's no trace and never will be. It's as though the body vanished at the moment of the murder and all he has to go on is a hair. He says he had evidence go missing once before he had a chance to see it. But this sets an all-time record; he just shakes his head.

I think: All-time? It's not even a bad pun.