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Intelligent Life in the Universe

Principles and Requirements
Behind Its Emergence

Second Edition

With 156 Figures and 24 Tables
Including 37 Color Figures

 Springer

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Preface to the Second Edition

In the first edition of this book it was argued that the uniqueness of human intelligence is the consequence of a very large brain and man's outstanding specializations in communication and tool use. No other life form on Earth is able to communicate in such a detailed manner by both vision and language and is able to handle so many diverse objects and tools. Yet apes, monkeys, dogs, elephants, seals, dolphins and even corvids all show highly intelligent behavior, which in recent years has become increasingly understood and appreciated. Palaeoanthropologists argue that exceptional human intelligence arose from keen vision acquired in the rainforest, an upright walk together with a complete freeing of the hands for tool use adopted after our ancestors entered the open savannahs, and from our intimate social interactions in group living. Since our technological intelligence is based on the development of hands it is intimately connected with life on land. This is seen, for instance, by the modification of arms into fins or flippers when vertebrate land animals evolved back to life in the oceans. The development of our type of intelligence therefore is a consequence of the conquest of the land by animals and plants, which by a mutualistic relationship makes animal life on land possible.

For this reason a whole new Chap. 3 "The Earth" on geology has been added, in which the phenomena of plate tectonics and continent formation are discussed. This has resulted in a renumbering of the remaining chapters. In addition, sections on the conquest of the land by plants and animals are greatly expanded to show the enormous difficulties that life encountered before it finally mastered the land 470 million years ago, over 3.5 billion years after it first appeared in the Earth's oceans. The planetological history of the early Earth is discussed in greater detail to give more insight into how Earth-like planets form and how the chemical composition favorable for life arose. Finally, the rapid advances over the last four years in all fields, from the search for planets to the search for the Last Universal Common Ancestor of all life, has been brought up to date.

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VI Preface to the Second Edition

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Heidelberg, January 2006

Peter Ulmschneider

Preface to the First Edition

One of the most exciting questions for mankind is whether we are alone in the universe. That intelligent nonhuman beings exist was commonly believed in prehistoric times as well as in antiquity. Creatures such as giants, centaurs, angels, and fairies were essential and universally accepted parts of Greek, Jewish, and Germanic mythologies. Although no fossil traces of such beings have ever been found, most of us firmly believe that nonhuman intelligent beings do indeed exist. This conviction is derived from the staggering size of the universe with roughly 100 billion times 100 billion (10^{22}) stars, which makes it inconceivable that we could be the only intelligent society in the universe. Indeed, modern science has shown that since the Copernican revolution all attempts to define our position as an exceptional one in the universe have failed dismally.

But if other intelligent civilizations do exist, how can we find them? Why is there no terrestrial or astronomical trace of them, despite great technological advances in recent centuries and especially in modern times? Why have we never found artifacts discarded by visiting aliens, which would convincingly prove the existence of nonhuman intelligent beings? Is the number of planets on which life is able to evolve too small, or is the formation of life – and particularly intelligent life – an extremely rare event? Could these intelligent societies face insurmountable difficulties in traveling over large galactic distances, or do they no longer exist?

Recent advances in search techniques for planets, in the theory of planet formation, and particularly in biochemistry, molecular, and cell biology are about to give answers to these questions: how life appeared and how many planets can be expected in the universe on which life, and eventually intelligent life, developed. New in this book is the argument that, by thinking carefully about the future development of mankind, one can gain insight into the nature of extraterrestrial civilizations.

The book consists of three parts: planets, life, and intelligence. In *Part I*, Chaps. 1–3 discuss stars, galaxies, and the origin of chemical elements, our recent planet formation theories, the search methods for extrasolar planets and what has been found so far. Chapter 4, “Planets suitable for life”, describes what constitutes an Earth-like planet and how many of them can be expected in the universe. In *Part II*, Chaps. 5 and 6 outline life and its origin on Earth, how it evolved, and how intelligent life developed. Chap-

VIII Preface to the First Edition

ter 7 discusses the search for extraterrestrial life and intelligent societies. In *Part III*, Chap. 8, “The future of mankind”, gives possible insights into what can be expected about the nature of extraterrestrials. Finally, Chap. 9, on extraterrestrial intelligent life, constructs a likely picture of these beings and attempts to answer the question of why they don’t interact with us.

Heidelberg, June 2002

Peter Ulmschneider

Table of Contents

Part I Planets

1	Stars, Galaxies, and the Origin of Chemical Elements	3
1.1	The History of the Universe	3
1.2	Molecular Clouds	6
1.3	The Pre-Main Sequence Evolution of Stars	8
1.4	The Post-Main Sequence Evolution of Stars	11
1.5	Element Composition and Dating	13
1.5.1	Population I and Population II Stars	13
1.5.2	Dating with Radiometric Clocks	15
2	Planet Formation	19
2.1	Accretion Disks and Planetesimal Formation	19
2.2	Terrestrial Planets	21
2.3	Jovian Planets and Kuiper Belt Objects	24
2.4	The Migration of Jovian Planets	25
2.5	The T-Tauri Stage	26
2.6	Asteroids	28
2.7	Comets	31
2.8	Meteorites	33
2.9	Early History of the Solar System	34
3	The Earth	39
3.1	Planetological History of the Early Earth	39
3.2	Formation of the Moon	40
3.3	Ocean-Vaporizing Impacts	42
3.4	The End of the Heavy Bombardment	44
3.5	The Environment on the Early Earth	45
3.6	Seismology and the Earth's Interior Structure	49
3.7	Volcanism and the Composition of Rocks	52
3.8	The Earth's Core and Mantle	56
3.9	The Earth's Magnetic Field and Sea-Floor Spreading	58
3.10	Convection, Hot Spots and Plate Tectonics	60
3.11	Mountain Building and the Evolution of Continents	66
3.12	Plate Tectonics on Mars and Venus?	71

4	The Search for Extrasolar Planets	73
4.1	The Recently Discovered Planets	73
4.2	Direct Search Methods for Planets	76
4.3	Indirect Search Methods	76
4.4	Circumstellar Disks	79
4.5	New Search Strategies	80
5	Planets Suitable for Life	87
5.1	Habitable Zones	87
5.1.1	The Solar Habitable Zone	88
5.1.2	Habitable Zones Around Other Stars	90
5.2	Planetary Mass and the Evaporation of the Atmosphere	91
5.3	The Lifetimes of the Stars	94
5.4	Tidal Effects on Planets	95
5.5	The Increase in Solar Luminosity and the Continuously Habitable Zone	97
5.6	Instabilities of the Planetary Atmosphere	98
5.6.1	The Greenhouse Effect	99
5.6.2	The Carbonate Silicate Cycle	99
5.6.3	The Runaway Greenhouse Effect	100
5.6.4	Irreversible Glaciation	101
5.7	Axis Variations of the Planets	103
5.8	Biogenic Effects on Planetary Atmospheres	105
5.9	Proterozoic Glaciations and Snowball Earth	107
5.10	The Requirements for Continuous Habitability	109
5.11	The Drake Formula	109
5.12	The Number of Habitable Planets	111

Part II Life

6	Life and its Origin on Earth	117
6.1	What is Life?	117
6.2	The Special Role of Organic Chemistry	118
6.3	The Elements of Biochemistry	118
6.3.1	Proteins, Carbohydrates, Lipids, and Nucleic Acids	119
6.3.2	The Genetic Code	124
6.3.3	ATP, the Energy Currency of the Biochemical World	124
6.3.4	Synthesizing RNA, DNA, and Proteins	125
6.4	Cells and Organelles	127
6.5	Sequencing and the Classification of Organisms	129
6.5.1	Classification by Sequencing	129
6.5.2	The Molecular Clock	129
6.5.3	The Evolutionary Tree of Bacteria	130
6.5.4	The Timetable of the Evolution of Life	131

6.5.5	Sequencing and the Complete Genome	133
6.6	Geological Traces of Life	135
6.7	The Stage for the Appearance of Life	136
6.7.1	The Origin of the Genetic Code	137
6.7.2	The Urey–Miller Experiments	138
6.7.3	The Search for the Last Universal Common Ancestor	139
6.7.4	Summary: The Boundary Conditions	142
6.8	Abiotic Chemical Evolution and the Theories of How Life Formed	143
7	Evolution	149
7.1	Darwin’s Theory	149
7.2	The Development of Eukaryotes and Endosymbiosis	151
7.3	Oxygen as an Environmental Catastrophe	153
7.4	The Cell Nucleus and Mitosis	154
7.5	Sexuality and Meiosis	155
7.6	Genetic Evolution	157
7.7	Multicellularity, the Formation of Organs, and Programmed Cell Death	159
7.8	Problems of Life on Land	162
7.8.1	Conquest of the Land by Plants	163
7.8.2	New Organs of Land Plants	166
7.8.3	Conquest of the Land by Animals	171
7.9	The Great K/T Boundary Event	173
7.10	The Tertiary and the Evolution of Mammals	177
7.11	Primate Evolution	178
7.12	DNA Hybridization	187
7.13	Brain Evolution and Tool Use	188
7.14	Stone Tool Culture	190
7.15	Diet and Social Life	192
7.16	The Logic of the Human Body Plan	193
7.17	Evolution, Chance, and Information	196
7.18	Cultural Evolution	199
8	The Search for Extraterrestrial Life	201
8.1	Life in the Solar System	201
8.2	Europa’s Ocean	202
8.3	Life on Mars	204
8.3.1	Early Searches	204
8.3.2	The Viking Experiments	206
8.3.3	Mars Meteorites	208
8.4	The Early Atmosphere of Mars	210
8.5	Future Mars Missions	212
8.6	Life Outside the Solar System	214
8.7	UFOs	216

Part III Intelligence

9	The Future of Mankind	221
9.1	Predicting Mankind's Future	221
9.2	Settlement of the Solar System	222
9.2.1	The Space Station	223
9.2.2	Moon and Mars Projects	225
9.2.3	Space Travel	228
9.2.4	Near-Earth Asteroids and the Mining of the Solar System	230
9.2.5	Space Habitats	231
9.2.6	Cultural Impact of Space Colonization	234
9.3	Interstellar Travel	236
9.4	Mastering the Biological World	237
9.4.1	Creating Life in the Laboratory	238
9.4.2	The Decoding of the Human Genome	239
9.4.3	Understanding Intelligence	239
9.5	Androids and Miniaturization	240
9.6	Connected Societies	241
9.7	Fear of the Future	242
9.8	The Dangers for Mankind	242
9.8.1	Bacterial or Viral Infection	243
9.8.2	Episodes of Extreme Volcanism	244
9.8.3	Irreversible Glaciation and the Runaway Greenhouse Effect	245
9.8.4	Comet or Asteroid Impact	246
9.8.5	Supernova Explosions and Gamma Ray Bursts	248
9.8.6	Irreversible Environmental Damage	250
9.8.7	Uncontrollable Inventions	250
9.8.8	War, Terrorism, and Irrationality	251
9.9	Survival Strategies	252
10	Extraterrestrial Intelligent Life	255
10.1	Does Extraterrestrial Intelligent Life Exist?	255
10.2	What is the Hypothetical Nature of the Extraterrestrials?	257
10.3	The Drake Formula, the Number of Extraterrestrial Societies	260
10.4	The Lifetime of an Extraterrestrial Civilization	262
10.5	Distances to the Extraterrestrial Societies	263
10.6	SETI, the Search for Extraterrestrial Intelligent Life	265
10.6.1	Radio and Optical Searches for Extraterrestrial Civilizations	266
10.6.2	Possible Contact in the not too Distant Future	270
10.7	The Fermi Paradox: Where are the Extraterrestrials?	272

10.7.1 They do not Exist 273

10.7.2 Technically, a Visit is not Possible 274

10.7.3 They are Nearby, but have not been Detected 275

10.7.4 They are not Interested in Us 275

10.8 The Zoo Hypothesis 276

References 279

Author Index 297

Subject Index 303