

Preface

The search for life in the universe is one of the most challenging topics of science. It is not a modern topic at all, since more than 100 years ago, it was speculated that on the Moon, there are oceans and seas; on Venus, there are swamps and also Mars is inhabited. However, now we have the scientific background and the scientific tools to answer this question and it is also certain that the answer would have deep implications for our culture, philosophy, and religions. If we find that life has developed on other planets or satellites of giant planets, then this would be the final breakdown of our central position in the universe. But is life a widespread phenomenon? How vulnerable is it to changing conditions and even catastrophic events? These topics will be discussed in this book.

If life is in the extreme case a unique phenomenon found only on planet Earth, which seems to be highly unrealistic, then also it is important to discuss how it is adaptable to changing external conditions. Can we survive a cosmic catastrophe? How do these catastrophes change habitability? Which forms of life are more vulnerable?

It was mentioned that now science has made great progress to answer such questions. Let us give some examples.

In modern biology, in connection with organic chemistry, the origin of life is studied. Still some surprising discoveries have been made over the last decades such as life under extreme conditions, the extremophiles. The chemical elements that are necessary for life (e.g., carbon, oxygen) have been produced at the centers of stars by thermonuclear fusion reactions. Thus, life could not exist in the early universe because at that time only hydrogen and helium were present, both had been formed within the first three minutes after the Big Bang.

Recent astronomical observations have proven the existence of extrasolar planetary systems; more than 250 such planets have been detected. With new upcoming satellite missions it will be possible to detect directly Earth-sized extrasolar planetary systems and even to measure any sign of biologic activity there. Also, great discoveries were made in our solar system. Since the surface of Venus turned out to be too hot, only Mars remained a possible candidate; however, the discovery of satellites of Jupiter and Saturn that are covered by a thick ice crust and where there is a liquid water ocean beneath that crust extended the search for life in the solar system.

Thus, it has to be expected that the question whether there exists life on other planets or not will be answered within the next few decades.

The investigation of habitable conditions on a planet or moon of a planet has also to be seen in the context of possible catastrophes. That such catastrophes happened on Earth is now well established, e.g., 65 million years ago the dinosaurs and other species became extinct due to an impact of an asteroid. Are there other possible cosmic catastrophes that could be dangerous to the habitability on a planet? In this book, we will discuss about collisions, orbit instabilities, supernova explosions, intense stellar activity outbursts, activity in galaxies triggered by their supermassive black holes, and other topics which are really cosmic catastrophes and could destroy habitability on a planet.

Cosmic catastrophes lead to mass extinction and could make a planet inhabitable. However, they also provide a chance for new lifeforms to appear. On Earth, maybe without the extinction of the dinosaurs, mammals never would have had a chance to evolve and propagate so rapidly. Intense UV radiation leads to mutations, many of which become extinct but some of them provided big progress in the evolution.

The book is intended for students and teachers in science, biology, chemistry, astrophysics, and physics and it provides an overview of the above-mentioned topics; in the appendix, some details on organic chemistry and astrophysics are given. For the interested reader, about 250 recent papers and articles are cited. This will help the reader to penetrate deeper into special topics. In the beginning of the chapters, books and review articles that provide a deeper insight into the topics discussed are mentioned in the footnotes.

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