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Planetary Systems: Detection, Formation and Habitability of Extrasolar Planets by M. Ollivier, T. Encrenaz, F. Roques, F. Selsis and F. Casoli, Springer, 2009, pp. xiii + 340. Scope: monograph. ISBN 978 3 540 75747 4. Level: undergraduate and postgraduate physicists and researchers.

Are we alone in the Universe? Or are there myriads of other habitable worlds teeming with life and intelligence? These are questions of long standing, going back at least to the ancient Greeks, e.g. Epicurus (341-270 BC) who opined: "There are infinite worlds similar to and different from our own". Until the end of the 20th century, however, all was speculation because the necessary observational techniques did not exist. It is only very recently, in the last decade, that the situation has started to change. Although we are still cannot answer the questions about life, there has been an avalanche of evidence pointing to the existence of exoplanets, i.e. extra-solar planets in orbits around other stars. The authors have set out to provide a detailed snapshot of this rapidly developing research field at a particularly exciting moment in its evolution.

At the core of the book, always there in the background even when not being discussed explicitly, is the question of whether or not our solar system is typical. If so, numerous other planetary systems of a similar kind are to be anticipated; where the central star is of similar mass to the Sun, many of them will include Earth-like planets. The antithesis also applies, of course. If the solar system was formed as the result of an unusual and special event, e.g. a close encounter between the Sun and another star, then the occurrence of planetary systems would correspondingly be rare. The discovery of several hundred exoplanets during the last few years suggests that planetary systems are actually rather common, especially given the extreme difficulty of making and analysing the observations, which means that most exoplanets probably remain undetectable.

The direct detection of exoplanets, in the sense of detecting separately the photons emitted from the planet and from the star, is virtually impossible. The angle subtended between the sources is too small, and the emissions from the planet too weak compared to the brilliance of the star. The authors liken the problem to "...trying to observe a glow-worm 30 cm from a lighthouse in Marseille, when the observer is in Paris (at a distance of about 700 km)". The problem is exacerbated by the existence of the zodiacal light emitted by dust in the plane of the ecliptic. So in practice exoplanets must be detected by indirect means: by observing their effect on the motion of the star, or by measuring

the slight reduction in light coming from the star as the planet passes in front of it.

Given the difficulties and indirectnesses of the observations, it is hardly surprising that most of the exoplanets discovered so far are relatively large, often Jupiter-like, objects that are easier to detect than Earth-sized planets. But this will surely change over the next few years as the observational methods are further refined. Already, there are several surprises including numerous "exoJupiters" 50 or 100 times closer to their stars than Jupiter is to the Sun. There is also the question of why many exoplanets seem to have far more elliptical orbits than those of our own planets, which are mostly well-approximated as circular. The authors mention in their Preface that, just after completion of the rest of the book, the space mission COROT discovered "...an enigmatic object between a star and a planet with a density twice that of platinum". There will probably be a profusion of comparably unexpected observations in the coming years.

The authors have given a full and detailed coverage of their subject, dealing with detection methods, what is known of stellar and planetary evolution, planetary dynamics including migration phenomena where planets move to different orbits, and a discussion of the search for life and its likely prevalence. The book is well-written and translated and, despite the large number of authors, it hangs together as a coherent whole without too much repetition (though the memorable image of the surface of Titan, recorded by the Huygens probe, appears twice). The text is illuminated by numerous figures and graphs. Appendices describing e.g. gravitation, Kepler's Law, Black-body radiation, and the Hertzsprung-Russell diagram are provided to help the general reader. The authors predict that 'exoEarths" – planets with masses comparable with that of the Earth – will be detected within the decade. Of course, detecting possible biosignatures in their atmospheres presents a far more challenging problem, and they prudently refrain from hazarding a guess as to how long it will take to solve.

Although the questions mentioned at the beginning still remain unanswered, *Planetary Systems* provides an excellent account of the enormous progress that has been made in recent years, together with a discussion of the prospects for the years to come. It is a fascinating book that can be read with interest by any physicist.

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