# Planetary Systems

Detection, Formation and Habitability of Extrasolar Planets

Bearbeitet von
Marc Ollivier, Therese Encrenaz, Francoise Roques, Franck Selsis, Fabienne Casoli

1. Auflage 2008. Buch. xiii, 344 S. Hardcover
ISBN 978 3 540 75747 4
Format (B x L): 15,5 x 23,5 cm
Gewicht: 695 g

# Preface

Are there inhabitable worlds elsewhere in the Universe? Or better, inhabited worlds? Or is the third planet of the solar system really special? More than two thousand years ago, some Greek philosophers were already speculating about the existence of Earth-like planets. For the atomists like Epicure, it was a matter of principle: there should be planets around every star. But despite these high expectations and several research programs, only nine planets orbiting a main sequence star were known at the beginning of the nineties: the nine planets of the solar system.

Since then, the situation has changed drastically. While the nine planets of the solar system are now only eight (Pluto having lost this appellation), more and more extrasolar planets are now being detected, observed and catalogued by the astronomers.

Indeed, extrasolar planet, or exoplanet, is the name given by astrophysicists to these new worlds—a name not yet in all dictionaries—as well as exoEarth, exoJupiter, exoUranus, depending on the mass of the exoplanet. In mid-2008, there were more than three hundreds of these extrasolar planets, many of them belonging to planetary systems with at least two planets orbiting the same star. The solar system is thus far from being the only one of its kind: a revolution that both astronomy and planetary science have awaited for a long time.

And, indeed, it is a revolution. Exoplanets are not at all what astronomers expected. Actually, they do not look like if they were twins, or even cousins of the Earth, Jupiter and solar system planets. Most of them are giant, likely gaseous planets. This is not completely surprising since our detection methods, at least in the first years of this story, were not sensitive enough to detect less massive planets. But what was a real shock was the discovery of dozens of such exoJupiters 50 or 100 times closer to their star than Jupiter is from the Sun—a really hot place to live. How were these hot Jupiters formed? Another mystery is the rather elliptical orbits of many extrasolar planets, while planets in our solar system are on rather circular orbits. In the end, could it be that our solar system has exceptional features? The discovery of extrasolar planets has then led researchers to reconsider all theories of planetary formation and evolution. For example, the role of a phenomenon called *migration* is now widely recognized: most planets do not stay in the region of the

planetary system where they were formed. With the discovery of more and more "superEarths," with masses between several Earth masses and the Uranus mass, it also seems that the distinction between telluric and giant planets is fading away.

Exoplanets were a challenge not only for the theoreticians, but also for observers. These tiny dots are not yet directly observable except in very exceptional cases. It is an indirect method (velocimetry) that has yielded the majority of the discoveries, but astrometry, microlensing, transits, and pulsar timing are among the methods that observers have invented to circumvent this problem. The ultimate goal for the next 20 years, however, is to detect exoEarths—planets with a mass close to that of Earth, and located at the right distance from their star for life to be able to develop. Thanks to innovative methods, detecting exoEarths should be feasible in the next 10 years, while detecting signs of life (biosignatures) in their atmospheres is still an immense challenge, and the goal of extremely ambitious space projects.

This book attempts another challenge, which is to draw a picture as complete as possible of this field while it is still quickly evolving. The first chapters describe what is currently known of exoplanets, from a description of the detection methods and of the observed properties of the known objects to the dynamics of planetary systems and the structure and evolution of planets in general. It appears that the solar system planets are still the reference for all models. The last two chapters deal with current and future detection projects, and the final goal—the search for life on exoplanets.

One could hope that the field of exoplanet research has reached a mature state and the major results that one can get with present-day techniques are known. However, the "other worlds" are still capable of amazing us. In such a dynamic field, the foreword is the best place for the latest news. Indeed, three months after this book was completed, the space mission COROT discovered an enigmatic object between a star and a planet with a density twice that of platinum. The team using the HARPS spectrograph on the 3.6 m telescope at the European Southern Observatory announced that a system of three superEarths orbits the star HD40307. When will be the first announcement of the discovery of a true Earth twin? Two years, five years, ten years from now? Let us guess that exoplanets will surprise us again.