

Cambridge University Press

978-0-521-79480-0 - Our Cosmic Origins: From the Big Bang to the Emergence of Life and Intelligence

Armand Delsemme

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Looking at the stars at night, we have all wondered where we have come from and why we are here. *Our Cosmic Origins* traces the remarkable story of the emergence of life and intelligence right through the complex evolutionary history of the Universe. Starting from the searingly hot soup of exotic particles in the Big Bang, we are taken on a breathtaking chronological tour, right up to the present day, and the recent findings of bacteria on Martian meteorites and planetary systems around other nearby stars.

Armand Delsemme weaves a rich tapestry of science, bringing together cosmology, astronomy, geology, biochemistry and biology in this wide-ranging book. In following the complex chronological story, we discover how the first elements formed in the early Universe, how stars and planets were born, how the first bacteria evolved towards a plethora of plants and animals, and how the coupling of the eye and brain led to the development of self-awareness and, ultimately, intelligence.

Throughout the book, Professor Delsemme shows how this ascent always seems to follow the easiest route. He suggests that, however complex and tortuous this evolution has been, it is unlikely to be unique. The author concludes with the tantalizing suggestion that the existence of alien life and intelligence is likely, and examines our chances of contacting it. This provocative book provides the general reader with an accessible and wide-ranging account of how life evolved on Earth and how likely it is to exist elsewhere in the Universe.

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From the Big Bang
to the emergence of
life and intelligence

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To Delphine

‘to be in love is not to look at each other,
but to look together in the same direction.’

Saint-Exupéry, *Terre des Hommes*, 1939

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FOREWORD

From the Big Bang to the human brain, it has taken the universe some fifteen billion years of cosmic, physical, chemical, and biological evolution to reach a stage where, on our own little speck of dust, it is beginning to look into itself and ponder its origin, nature, and significance.

How did it all happen? What is known, suspected, or assumed of each of the steps whereby time and matter first arose out of nothing, elementary particles condensed out of the original plasma, and, out of them, in turn, the atoms of the various elements came to be? Of the steps whereby galaxies were born, spawning billions of stars, many probably surrounded by planetary systems? Of the steps whereby, on one particular planet, which happened to combine a special set of physical conditions, life emerged and evolved, finally leading to conscious, thinking beings?

How much of this extraordinary history is due to deterministic forces, how much to chance? Did it happen only once? Or does the cosmos contain many planets that have given rise to life, perhaps even to intelligent life? What is it about the cosmological constants that endows our universe with its unique properties? Is only one such universe possible? Or are there many universes, of which ours happens to bear life and mind, and thus to be knowable, because of a special combination of cosmological constants? What triggered the Big Bang? A creative act of God? Or just randomly fluctuating nothingness?

These questions have become popular themes for contemporary thinkers, from cosmologists to theologians. Rarely have they been addressed by a single author. Armand Delsemme has risen to the challenge. As an expert on comets, some of which may have brought to our young planet the water and organic chemicals out of which life arose four billion years ago, he is well placed to tell us about what preceded and what followed that decisive event. He has done his homework well,

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using the same even-handed and well-informed style to describe all the phases of cosmic history. He explains the facts as they are known and the hypotheses as they have been propounded, in a sober and objective manner that hardly allows whatever personal biases he may harbor to get through.

On the whole, this is an eminently readable and informative account, consistently written in a language that tries to eschew technical difficulties, while remaining solidly anchored to the realities of scientific concepts. Readers could not wish for a better introduction to the history of the universe, nor a better appetizer for more solid fare on any one period of this astonishing history.

Christian de Duve
Nobel laureate

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Humankind has just awoken to the cosmic origins of the human adventure and I have striven to reconstruct this story as science now sees it. In order to keep it accessible to the enquiring reader, I have not used mathematics but followed the thread of chronology.

Recently, it has become possible to tell this story without leaving too many gaps. At the beginning of this century, the different natural sciences, originating in the same discipline of natural philosophy, had become specialized; they were cut off from one another. Now, physics, cosmology, astronomy, chemistry, geology, paleontology, biochemistry and biology are coming together again.

So my thread follows the Universe from the moment of its beginning; I tell how its expansion led to the formation of the galaxies and stars. The pursuit of the thread shows us how life could finally emerge, through the most probable cosmic processes, while using the most abundant elements made in the crucible of the stars' cores.

I have tried to keep the story simple; I cannot say that I have always succeeded. Occasionally, I had to cut short explanations that might have become tedious. The pages that seem too difficult can be skipped; in order to help the reader to follow the thread to the final goal, I have tried to give short summaries throughout the book.

The purpose of the first chapter is to familiarize the reader with the extremely large and the extremely small. The physics of elementary particles is needed to understand the Big Bang; the reader who wishes to avoid the technicalities can skip a couple of pages and go to Chapter 2, where the chronology of the early events is laid out.

In a popular book like this one, it is not possible to debate all doubts and explore alternative views. Nothing is ever certain in science, since its progress is steadily reached by trial and error. This book is only a balance sheet for the end of the twentieth century; when in doubt, I

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have sometimes accepted the interpretation that looked most reasonable to me. Some scientists who read this may discover that I have glossed over details of their particular discipline. That is the price of my effort that aims at a comprehensive view of the human condition in a still very mysterious Universe, at a time when it has become impossible to be an expert in all areas of science. I hope therefore that, in my striving for an integrated account, imperfections will be forgiven. My major goal has been to show that it has become possible to assemble enough of the story of our cosmic origins that we can follow it without any major gaps in our understanding.

An interdisciplinary approach like this often meets another obstacle: jargons from different scientific disciplines are difficult to assimilate. I have cut their use as much as possible, and when a paraphrase would be too lengthy I have explained terms in a Glossary at the end of the book.

Questions still unresolved and related philosophical issues have been left for the final chapter of the book. Finally, in order to express the extremely large or small numbers encountered in astronomy or in physics, I have used exponential notation, assuming that the reader knows that $10^3 = 1000$, $10^6 = 1$ million, $10^9 = 1$ billion and more generally, that 10^n indicates that 1 is followed by n zeros. Similarly, for the negative exponent, e.g. 10^{-3} , 1 is *divided* by 10^3 .

Delphine Delsemme, my wife, has been of great help, not only in reviewing the final text, but also in discussing ideas and clarifying difficult passages. Without her assistance and her constant support, I do not know whether I would have had the patience to finish the task.

Revisions incorporated into the English edition have been considerably helped by comments and constructive criticisms of many friends; André Brack, Christian de Duve, Gérard de Vaucouleurs, Audouin Dollfus, Léo Houziaux, Henri Mertens, André Lausberg, Jean-Claude Pecker, Hubert Reeves, Evry Schatzman and John Schlag, who read the first edition in French. Phil Mange did even more: in his enthusiasm to push me to publish the book in English, he even produced a preliminary translation from the French. Unfortunately, I was not able to use it.

The English edition was updated in 1997, to include in particular the recent discoveries of giant planets around nearby stars, and the possible identification of fossil bacteria inside meteorites coming from Mars. Both discoveries must be carefully interpreted before any con-

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clusions are drawn. However, they are in line with the thread of the book, and both were foreseen in the 1994 French edition. Even if new discoveries are in line with my expectations, they are important enough to be subjected to careful scrutiny.

Finally, I want to thank the whole team at Cambridge University Press, particularly Adam Black and Sandi Irvine, for their invaluable help.

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