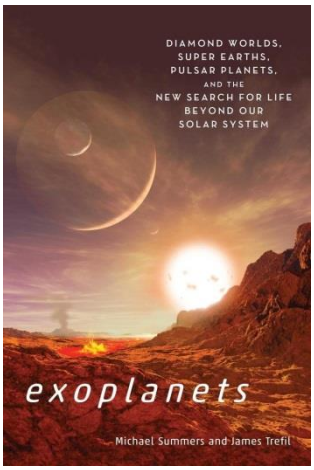

Exoplanets: Diamond Worlds, Super Earths, Pulsar Planets, and the New Search for Life beyond Our Solar System

By Michael E. Summers and James Trefil

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"We labor under what we call 'the curse of the single example' – that is how the authors Michael E. Summers and James Trefil introduce the first chapter "not your Grandfathers Galaxy".

Almost to the day, sixty years after the then called Soviet Union sent the first man made satellite ("Sputnik") into low Earth orbit, the authors summarize the findings and answers to age-old fundamental questions which humankind was enabled by this event – by having driven space exploration to unbelievable heights never before thought possible.

Definition of exoplanets
The initial idea for a habitable exoplanet was the "Goldilocks" model: a hypothetical body similar to Earth situated in a position near its star that makes it "not too hot, not too cold, but just right", just right meaning it can have oceans of liquid water on its surface i.e., in what has been termed the continuously habitable zone (CHZ).
The notion of planetary systems circling other stars was confirmed in 1992, however that discovery was a surprise – the planets were found to be circling the wrong kind of star, a pulsar, i.e., a star at the end of its life. The next surprise, using the measurements from the Kepler spacecraft, was a diverse assortment of exoplanets such as *Super Earths* (rocky planets), *Styrofoam worlds* (planets so light it is difficult to explain how they have not collapsed under their own gravity), *Diamond planets* made of almost pure carbon, *Multi star worlds* (planets that circle up to four stars), *Hot Earths* (so close to their stars that their surface rocks are vaporized) and *Rogue planets* wandering around unattached to stars. All those exoplanets are described in detail in the book, and to those types of planets for which we know enough about their properties we are taken on hypothetical visits.

Measurement methods
The first robust technique for detecting exoplanets was to look for small motions their central star due to the gravitational pull of the orbiting planet. Of course, this technique worked mostly for "big" planets. This technique discovered many "hot" Jupiters, i.e., big planets circling its star *inside* what would be inside the orbit of Mercury in our solar system.
With the development of new detection techniques and with the help of the Kepler Space Telescope, a whole variety of exoplanets was detected (see above). Kepler used observations of transits of planets "dimming" the light of their central stars to find much smaller planets than before.

Life on Exoplanets
Picking up Fermi's question of "where is everybody?", the authors speculate on possible life forms on exoplanets in the final chapters of the book.
The question of "why the great silence?" can be divided into three categories: (1) they are really out

there but are not interested in us, (2) they really are out there, but they're protecting us, (3) they are really out there, and we're going to get it unless we mend our way.
In theorizing about getting in contact with possible exoplanetary life I can only sympathize with the conclusions of the authors, that given our violent evolutionary history, Homo Sapiens is "not the sort of species you'd want to meet in a dark alley" – on the other hand when advanced and less advance groups encounter the best strategy is to lie low and don't call any attention to themselves, the argument goes.

The extreme benefit of the book is – by focusing on the subject exoplanets – to "connect the dots" starting with very early speculations by Aristotle, Galileo, Kepler, Laplace and many other not so famous astronomers leading up to and describing the latest findings of the Voyager, Galileo, Kepler, Cassini and New Horizons missions with respect to potential habitable planets within our solar system (Europa, Callisto, Ganymede and Enceladus, all having subsurface oceans). Although those missions have been highly published – I have never seen the scientific results and conclusions having been told more concisely and understandably – and indeed they are breathtaking. Having been involved in the operations of some of the missions myself, I never had time to follow up the analysis of the findings because by the time the scientists published their results to a very limited audience my attention was drawn to new projects.

So this is the book to catch up with the Kepler mission and other contributing extraordinary projects like Voyager, Galileo and Cassini to see the big picture – at least this was my experience, and I am very grateful that the authors published this book for all the people interested space exploration helping us understand and appreciate the big strides we have taken to release us from the "curse of the single example."

The authors take us on a tour to the most surprising exoplanet candidates like 55 Cancri-e, featuring carbon-diamond volcanos or "Haven" the rogue planet, and to the "Ice World", Kepler 186f or Gliese 1214b. The planets are characterized in detail using observations and educated and plausible speculations where results are not available. By adding caveats at the end of the description of each exoplanet the reader is motivated to take part in the speculations, make up his own opinion, agree or disagree with the findings.

The last chapter "Photography and Illustration Credits" provides a "who is who" in exoplanet science, although I would have found a glossary and reference chapter helpful. However, the Kindle edition – which I used for the review - provides a search machine (in addition to the bookmarking tab) .which worked excellently.

"Exoplanets" is an intelligent, easy to read, entertaining and highly recommended contribution to the timeless effort of unraveling of the mystery of where we came from and where we are heading. Given the current state of our Earth - as the only available example - this book might sharpen your sensibility the insight that the "great filter" for our fate still might lay in front of us.
To conclude with the author's statement: "…there is a lot more to be explored out there than we thought. Let's get on with the job!"

September 2017, Joachim J. Kehr, Editor SpaceOperations News for the Journal of SpaceOperations & Communicator"
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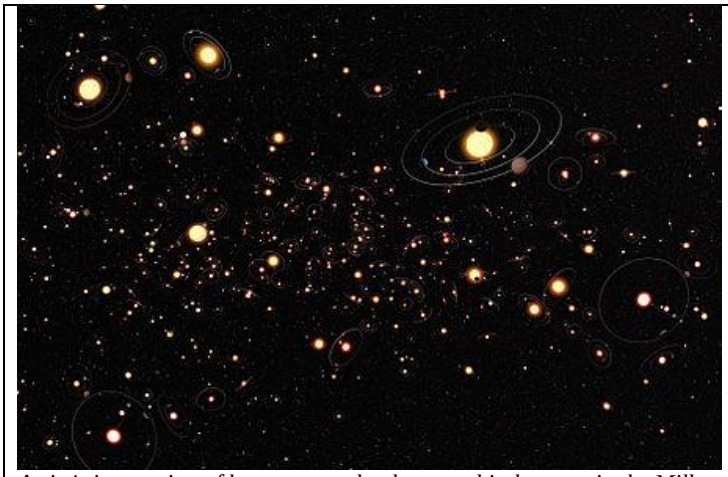
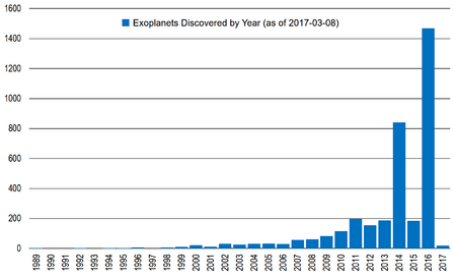


Artist's impression of how commonly planets orbit the stars in the Milky Way[1]

*An **exoplanet** or **extrasolar planet** is a planet outside of our solar system that orbits a star. The first scientific detection of an exoplanet was in 1988, but the first confirmed detection did not come until 1992. As of 1 October 2017, there are 3,671 planets in 2,751 systems, with 616 systems having more than one planet. [1]*



Discovered exoplanets each year as of March 8, 2017[1]

[1] Reference for both pictures: Wikipedia, https://en.wikipedia.org/wiki/Exoplanet