THE MYSTERY OF THE MISSING BANG

"The horror of that moment," the King went on, "I shall never forget!"

"You will, though," the Queen said, "if you don't make a memorandum of it."

Lewis Carroll (1871)

"Is there any point to which you would wish to draw my attention?"

"To the curious incident of the dog in the night-time."

"The dog did nothing in the night-time."

"That was the curious incident," remarked Sherlock Holmes.

Arthur Conan Doyle (1892)

As a scientist I simply do not believe that the present order of things started off with a bang.

Arthur Eddington (1928)

If there were an instant, at a "big bang," when our universe started expanding, it is not in the cosmology as now accepted, because no one has thought of a way to adduce objective physical evidence that such an event really happened.

Jim Peebles (1993)

Although it is called the "Big Bang theory," it is not really the theory of a bang at all. It is only the theory of the *aftermath* of a bang. … It gives not even a clue about what banged, what caused it to bang, or what happened before it banged.

Alan Guth (1997)

It is Monday. A day for fresh beginnings, I think as I wait, hoping he'll arrive. That the coffee is already stale says that I hope too much and as moods go it doesn't last too long.

Let the list begin, I think, checking off the topmost item: Missing Bang. Already it is clear this list's a dumb idea. It's open-ended so it could go on and on; I need it shut. But it's her idea and she pays the bills; so the list gets shut without a word, long live the list. But first I delist a dozen decently deserving problems that I've come across. She'll never know they're gone. If forty-seven clues are not enough, what could another dozen do?

First thing about the Bang is that it isn't first. It's like the origins of China.

Erlitou was first as I recall. I check it out. Erlitou is today's name for what the archeologists can find of China's origins, its Xia capital. But how did Erlitou begin? First is a word before which nothing. What was before Erlitou? What was truly first? Nobody knows. If China cannot answer this four-thousand-year-old puzzle how can anyone resolve a thirteen-billion-year-old problem? And yet . . .

One thing's almost certain: Just before the Big Bang, the whole universe was very small. How do we know? This is the missing calculation of Lemaître, made with GR. Today this is the second thing I say. First I launch into my ready spiel on clue lists and canaries. I hit him with it as he takes his seat; before his mind can settle into lazy rhythms; before the glaze sets in his eyes. Fat lot of good it does! He sits; he settles in; he glazes.

The idea is to get him thinking forwards. The excerpts that he gets to see, the bits of books, of articles and even physics papers, they all are looking back in time. Soon it is a state of mind. It's easy to slip into: It's the way it looks from where we are. It's easy but it's not the way to get to where we have to go. He needs to think of it, I tell him, from the *other* side, the side that no one ever saw. He gripes that it's like asking him to think about the dark side of the Moon. Happy to get some reaction, I don't mention that it doesn't *have* a dark side—except slave labor camps at Peenemünde. Instead I say he needs to think about the Bang as something *after*, not before. It comes *after* the beginning when what has just begun begins becoming bigger. It's an era full of clues but with a plethora of problems. He looks confused. I need to ease him in.

To make matters worse this clue is covered in confusion in the Henry Miller sense: 'Confusion is a word we have invented for an order which is not yet understood.' The order that's not understood here is the essence of his problem. Here's the order as I see it, stripped down to its basics. First the Beginning; it is first by definition and so far that's all we know. Next it gets bigger. Well, it must have since the universe is big. Finally, it still is getting bigger. He looks at me like I am simple-minded. That's okay; he might be right.

Another version of the order is the one the public now believes in. First came the Big Bang. I can see it in his eyes—he *still* believes it. Hold it right there! Amid much uncertainty, one thing we know for certain-sure is that this isn't so.

A third version of the order begins with a beginning of some kind but no one wants to check it out. Next, there is an instant while the universe gets bigger, but still tiny. Third step, a weird new process kicks in. It's called *Inflation*. In almost no time it expands the tiny universe to some vast size. But for a minor detail, I would have to think this is the favorite for physicists. The detail is that by this term 'Inflation' different physicists mean widely different things. This detail gets to be a Problem of its own. So for now let's draw the veil; call it step three in this

version of the order. Step four is Inflation stops abruptly. Step five is the universe expands.

This version has sub-versions. By this I don't mean a pun. In sub-A step five is the Big Bang. In sub-B step three—one of the Inflations—seems to fill the bill.

But take a closer look, I tell him. Version three is many versions—more than he will want to count. What they have in common is they're cosmic band-aids that disguise the fact that no one knows the way the universe could get to be the way it is. In other words this version three's a mess. Park it now, I tell him, and we'll look it over later.

The second version's easy, as I show him. It's nothing more than a mistake. The universe did *not* begin with a Big Bang. I'm hoping that repeating it will fix this in his mind because he'll hear—he has *already* heard—the opposite so many times.

So what he's left with is the basics. A beginning that starts small, gets big and even now still grows. Katie Freese says best that the beginning wasn't banging: 'No, no; no bang.'

Of course my sweeping summary can't clear the decks completely. Almost all current cosmological models now invoke Inflation very soon once things begin. The reason is that Inflation's said to solve some problems about aspects of the early universe that otherwise must be incredibly fine-tuned. But Inflation doesn't actually solve the problems. It repackages them. As Lockwood puts it:

> It turns out that the inflationary model itself needs to be exquisitely fine-tuned, if it is to deliver the required goods! So far from solving this fine-tuning problem, therefore, inflationary theory, to a considerable extent, merely shifts it, like the proverbial ruck in a carpet, from one place to another.

As well, cosmologists must make models stand on their heads, so to speak, in order to induce them to inflate. This doesn't meet ideals of beauty. To be blunt, it's ugly—a blot upon the landscape that we need to navigate.

It's time, I think, to offer him something a little lighter. Something like a lark or Snark from Lewis Carroll, whose interest in deep physical and philosophic issues is concealed by whimsy in his works. For example, though it will not be discovered until long after he is dead, looking-glass milk—made of mirror-image molecules—is, as he has Alice speculate to Kitty, not good to drink.

Much later, a prestigious physics journal blocks the publication of a paper on things falling in black holes. It is an event—deliberate delay, that is—so rare it calls for editorial excuse. The paper happens to kick off with lines from Carroll's comic epic poem *The Hunting of the Snark: An Agony in Eight Fits*. Whimsy is not absent from the halls of the establishment but tends to discombobulate the powers that be.

So, while writing of deep thoughts disguised as nonsense from the King and Queen of Hearts, is Carroll thinking of a universe that seems to have no record of its birth? This isn't as far-fetched as it may seem. Carroll is familiar with *Eureka*, a cosmogony by Poe, packaged as a long prose poem that achieves wide notoriety. Though Poe hedges that it is 'a Poem only,' it's a metaphysic on the origin and nature of the universe. He claims outright: 'What I here propound is true.' He anticipates it might 'be now trodden down so that it die.' If so, he says that it will rise again.

It is ethereal; one could dismiss it as a dream of Poe, not to be confused with the doom-metal band. Poe has heavy dreams. He often writes of them. *Eureka* is a dream that says the universe expands and will collapse. This is the first whisper of the Big Bang though he doesn't call it that. He dreams no bang but writes of infinite divisibility and of diffusion from Unity. Such ideas intrigue Carroll. Though it may seem strange in retrospect, it is in tune with his times that he like Poe should push the envelope of physics with frivolity.

A century past Poe and his prose poem, Hoyle promotes a universe that definitely does not bang. Indeed it does nothing of note. His model is a 'steady state' where atoms pop into existence at the rate that's needed to ensure that nothing needs to change. Within twenty years new observations show this model to be wrong. But Hoyle invents 'big bang' as a description of expanding universes and his label sticks.

Today, 'Big Bang model' is specific. It means results obtained from the equations of GR. In 1948, Gamow uses them to show how atoms (or their nuclei) form in the first few minutes of the universe when it is hot and dense. After fifteen minutes these hot dense conditions don't exist and never will. Not anywhere except at Fermilab and now the LHC. The Big Bang model says how much of each kind of atom there should be in the universe. Observations say that what the model says is right.

The model depicts matter in the early universe as dense and hot and rapidly expanding. Today hardly anyone would disagree with that. Of course our experience is that dense, hot, rapidly expanding matter comes from an explosion. Its shock wave is what makes it bang, expanding from the hot spot into cooler and less dense surroundings. It's our mental imagery from experience that props up both the inapt name, Big Bang, and the false image of it as beginning with a bang. The Big Bang makes no shock-wave sound. Though the very early universe is fiercely dense and hot it has nowhere less hot and dense to go. It just gets bigger; its expansion cools it down. So Freese has got the picture, and there was no bang. But before it didn't bang there was a Something.

The space and mass and energy of the very early universe were confined to a

volume that, as physics tracks it back in time to the first tiny fractions of a second with GR, seems to have been vanishingly small. Of course Einstein devised his theory for a different circumstance. In consequence, GR has two well-known and serious deficiencies that undercut its value for the task of probing how the universe began. It is based on space and time concepts that have no application and, it's thought, no meaning when the universe began. And it is inconsistent with QM, which is so successful in describing what's observed at the small scales that GR gives the universe as it is beginning. So it is not surprising that GR, when it's projected back to the beginning, becomes fickle and then runs into a wall.

Being based upon GR, the Big Bang model suffers from these same deficiencies. Thus it can't and doesn't tell us anything about the most exciting moments—the moments that lead up to the Big Bang. Jammer says: 'It is, of course, precisely the very "beginning of the expansion," the question of how and why the universe started, that attracted the attention of theologians and philosophers.' It seems odd, or maybe it's in character, that physicists avert their eyes from such a prize.

Holmes observes a happening that should but doesn't happen—a dog that doesn't bark. It tells him that the dog knows the intruder. What does the Bang that doesn't happen say? Frank should be pondering this question. But of course he's not.

But suddenly he is. Or rather someone is. Somewhere in my head, not in my ear, I seem to hear a sound:

"Is it a bang that's missing?"

Then it's gone.