DÉNOUEMENT

"The principal difficulty in your case," remarked Holmes, "lay in the fact of there being too much evidence."

Arthur Conan Doyle (1882)

The passengers came crowding into the restaurant car and took their seats round the tables. They all bore more or less the same expression, one of expectancy mingled with apprehension.

Agatha Christie (1934)

For the clarity we are aiming at is indeed *complete* clarity. But this simply means that the philosophical problems should *completely* disappear.

Ludwig Wittgenstein (1946)

If they want to grab for the gold ring, you have to let them do it, and not say anything.

J.D. Salinger (1951)

There … are things that are facts because they have to be facts, because nothing makes any sense otherwise.

Raymond Chandler (1958)

Curiosity is like an itch; it demands to be scratched. And for a physicist, nothing itches like a paradox, an incompatibility among the various things that one thinks one knows.

Leonard Susskind (2008)

"Take a look."

I'm not sure if I was dreaming but it is an instant waking nightmare.

In his reeling brain—my brain—the picture if it is a picture is brilliant but too new. It's pointillist, all dark dabs and bright splogdes, shifting light and shade. His doubt is pungent in my air. Has he done it? His sanity hangs in the balance. He's giving me a window into *his* anxiety attack. He has a need to step way back to see where the mindwinds have brought him. I see this now and beg him: Turn it off!

It stops and I'm exhausted. Eyes open now, I see the sun is not yet in the sky.

Slowly in my torpor I can see how I might help him. He's like Maigret who, in his mind, as he's solving it, *commits* the crime. His need is for confession. Lying limp upon the covers I consider a convention of the *fin de siècle* detective story. It's the dénouement, a modern version of a classic literary form. The word—it's French for the undoing of a knot—to a detective means unraveling the intricacies

of a plot. As a device for literary after-action satisfaction the dénouement reaches back two thousand years. Not sure if it will help, I open up my laptop and make notes.

The detective-story version first takes form with Holmes though Dupin knew its uses. The detective convenes with his sidekick in the drawing room where he reviews the clues, explains the crime, exposes culprits and ensures the reader can appreciate the cunning of the plot. It reaches apogee some decades later in an elegant debriefing by Poirot before a cast of characters—all of them guilty of the crime—in a train's restaurant car.

It's a fashion not all follow. Chandler's Marlowe is less than enchanted with it, but then he is disenchanted with the world. So Chandler makes him do it, slips it in. You ought to have given a dinner party, Chandler has a lady say to him. She means a dénouement. So he holds one just for her. In truth he's a softie. Chandler says, 'The dénouement would justify everything.'

From Simenon a dénouement is rare. And then Columbo gives the thing an on-screen fling few fans could feel went well. Today's *aficionado* may think it well buried; today's readers want less reason and more action in the end. But in its day and even now the dénouement serves this objective: The detective can convince the cast (and reader) the true culprit was exposed. But with no crime and with no culprit, with the edge off the suspense, how can we—or how can *I*—set up a dénouement? Well, he does have a motley but distinguished cast of characters. Of course I keep a list. It's not just experts either; even singers did their bit. And we should invite Page and Brin, who found me almost everything I needed. His cast must number hundreds. Not a problem as he can't assemble them in space or even time. He'll have to settle for a list and a report as if they might be listening. A monologue no doubt, but that's a tendency the dénouement has always had. And surely no detective ever juggled such a set of clues with such a need to reify their resolution.

So he's fumbling through my list of Problems. It seems that in some fashion he has seen them all along. From time to time one flashes briefly into stark relief. Beneath his seeming calm I sense the turmoil as he's forcing the Beginning into shape. He needs method; he needs order. So he needs to check it out. Check each clue to see how it fits into his whodunit. And yes, it could be a dénouement, an accounting to his Cast of Characters, whose thoughts and words he's drawing on. Foolishly, as there could hardly be a less-demanding audience, it makes me nervous. I can't be sure he'll put in an appearance. But he does.

"Compactification, not."

My thoughts in a nutshell. It's surely not happenstance how well the Beginning fits with string theory's ideas of extra dimensions. But then it differs too. He

has no need to shrink six space dimensions to make them invisible. They are tiny because that's the way they always were. For me the hardest concept was that that is all the space there was in his initial Manifold—six curled-up dimensions that collectively have volume. It seems simple now. And elegant, supremely elegant. Can he take a bow? I have a feeling that he's preening in some pseudo-spotlight of the mind.

"Every Fleck is just a replica of that first Manifold."

I get it. If his Cast were really here they'd get it too. And I understand that his Beginning meets the challenge of no background. Absolutely none. There is only the Beginning. There's no space, no time. Rather the Beginning *builds* up time and space. Just as Smolin said it should be done, he's done it 'without making any reference to anything that exists, or anything that we might imagine happened, outside of the system we are describing.'

And he's done it with a simple Rule, about as simple as a Rule can be, the Move. I write it for him:

One → Two

The first Move answers a deep question: Is space or time more fundamental? Yourgrau writes that, 'For Kant, space and time are the two essential "forms of human sensibility," with time … being the more basic.' His Beginning sides with Kant. His time comes first and space is built in time. A very short time, it is true. Three Moves to become 3-D. Barely enough time to really *be* time. But this time is missing from the models I've been browsing. It's *this* time that the Big Bang can't reach back across. Starting with no background, his Beginning builds the background time and space. Lemaître's Big Bang begins *after* his Beginning has begun.

"So how . . . ," he asks but not as if he wants to know—he's speaking as if reading from a script. "How can we show that this Beginning's true?"

It seems he wants me to respond. This ball is in *my* court? Well, I think, why not? I know this stuff, although it leads to physics. Physics has been built up on assumptions. Far too many of them, many say. Frank is building on a few assumptions too. I'd say the first step is: Do they offer a coherent synthesis? Of the competition I could say, quoting Rovelli, 'We do not have a new synthesis.'

"Most of all," he interrupts, "it solves the Problems."

Yes, well, I was about to get to that. It solves some of them anyway. I pull up my list to check them off. First, no background, so no Background Problem. Check. And the Problem of the Initial Condition, which for some may be the biggest of them all, is no problem—it is the solution! Though he'll have to show it makes some Problems go away. For now, the main thing is it sets out the IC. It is amazing. It provides a simple answer to the ancient question: How did this begin?

Another check.

Next it blows away the Problem of Kaluza; physics should have faith in Klein. The Beginning says each extra space dimension is, if not Compactified, at least compact. It sees no clash between its fixity and relativity because it's separate from space. The size of these dimensions can't be influenced by gravity. From gravity's perspective they don't *have* a size. So maybe K and K seemed hot because they were on the right track? The reason they were ditched back then now makes no sense. A check.

And now I see the Problem of the Boundary is simply not a problem. Einstein deduced that space has no edge, yet it is finite. The Beginning shows in fine detail how this could come to be. More esoteric is the boundary of time: Did time begin? The Beginning shows how time begins with Move 1 and must then Move on. So time and space begin because the Manifold can tunnel. It's a check.

The Problem of Under-Determination disappears: One simply cannot ask why would the universe be here rather than there. It is neither here nor there. As at its Beginning, there's no there for it to be. Check five.

He no longer has a Problem of Two Theories. He has no theory, but he needs one. His Beginning lays a good foundation for just one. Call that a check. Maybe it could even be the much-sought quantum gravity. He hints that it will be but he won't say how he knows. I say nothing; he must know I'm from Missouri on that one. But if it is, then the Beginning should explain QM. It should make *sense* of it. And that would take out the Measurement Problem. But 'should' and 'would' don't tally up to 'solved.' No check for that. Not yet. Measurement is still a problem on my list.

He didn't find the Missing Bang; he made its problem disappear. There was no bang. It seems to me a bang is something that a self-respecting Big Bang needs. It goes with the idea it all started with a Singularity. His Beginning says that it did not. So there is no need for a bang, or at least not that kind of bang. A Fizz will do just fine. Or call the Fizz a bang and say he found it. Either way it seems to me that is a check.

What about Inflation? His Fizz looks a little like Inflation but Inflation starts with space and then inflates it. His Beginning tells another tale; Fizz is what starts space. He says that, though it starts with almost nothing, Fizzioning a few times, fewer than a thousand, it becomes far larger than a galaxy. I guess this could be called Fizzflation. But it differs deeply from Inflations on my list. The differences look good: The Beginning needs no help from Rube Goldberg to make the universe inflate. Fizzflation's built right in. It's just a hankering for twoness. So it keeps on replicating until it runs out of gas. This solves the Problem of Inflation in a very simple way. Go check.

As Fizzflation unfolds it solves the Problem of Filling Space. Guth says the puzzle is how the Big Bang fireball came to fill space from the beginning. The Beginning gives a simple answer: It fills space because it *is* space. Check. And so goes the question Whether Space is Something. It is as real as other forms of matter. Maybe more so since without it other forms would not exist. More so again because it's more than half the total matter in the universe. Descartes is wrong and Newton's right: Space exists regardless of the objects in it. Check. So too goes the Problem of Dark Energy. What is it? It is space! More precisely, it's the little bit of energy required to make each Fleck. It is *very* small. It carries false ID until he blows its cover. It's not fudge; it is a basic number nobody has had in focus.

Flecks unravel the ridiculous discrepancy of the Vacuum Catastrophe. The QM calculation assumes space must be continuous; it's not. It calculates the energy of all the points in space; they don't exist. It assumes that space is nothing; but it isn't. It assumes these properties of vacuum; there is no vacuum in this universe, it is a meaningless idea. Ask a silly question and you get a silly answer. Check.

Fixating still on space, I recall Smolin's smoothness problem. He says that if space is made of pieces it's unlikely they would have the smooth and regular arrangement we observe. 'Incredibly improbable' is what he says. The Beginning makes the reason easy. And it's not improbable, it's unavoidable because Flecks are identical, each a facsimile of the original. They are the same throughout the universe. Their Fleck-size lumpiness can never be detected. It's as smooth as anything can get. Another check. Of course I wonder how they stack, whatever that means. In my mind's eye I see beeswax but I'm sure that this is wrong.

However space may stack, its pieces ensure continuity is not a problem. There's no continuity at all. Kiss the frog, the Curse is lifted. Rather, it's a curse that never was. Could it be an object lesson? Physics shouldn't blindly follow math. And check.

Which leads my thoughts to Mathematics and its Problem: Why would physics follow math at all? He says the answer is: The universe is based on mathematics from its roots, like a computer's based on binary. Up close it's obvious; it's just the way it works. One might almost say it *is* math. Score another check for that.

Did he leave? Or could the audience be dropping off? Hopefully not. My score sheet tallies fifteen checks. I could go on about each one of them but there are lots more items on my list. There is the reappearance of the re-re-reappearing aether. It's no longer dressed up as a Problem. It is splendid in its latest costume as it takes a bow not on but *as* the stage. The Beginning shows the reason why the aether keeps on going: It *is* space. It's been around time out of mind. And Einstein's right: This *is* the aether of Lorentz. And it's a check.

The Horizon Problem lost some traction when Inflation came along. Inflation didn't so much solve the problem as maneuver it into another room. Fizzflation should abolish the Horizon Problem. So it seems to me that that's a check. And I've seen how random divvying of mass between Flecks manufactures lumpiness. The lumps then spread out almost evenly since fatter Flecks are better replicators. I am on a roll so he takes me aback when he says:

"What . . . ?"

He always has a question!

"What's the distribution of the Fizzion products?"

Luckily I get what he is getting at. He's showing off. He's using fancy language for what we worked out before. As a Fleck Fizzions, it divides its matter load between two daughter Flecks. We said that the division must be random. Now he's asking *how* it's random. As in, is it likely to be close to 50/50 or, say, 60/40? Maybe even 90/10? Well, the answer must be: I don't know.

Does it matter? Well, the answer will affect the balance between uniformity and lumpiness of matter in the universe. He says lumps arise from random splitting of the matter between Flecks. It's a Goldilocks-type balance. It has to be just right or else the universe would be all wrong by now. So in a sense he's right to raise the question as *he* doesn't know the answer either. But there is another way to look at it. The answer could be some weird distribution like the fission products of uranium. When a uranium nucleus is loaded up with one too many neutrons it breaks up, but it usually doesn't split exactly—even nearly—into halves. For example, 60/40 happens more than 50/50. It's all about the oddities of jamming neutrons in a nucleus. These days, physicists compute this kind of stuff for fun. What fun, I wonder, will they get from Flecks? I see it this way: Physicists can figure what the Fizzion products *must* be doing to produce precisely what they see in the Big Flash. Will they need a new parameter? This too I don't know. But I reckon this provides a reason for the Lumps. Another check.

Even though it's fundamental I have left the Problem of the Three Dimensions until now. It's so easy! Vintage Holly. The Beginning solves it so directly. The answer's in the Rules: Each Fleck has a certain volume. Volume is an attribute of three dimensions. Or rather, 3-D is a property that physicists attribute to a volume. So, when Flecks rev up their rabbit act, the space they make has three dimensions and it gets a check.

It's true this means the problem's solved by an assumption. There's nothing wrong with that. Any model must have some assumptions. A useful model yields more benefit in explanations than it costs in assumptions. So far, his ratio of benefit to cost is shaping up okay. The best assumptions have, like this one, no parameters.

What does the Beginning say of gravity and why it doesn't merge with other

forces and why it's weak? Gravity, says Einstein, is the curvature of Spacetime. So it should be born as space and time are born. It propagates at light-speed. So in five hundred Tocks most of the space is out of sight and gravity's gone almost nowhere. Why do I feel there's an important insight here? I can't grasp it. This is definitely not a check.

"What *is* the shape of space?"

What's he on about? He wanted *me* to pull this stuff together. Mostly I get nervous when he's silent. Now it bugs me when he interrupts.

The Problem of the Cosmic Constant may be the most problematic on my list. It comes with a flock of problems. Is it zero? His Beginning answers: No, it's not. Is it negative? It's not. Is it constant? Yes it is. Then what *is* it? Up close it's the energy tied up in making Flecks. Not fudge, it's fundamental. Cleaning up the constant mess gets him another check.

From space to time, and Barrow's popular refrain: 'The existence of time is a mystery. There is no use for it.' The mystery lifts like morning mist once one sees what time is. At first I thought he meant the Moves make time. But now it's clear. They don't make time; they *are* time. True time. Time that's more than measurement of motion. No use for it? Well, true, no mundane clocky kind of use; it only runs the place! And thus there *is* no problem whether time is real. The problem is the physicists who fail to fathom physics. Time's Troubles are not time's, they're his and mine and theirs. It gets a check.

Next up is Time's Arrow. Time runs; it's the Cosmic Clock that runs it. Tock, Tock, Tock . . . the Tocks run on in one direction. Not coincidentally it's *our* direction. Or rather, should I say we run in *its* direction? Better yet, the UC's running *us*. Some chicken!—Churchill said to France's generals who, defeated, claimed that England would in three weeks have her neck wrung like a chicken—Some neck! Just so he may say to those who say time's only an illusion: Some illusion!

Knowing the Beginning, I can see what it would take for time to now go back a single Tock. It would need the next Move to reverse the one that went before for the whole universe, for every Fleck of it. In principle this could occur. It has the smallest probability one can imagine. So small there's no risk that this will *ever* happen in the lifetime of the universe. But, if it did, next Tock the UC would roll on, the odds would reassert the Arrow and we'd never notice. In a few Moves—two Flecks, four Flecks, eight Flecks—the Beginning has the Arrow pointing down the slipperiest slope one can imagine. That gets another check.

And so goes the Problem of Perfection. Penrose, Greene and others almost had the answer: The universe begins in a low-entropy condition. But they don't see why. The reason is the entropy of one Fleck, when it is the only Fleck, is zero.

There is *no* disorder in the Beginning. True, the reason is he picks an IC that has perfect order. But it's not some arbitrary number that he picks to get a fit; it's the simplest starting point and it is solving lots of problems. Check.

The Problem of the Second Law was tangled with Time's Troubles, and its Arrow, and the Problem of Perfection. Knowing what time is, it is much easier to disentangle them and see the Second Law for what it is. And what it is emerges from the Rules as what so many felt it should be though they couldn't find a way to make it: It's a fundamental law, the first one that emerges. It's a check.

Now back to space wherein there *is* a Special Frame but now it's *not* a problem. As some physicists suggest, it is the frame of the expanding universe or of the cosmic background radiation. More or less. But more precisely—as exactly as it gets—it is the frame of space. Up close it is a froth that jitters in a random fashion. Lacking labels, it provides no precise reference. Thank Lorentz and mark a check.

Then there's the Problem of the Speed of Light. Some say this is what kicks off the revolution. Einstein disagrees but there's no doubt it is a vexing problem. Kennedy observes there still is no deep explanation. Now there is one. It's so deep it's simple. The UC will not punt anything through two Windows in just one Move. I cannot reason why. It is a Rule. But like I say, this is okay. It gets a check.

The Reality of Non-Locality looms into view. With his Beginning I can dimly see its shape before me. Seeing space itself entangle at the quantum level makes the concept of non-local easy to accept. Another check. The surprise is non-locality's Entanglement itself: the Spooky Action Problem. Once again, what *is* Entanglement? I still don't know. If he knows he's not saying. Perhaps he's working on it now. I bet it's all about relations through those Windows. But that's just a guess so no cigar; no check.

He does have a solution for the Matrioshka Problem. Well, to half the Matrioshka Problem. Will there ever be an end to cutting up the atom?

"Wait!" His tone is sharp.

I wait a moment with no grasp of what he wants or why I'm waiting . . . and my mind runs on. How am I sure there is an end? Well, each time the atom-cutting's taken down another level it makes fragments of a smaller size. The Beginning shows there *is* a smallest it can go: Nothing can be smaller than a Fleck. Of course, current physics is far short of that. Even though I don't know *what* is smallest, this is good enough for me to score it as a check.

Because space comes in bits there never is a Singularity so this is a non-Problem. So too for the infinities that hover over physics calculations. Indeed—my brain reels yet again—neither zeroes nor infinities can happen in this universe! The implications bid to overload my mind. Move on, I tell myself, move

on. And check, I think; two checks.

Next I shall assert Reality *is* Real. Once one has a real Beginning it's straightforward to conclude what follows must be real too. No doubt perception is the only way to touch it. But that's *our* problem.

Then, best of all is his response to Zeno. Finding that all Flecks (the 'many') are identical with the initial universe (the 'one') is a delicious answer to the Problem of the One and Many. It is the epitome of elegance. Zeno would have been ecstatic.

"What do we have?"

He's not one for rhetoric. So is he trolling for summation? I know it's self-indulgent but I feel that some of this is mine.

He starts with Lemaître and the concept of a quantum. Shades of some string theories, it's a 6-D Calabi-Yau Manifold. Up close he sees more. It Moves. The Moves turn into time. Kachunk, kachunk, kachunk with no banana kiss for Bonnie, it runs on whole-number math. There's space that's made of quantum volumes one can count on fingers but one never finds. It grows like foam. There's time to count too, and a Cosmic Clock that oversees its Arrow. 3-D space is foliated in the time dimension and there's built-in non-locality for Bell. There's reconciliation for the puzzles of the Big Flash picture. Space and time may well combine as Einstein wanted. But to me their relativity's like neither Einstein's nor Minkowski's; rather Larmor's and Lorentz's. There is Lorentz's aether. So there is a Special Frame; but no one can get hold of it. Simultaneity is absolute but coexists with relativity. And in a way Einstein is vindicated: QM's incomplete. What's it missing? Quantized space—entangled quantized space. And so Dark Energy's another name for space. Its Flecks still Fizzion so space is expanding. But there is no nothing and there are no zeroes or infinities. None of them—not ever—anywhere.

I'm sure that in the rush I have missed something. Though it seems a lot, it's somehow not enough. My head says: Hold it! Why the nerves? He explains more, *way* more, with so few parameters, than any other concept claims to do. I could find other ways to pitch the Problems but there are forty or more any way one wants to slice and dice them. My score-sheet says he's solved thirty-two of them thus far!

So what's to say? In hindsight it's a made-from-not-quite-nothing notion of the way the universe began. A quantum duplicating, so it has that primal virtue: It is simple. A few of his assumptions may be nonconformist but what's wrong with that?

"So," his voice says as if from a hollow distance, "there are people and there's Pirandello's—"

He cuts off this cryptic thought abruptly like there's more that should be said.

By convention the dénouement marks the ending in detective fiction. Is it over? Is the job done? It feels weird to think this, knowing she knows nothing. A dénouement in her absence feels unfinished. There are fifteen clues to which he has made no connection. And there is expansion that accelerates, outlandish, though it didn't make my list. Can he explain it? I thought that Dark Energy would soon explain it once Dark Energy itself could be explained. Seems I was wrong. Still frowning over that one, I lock up and head for home. Turning onto Lankershim I know it's not the last time. It's not over, that's for sure.

Meanwhile, I remember, walking to the Metro, I don't know what *she* is doing. I don't even know for sure—though I feel pretty sure—that she's up to no good.