BOOKS & ARTS

From here to eternity

How do physicists cope with the concept of infinity in an expanding Universe?

The Infinite Cosmos: Questions from the Frontiers of Cosmology

by Joseph Silk

Oxford University Press: 2006. 256 pp.
£18.99, \$29.95

Peter Coles

Scientists usually have an uncomfortable time coping with the concept of infinity. Over the past century, physicists have had a particularly difficult relationship with the notion of boundlessness. In most cases this has been symptomatic of deficiencies in the theoretical foundations of the subject. Think of the 'ultraviolet catastrophe' of classical statistical mechanics, in which the electromagnetic radiation produced by a black body at a finite temperature is calculated to be infinitely intense at infinitely short wavelengths; this signalled the failure of classical statistical mechanics and ushered in the era of quantum mechanics about a hundred years ago. Quantum field theories have other forms of pathological behaviour, with mathematical components of the theory tending to run out of control to infinity unless they are healed using the technique of renormalization. The general theory of relativity predicts that singularities in which physical properties become infinite occur in the centre of black holes and in the Big Bang that kicked our Universe into existence. But even these are regarded as indications that we are missing a piece of the puzzle, rather than implying that somehow infinity is a part of nature itself.

The exception to this rule is the field of cosmology. Somehow it seems natural at least to consider the possibility that our cosmos might be infinite in extent or duration. If the Universe is defined as everything that exists, why should it necessarily be finite? Why should there be some underlying principle that restricts it to a size our human brains can cope with?

But even if cosmologists are prepared to ponder the reality of endlessness, and to describe it mathematically, they still have problems finding words to express these thoughts. Physics is fundamentally prosaic, but physicists have to resort to poetry when faced with the measureless grandeur of the heavens.

In *The Infinite Cosmos*, Joe Silk takes us on a whistle-stop tour of modern cosmology, focusing on what we have learned about the size and age of the Universe, how it might have begun, and how it may or may not end. This is a good

Very distant objects, such as the comet Encke, make it seem reasonable to think of an infinite Universe.

time to write this book, because these most basic questions may have been answered by a combination of measurements from satellites gathering the static buzz of microwaves left over from the Big Bang, from telescopes finding and monitoring the behaviour of immensely distant supernova explosions, and from painstaking surveys of galaxy positions yielding quantitative information about the fallout from the primordial fireball. Unless we are missing something of fundamental importance, these observations indicate that our expanding Universe is about 14 billion years old, contains copious quantities of dark matter in some unidentified form, and is expanding at an accelerating rate.

According to the standard model of cosmology that emerges, the Universe has a finite past and (perhaps) an infinite future. But is our observable Universe (our 'Hubble bubble') typical of all there is? Perhaps there is much more to the cosmos than will ever meet our eyes. Our local patch of space-time may have its origin in just one of an infinite and timeless collection of Big Bangs, so the inferences we draw from observations of our immediate neighbourhood may never tell us anything much about the whole thing, even if we correctly interpret all the data available to us.

What is exciting about this book is not that it is anchored by the ramifications of infinity, but that it packs so much into a decidedly finite space. Silk covers everything you might hope to find in a book by one of the world's

leading cosmologists, and much more besides. Black holes, galaxy formation, dark matter, time travel, string theory and the cosmic microwave background all get a mention.

The style is accessible and informative. The book also benefits from having a flexible structure, free from the restrictions of the traditional historical narrative. Instead there are 20 short chapters arranged in a way that brings out the universality of the underlying physical concepts without having too much of a textbook feel. The explanations are nicely illustrated and do not involve any mathematics, so the book is suitable for the non-specialist.

If I have any criticisms of this book at all, they are only slight ones. The conflation of the 'expanding Universe' concept with the Big Bang theory, as opposed to its old 'steady state' rival, is both surprising and confusing. The steady-state model also describes an expanding Universe, but one in which there is continuous creation of matter to maintain a constant density against the diluting effect of the expansion. In the Big Bang, there is only one creation event, so the density of the expanding Universe changes with time. I also found the chapter about God in cosmology to be rather trite, but then my heart always sinks when I find myself lured into theological territory in which I am ill-equipped to survive.

Peter Coles is in the School of Physics and Astronomy, University of Nottingham, University Park, Nottingham NG7 2RD, UK.