Jan 2002
Reviews

'Our Cosmic Habitat'

reviewed by Patrick R. Andrews

Our Cosmic Habitat

Martin Rees

> *Everything astronomers can see (some 10^{78} atoms), stretching out to distances of 10 billion light years, emerged from a single, infinitesimal speck.*

Research on the Universe leads to many such startling conclusions and this book attempts to describe some of the surprising phenomena which occupy astronomers and cosmologists.

Our Universe, Martin Rees' laboratory, allows its natural laws to be cleverly interpreted at arm's length, by observing the 'extreme' physics which we could never replicate in a laboratory. The biggest questions have an almost philosophical tenor. What happened before the Big Bang? What causes gravity? Is the Universe infinite? Why are some atoms common (e.g. carbon) and others rare (gold)?

Even the idea of atoms was speculative once, but now we are told by cosmologists that our Universe is full of dark particles, latent energy and hidden multidimensionality. Much of this is truly unearthly. For example, when we drop a pen on a tabletop, it makes a noise. The same event on a neutron star, Rees explains, would release as much energy as a kiloton of high explosives. Similarly, empty space is actually anything but simple, consisting of strings, a kind of stretched cosmic elastic, storing a form of 'vacuum energy'.

It's even something of a mystery that there are laws of Nature that seem to apply everywhere we look. This is true for the dozens of distant planets which have been recently detected. The central theme of *Our Cosmic Habitat* is that our Universe (or at least our part of our Universe) seems unaccountably predisposed to life. How long will it be before anything that we would recognise as life, let alone intelligent life, is discovered on one of these planets? Rees first describes some of the events which have formed the astronomical 'species' which inhabit our Universe.

In 1965, about 13 billion years after the event, evidence of the hot, dense beginning of the Universe was detected − the Big Bang. The afterglow of creation still exists as background microwave radiation which gives rise to about 1% of the interference on a television set.

Rees makes the surprising claim that we are 99% sure of what occurred one millisecond after the Big Bang, but events before that remain unexplained. There followed the formation of stars and so−called dark matter, the dominant stuff of our Universe. The properties of this common material are still largely unknown to Science.

There are huge numbers of black holes everywhere which distort space and time locally. If what Rees calls a 'prudent' astronaut could maintain orbit around a fast−spinning black hole, his clock would appear (to us) to run slower, and he could watch the future of the Universe emerge over a very short interval.

As if all this weren't challenging enough, Rees tells us that there may have been multiple big bangs, resulting in the possibility that our Universe is part of a 'Multiverse' : an ensemble of Universes. This is one means of coming to terms with the sheer unlikelihood of our existence: most other postulated Universes would be lifeless.

Determining the validity of this proposal requires that the very different scales of the cosmic and the quantum realms be linked theoretically − a breakthrough that eluded Einstein for the last 30 years of his life.

Such a Grand Unified Theory (GUT) may be Superstring or M−theory, in which each point in space is a tightly wrapped knot and the particles we feel familiar with are actually vibrating loops of cosmic 'string'. The section of Martin Rees' book that discusses this is outlined without much mathematics. Readers requiring deeper theoretical insights may regret the shortage of suitable references. While a GUT is an attractive prize for any scientist, Rees advises his students to choose their research topics by multiplying the importance of any problem by the probability that they will solve it, and maximise the product.

What happened during the Big Bang could easily have led to a Universe with no life, no chemistry, not even atoms. Rees describes the requirements for the 'interesting' Universe we inhabit. Among these are weak gravity, an asymmetry between matter and antimatter, Carbon atoms, few cosmic rays and a balance between atomic forces. His point is that some of these requirements are subtle and would have had to have been very finely tuned. If this can be shown to be highly unlikely, then the many−Universes theory may yet dominate.

The excitement of Martin Rees' subject matter is well conveyed throughout. Several of the key findings about our universe are relatively recent and there is good reason to believe that, with advances in remote sensing technology, particle accelerators and computer simulation, we will soon uncover the answers to some of the pressing questions about the origins, and fate, of our improbable Cosmic Habitat.

Book details:

Our Cosmic Habitat
Martin Rees
Hardcover − 216 pages (10 January, 2002)
Weidenfeld

ISBN: 0297829017

About the reviewer

Guest reviewer **Patrick R. Andrews** is a Chartered Mathematician who has worked in engineering, management consultancy and neurophysiology.

He is the Managing Director of break−step productions.

Plus is part of the family of activities in the Millennium Mathematics Project, which also includes the NRICH and MOTIVATE sites.