

BEAUTY AND A BEAST

Beauty is truth, truth beauty,—that is all
Ye know on earth, and all ye need to know.

John Keats (1819)

The theory of relativity of Einstein, quite apart from its validity,
cannot but be regarded as a magnificent work of art.

Ernest Rutherford (1932)

This result is too beautiful to be false; it is more important to have
beauty in one's equations than to have them fit experiment.

Paul Dirac (1963)

There is in all things a pattern that is part of our universe. It has
symmetry, elegance, and grace—those qualities you find always in
that which the true artist captures.

Frank Herbert (1965)

It is this kind of explanation, one that elegantly steps outside the box
... to explain observations with quantitative precision and artful
symmetry, that physicists describe as almost being too beautiful to
be wrong.

Brian Greene (2004)

There's a lot of parallel between art and science.

Anton Zeilinger (2008)

Physicists have attitudes to help them to discover physics. It's as if they're in a magic forest. Its trees are made of math. It's crossed by intersecting paths. Physicists shape physics by the paths they choose to walk and forest regions that they choose to haunt. And, unnoticed by the rest of us, physics shapes our world.

He needs to notice. He needs to know about their attitudes. So I will need to show him and it won't be easy. He's not exactly the esthetic type. It will be hard for him to grasp how physicists make choices based on beauty. Beauty is *their* word for it. Leading physicists see physics as their art. Some say so. Take Greene's choice of words. They're from his book *The Fabric of the Cosmos*: 'Elegant'; 'precision'; 'artful'; 'symmetry'; and 'beautiful'. He might be appreciating Ieoh Pei's architecture at the Louvre. Or a Jian tea bowl. But in fact he's speaking of GR.

This beauty is not simply in the eye of the beholder. It is not merely personal and thus debatable like pyramids or pots. Physics' beauty is not loved by some and equally disdained by others. Though few would go as far as Dirac it is more

like a consensus. This shared sense of beauty works; it leads to many an advance in physics.

This is the cerebral aspect of the physics beauty contest. Another aspect should be kept in mind: Like other lovers physicists can fall in love with beauty. Like other lovers they may be irrational in pursuit of their loves. And yet another aspect is the tides of physics fashion. Dirac is even said to say, 'A physical theory must possess mathematical beauty.' And explains, if this is explanation, that mathematical beauty 'is a quality which cannot be defined, any more than beauty in art can be defined, but which people who study mathematics usually have no difficulty in appreciating.'

Not all means what it seems to say. Rutherford says GR is a work of art. He does not mean to praise it. His comment is sarcastic. He sees his status slipping. He has cause to fear that, if this 'art' becomes the current fashion, he may have to take up tensor algebra to keep up with the physics Joneses. It's messy. But one way or another beauty fashions physics.

Then again, as in a romance novel, those seduced by beauty may soon be betrayed. The following confession comes from Smolin:

SU(5) is the most elegant way imaginable of unifying quarks with leptons, and it leads to a codification of the properties of the standard model in simple terms. Even after twenty-five years I still find it stunning that SU(5) doesn't work.

Forget the SU(5), I'll tell him. Ignore what Smolin says about the quarks and leptons. We will do them later. He should focus on how elegance has power. Why? Well, because it stuns the likes of Smolin! Frank will need it working *for* him. Elegance is special in the physics of the universe. Mark my words, I'll tell him, its beginning will be elegant. Then, reading this, I see my feeling may have carried me away.

There are physicists whose sense of elegance—or is it propriety?—leads them to say beginnings—*Initial Conditions* as they call them—are off limits. They are, they say, the proper subject of religion. This idea, I plan to tell him, is no beauty. It's a beast.

What's wrong with it? Well, it seems unscientific, like a misplaced article of faith. I find Hawking's on my side—though of course it is the other way around. He says,

In a way this attitude is similar to that of those who in earlier centuries discouraged scientific investigation by saying that all natural phenomena were the work of God and should not be inquired into. I think that the initial conditions of the Universe are as suitable a subject for scientific study and theory as are the local physical laws.

Initial Conditions are what she and he and I are after. It's odd: There are

models that avoid them, but they always seem to have them anyway. They are just not in plain view. The classic is the Big Bang theory itself. Not the sitcom but the real thing. In the sitcom the Big Bang is the beginning. The real thing says the Big Bang comes right *after* the beginning. It implies that the Initial Condition of the universe has all its matter packed into a point. Its density and temperature are infinite. Nobody thinks this actually happened. The truth is this: The Big Bang knows from nothing how the universe began.

The Big Bang does a dither between beauty and the beast. In this it's not alone. There are the *Big Bounce* models of the universe. They too try to duck Initial Conditions. They say the Big Bang comes after a universe collapses. Etcetera, ad infinitum, into the past. It's like Sabin's preacher who said the world rests on a turtle; asked what holds the turtle up, he said, another turtle of course. These models try to dodge that awkward question: Where did it begin? They avoid it by an infinite succession of preponements. It's ugly but to me it looks like an Initial Condition. So it doesn't really dodge the question.

Then there are models that start with empty space and laws of physics. So *these* are their Initial Conditions. Again the point is to avoid that awkward question. And again they don't. It's the same with models with no space and not even time—a condition that is called a void—in their beginning. Their universe is just a random fluctuation. But the void is a condition. Where did the void come from? And the rules that say that it can fluctuate?

Each of these models has a lot of mathematics. This too needs an explanation: Whence came the math?

What I learn is that attempts to dodge the awkward question turn out ugly. If beauty is their motivation, they don't work out very well. I feel sure the real beginning will have beauty. But to shoot for beauty? I hope my detective sees this as a beastly trap.