



An artist's impression of the Milky Way — one of hundreds of billions of galaxies in the Universe.

ASTROBIOLOGY

# Cosmic prestige

Mario Livio welcomes a lucid description of attempts to evaluate how special humans are.

All the astronomical discoveries made since Nicolaus Copernicus demoted Earth from its position at the centre of the Universe have continued to erode humanity's perceived physical significance in the grand scheme of things. Consider this sequence of events: in 1920, US astronomer Harlow Shapley showed that the Solar System does not occupy the centre of the Milky Way, but is about two-thirds of the way out. Then, Edwin Hubble discovered that there are many other galaxies — a few hundred billion in the observable Universe, according to the latest observations (made, fittingly, by the Hubble Space Telescope). Next, it was found that even the stuff we are made of — ordinary baryonic matter — constitutes less than 5% of the Universe's energy budget. To top it all, speculative models based on cosmic inflation and string theory suggest that our entire Universe may be but one member of a 'multiverse', a huge ensemble of some  $10^{500}$  universes.

On the planetary scale, there has also been an explosion of discoveries. Until 1992, there had been no confirmed discoveries of any planets outside the Solar System. However, observations since then (especially by the Kepler satellite) suggest that about 20% of all Sun-like stars in our Galaxy harbour approximately Earth-sized planets orbiting in the stars' 'habitable zones' — the regions of space that are neither too hot nor too cold, allowing liquid water to exist on a planet's solid surface. Given that liquid water is considered



**The Copernicus Complex: The Quest for Our Cosmic (In) Significance**  
CALEB SCHARF  
*Allen Lane/Farrar, Straus and Giroux: 2014.*

potentially a necessary ingredient for life, these statistics are (at the very least) promising for those who believe that there could be life elsewhere.

That Earth hosts life remains its last qualification for being special. How reasonable is it to think that we are alone in the vast expanses of space? And how significant is life on Earth on the Universal (or multiversal) scale? These are the questions that astrobiologist Caleb Scharf addresses intelligently and comprehensively in his beautifully written *The Copernicus Complex*. The book offers a grand tour of important findings from astronomy to biology that are relevant to the cosmic and microscopic search for life.

What sets this book apart from those that simply describe the hunt for exoplanets is Scharf's emphasis on the significance, or lack thereof, of our own existence. For instance, the realization that the human body contains ten times as many microbial cells as human

NASA/ESA/Z. LEVAY (STSC/AURA)

cells — as well as impressive advances in the understanding of the chemical origin of life — has forced us to rethink how we classify the ‘importance’ of life forms on Earth, and perhaps even to consider placing microbes at the top of the hierarchy, rather than at the bottom.

Scharf tackles in some detail the question of whether we can conclude anything about the expected frequency of extraterrestrial life from the known facts about the emergence and evolution of life on Earth, particularly two important clues. The first is that some

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form of life arose very early in Earth’s history, within only a few hundred million years of the planet’s formation; the second, that the appearance of

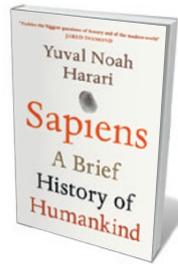
‘intelligent’ beings took a few billion years. After sketching the basics of Bayesian probability theory, Scharf describes the interesting results of astrophysicists David Spiegel and Edwin Turner. They have shown that in the absence (so far) of any evidence of life arising independently of our lineage, one cannot reach any conclusions about the rarity (or not) of life in the Universe. This highlights the importance of the search for that evidence.

Scharf ends his book with the reflection that life inhabits the border between order and chaos. For instance, the dynamics of the planetary orbits in our Solar System are so complicated that they may become unstable within a few billion years. Similarly, Earth’s climate and geophysics occupy that interface between order and disorder. From that, Scharf concludes that “our place in the universe is special but not significant, unique but not exceptional”. Note, however, that from the perspective of thermodynamics (entropy), life itself is an extremely ordered system.

I see two other important messages, with which I am sure Scharf would agree. One is that given the number of space telescopes that either are being built (such as the James Webb Space Telescope, to be launched in 2018) or have been proposed (including the Advanced Technology Large-Aperture Space Telescope), we may, for the first time in human history, be close to determining whether extraterrestrial life exists. Some optimistic estimates predict such a discovery in the next two decades. The second is that, notwithstanding our physical insignificance, the human mind is significant. Why? Because all the discoveries described in this book, from the subatomic realm to the multiverse, were made by us. ■

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## Books in brief



### **Sapiens: A Brief History of Humankind**

Yuval Noah Harari HARVILL SECKER (2014)

This newly translated Israeli best-seller by historian Yuval Noah Harari delivers a boldly synthesized account of *Homo sapiens'* rise through the hominin ranks, by way of the cognitive, agricultural and scientific revolutions. Harari offers some original reframing of phenomena such as symbolic thinking. A leitmotif of cruelty in domains from war to livestock rearing also emerges — perhaps unsurprisingly in a species that, Harari argues, reached the top of the food chain by acting like the dictator of a banana republic. A view of our ascent as nasty, brutish, long — and endlessly fascinating.



### **A Prescription for Psychiatry: Why We Need a Whole New Approach to Mental Health and Wellbeing**

Peter Kinderman PALGRAVE MACMILLAN (2014)

The furore over the 2013 edition of the American Psychiatric Association’s *Diagnostic and Statistical Manual of Mental Disorders* showed anew the rifts in psychiatry over diagnostic hair-splitting and medical interventions. Here, psychologist Peter Kinderman enters the fray. Arguing against biomedical reductionism, he offers a social and psychological model of mental illness, and calls for reforms such as multidisciplinary care, reduced use of pharmaceuticals, and big societal changes to promote mental well-being.



### **The New Moon: Water, Exploration, and Future Habitation**

Arlin Crotts CAMBRIDGE UNIVERSITY PRESS (2014)

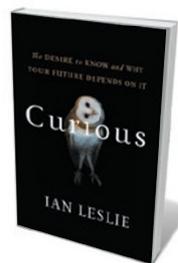
Is lunar exploration an old story? Pushing aside the political hurdles that impede a US return to the Moon, astrophysicist Arlin Crotts mines lunar research and its implications for human colonization in staggering, often deeply engaging, detail. Beginning with a scientific portrait of Earth’s satellite, he probes missions from the cold war and international space activity since then; delves into findings on lunar chemistry, the Moon’s far side and aspects such as outgassing and moonquakes; and explores in technical but accessible detail what we can glean from all this regarding a human presence on the Moon.



### **The Bee: A Natural History**

Noah Wilson-Rich IVY (2014)

Well over 100 million years ago, flowering plants debuted on Earth — and early wasps began to co-evolve with them into the bee. As key pollinators and providers of honey and wax, bees have buzzed their way into human history. But the natural history of solitary, bumble, honey and stingless bees is as gripping as our lengthy alliance, as urban beekeeper Noah Wilson-Rich and contributors show in this charming compilation. They cover evolution, biology (including a unique proboscis made of two organs), behaviours (such as honey bee “quacking”), the causes of catastrophic die-offs, and more.



### **Curious: The Desire to Know and Why Your Future Depends On It**

Ian Leslie BASIC BOOKS (2014)

Deep questing is essential to keeping your cognitive edge and social intelligence razor-sharp throughout life, posits Ian Leslie. He weaves ample science into his exploration; the brain’s caudate nucleus, for example, is associated with romantic love as well as the urge to learn, putting the latter “onto the same pathway as our most primal pleasures”. Staying curious into old age, he argues, demands that we imitate Benjamin Franklin: “sweat the small stuff while thinking big”, and never stop experimenting. **Barbara Kiser**