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978-1-107-02617-9 - Life Beyond Earth: The Search for Habitable Worlds in the Universe

Athena Coustenis and Thérèse Encrenaz

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## Life Beyond Earth

### The Search for Habitable Worlds in the Universe

With current missions to Mars and the Earth-like moon Titan, and many more missions planned, humankind stands on the verge of exciting progress and possible major discoveries in our quest for life in space.

What is life and where can it exist? What searches are being made to identify conditions for life on other worlds? If extraterrestrial inhabited worlds are found, how can we explore them? Could humans survive beyond the Earth?

In this book, two leading astrophysicists provide an engaging account of where we stand in our quest for habitable environments, in the Solar System and beyond. Starting from basic concepts, the narrative builds scientifically, including more in-depth material as boxed additions to the main text. The authors recount fascinating recent discoveries, from space missions and observations using ground-based telescopes, of possible life-related artefacts in Martian meteorites, of extrasolar planets, and of subsurface oceans on Europa, Titan and Enceladus. They also provide a forward look to exciting future missions, including the return to Venus, Mars and the Moon; further explorations of Pluto and Jupiter's icy moons; and placing giant planet-seeking telescopes in orbit beyond Jupiter, showing how we approach the question of finding out whether the life that teems on our own planet is unique.

This is an exciting, informative read for anyone interested in the search for habitable and inhabited planets, and makes an excellent primer for students keen to learn about astrobiology, habitability, planetary science and astronomy.

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## The Search for Habitable Worlds in the Universe

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and

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Contents

<i>Preface</i>	<i>page ix</i>
1 Introduction	1
1.1 The quest for life	2
1.2 The formation of planets	4
1.2.1 Formation of the Solar System	6
1.2.2 Migration in the Solar System	9
1.2.3 Elemental and isotopic abundances as insights to the formation of the Solar System	12
1.3 Looking for water	14
2 What is life and where can it exist?	19
2.1 The concept and conditions of life	20
2.1.1 The building blocks of life	20
2.1.2 Cells	25
2.1.3 Origin of life on Earth	30
Box 2.1 Stromatolites	34
2.1.4 Experiments on life: laboratory synthesis of amino acids	35
2.1.5 Chirality and the specificities of human life	41
Box 2.2 Panspermia	42
2.1.6 Another diagnostic for recognizing living matter: isotopic ratios of carbon	47
2.2 Definition of life and how to look for it outside its usual environment	48
2.2.1 Can we completely define life?	49
2.2.2 Extreme conditions on Earth today	51
2.2.3 Other possible forms of life	57

vi CONTENTS

2.3	What is a habitable zone (a habitat)?	59
2.3.1	Classical concept of the habitability zone	59
2.3.2	Extension of the habitable zone	64
2.3.3	Prebiotic chemistry	69
2.4	Searching for extraterrestrial life: from habitats to civilizations	75
2.4.1	Could there be extraterrestrial civilizations?	76
2.4.2	Searching for habitats	77
2.4.3	Searching with what?	79
3	Terrestrial planets and their diverging evolutions	85
3.1	Looking out from Mercury's desert	85
3.2	A past ocean on Venus?	87
Box 3.1	The sulfur cycle on Venus	90
3.3	Life on Mars? An old quest and a modern challenge	94
3.3.1	Schiaparelli's canali	95
3.3.2	The Viking mission, or the search for life	97
3.3.3	'Follow the water!'	99
Box 3.2	Methane on Mars?	106
3.3.4	The mystery of ALH84001	107
Box 3.3	Details of the mystery of ALH84001	109
3.4	Between Venus and Mars, the Earth. . .	110
3.5	Water on Earth: where did it come from?	112
3.6	Earth's companion, the Moon	114
3.7	Between terrestrial and giant planets, the asteroids	116
4	Searching for habitable sites in the outer Solar System	121
4.1	The outer Solar System: a huge reservoir of frozen water	124
4.2	Jupiter's satellites	130
4.2.1	Europa	135
4.2.2	Ganymede	139
4.2.3	Future exploration of Jovian satellites	141
4.3	Saturn's satellites	144
4.3.1	Titan: organic factory and habitat	146

4.3.2	Enceladus: water pockets far from the Sun	162
4.3.3	Future exploration of Kronian satellites	164
4.4	Comets	167
4.4.1	Comets: back to the origins	168
4.4.2	Origin of comets: two distinct reservoirs	170
4.4.3	What are comets made of?	172
4.4.4	Isotopic ratios and ortho/para ratios	176
4.4.5	Comets and the origin of life	179
4.5	At the orbit of Neptune and beyond	180
4.5.1	Cryovolcanic Triton	181
4.5.2	Trans-Neptunian objects	184
5	A revolution in astronomy: the exploration of extrasolar planets	187
5.1	From dream to reality	187
5.1.1	The key to success: velocimetry	188
Box 5.1	The velocimetry (or radial velocity) technique	189
5.1.2	Giant exoplanets close to their stars	194
5.1.3	Formation and migration in planetary systems	196
5.1.4	How to detect exoplanets from planetary transits	199
Box 5.2	The method of planetary transits	200
5.1.5	Gravitational microlensing	206
5.1.6	Indirect methods: what do they tell us?	207
5.1.7	Imaging exoplanets at last	209
Box 5.3	The radiation of stars and planets	210
5.1.8	Detecting exoplanets through their radio emission	213
5.2	The exoplanetary zoo	215
Box 5.4	The metallicity of the stars	215
5.2.1	The brown dwarf desert	216
5.2.2	Exoplanets close to their stars	218
5.2.3	Exoplanets on eccentric orbits	218
5.2.4	Many exotic objects	219
5.2.5	A large number of multiple systems	220
5.2.6	Planets around multiple stars	222

viii CONTENTS

5.2.7	Which candidates are most likely to be habitable?	222
5.3	From detection to characterization	227
5.3.1	Primary transits	228
5.3.2	Secondary transits	230
5.3.3	How to search for life in exoplanetary atmospheres	232
6	Extraterrestrial habitable sites in the future	235
6.1	Future exploration of possible habitats	235
6.1.1	Exploring the Solar System remotely and <i>in situ</i>	235
6.1.2	Exploring exoplanets from the habitability point of view	238
6.2	Protecting possible habitats	241
6.2.1	International treaties and organizations with relevance to planetary protection	241
6.2.2	Requirements for protecting life on other bodies	242
6.3	Fate of the Solar System and evolution of the habitability zone	245
6.4	Humans in space	247
6.4.1	Manned exploration: should we privilege it?	249
6.4.2	International Space Station: taking humans into space	250
6.4.3	Space cities	254
6.5	Transforming ('terraforming') possible habitats	260
6.5.1	Runaway greenhouse scenarios for terraforming Mars	262
6.5.2	Terraforming in the outer Solar System: icy satellites and asteroids	265
6.6	Hello to other lifeforms?	269
6.7	Conclusions from a planetologist's point of view	272
	<i>Further reading</i>	275
	<i>Index</i>	281

Colour plates section can be found between pages 150 and 151.



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## Preface

Life in space, whether strange beings on distant worlds, or an expansion of our own species into the Solar System and beyond, is a very exciting idea. Humankind may currently stand on the verge of major discoveries and exciting progress in both areas. The discoveries of possibly life-related artefacts in a Martian meteorite, in a subsurface ocean on Europa, Titan or Enceladus, and in the atmospheres of extrasolar planets, for example, show how close we are to finding out at last whether the life that teems on our own planet is unique. Some increasingly sophisticated space missions are currently under way, such as Cassini, which has been exploring the Saturnian system and Titan, the Earth-like moon, since 2004; others are in preparation, such as the Mars Sample Return and the Jupiter Icy Moons Explorer missions. Plans to return to Venus, Mars, the Moon and Titan, to orbit Europa and to place giant planet-seeking telescopes in space are thus on the table. These and other advances promise rapid progress in the coming years.

This is a book that deals with possible habitats in our Solar System and beyond. We will define which places might be harbouring past, present or future life, or can be considered as ‘habitable’ in the sense that human life could survive, adapt or continue to evolve therein. The book will include a necessarily brief but pertinent definition of life as we know it on Earth and review it as a phenomenon, considering its origins, properties and potential; we will combine a discussion of present knowledge with informed speculation, bounded by scientific realism but using non-technical language. We will briefly review the origin of life in the Universe, the reasons for thinking it may be unique and reasons, in contrast, for believing it could be commonplace. We will also offer some thoughts on its destiny and

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## X PREFACE

on scientific discoveries yet to be made in areas we can barely apprehend at present. The main goal is to update the reader on the current situation in our Solar System and beyond, in terms of exploration for traces of past or present life and of the existence of conditions for habitable worlds. We also aim to provide and provoke thoughts about our distant horizons in this respect.

The format of the book is such as to address a large audience (lay persons, students and others). The purpose is not to give an exhaustive description from the biological, geological or philosophical point of view, but rather to excite the imagination of the reader, by including up-to-date illustrations and clear, relevant and accurate text that only astrophysicists can provide on recent discoveries and future projects. As astronomers, we will offer a personal, inside view of space exploration, using our own knowledge and interests to describe the most interesting places outside Earth, as well as the vanguard techniques that we use to investigate them. We would like to thank here all of our colleagues (experts in various fields of astronomy) who assisted us with information, discussions and re-reading, and the artists who gracefully provided us with figures and photographs.