Beyond: Our Future in Space

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Human exploration has been an unceasing engine of technological progress, from the first homo sapiens to leave our African cradle to a future in which mankind promises to settle another world. Beyond tells the epic story of humanity leaving home—and how humans will soon thrive in the vast universe beyond the earth.

A dazzling and propulsive voyage through space and time, *Beyond* reveals how centuries of space explorers—from the earliest stargazers to today's cutting-edge researchers—all draw inspiration from an innate human emotion: wanderlust. This urge to explore led us to multiply around the globe, and it can be traced in our DNA.

Today, the urge to discover manifests itself in jaw-dropping ways: plans for space elevators poised to replace rockets at a fraction of the cost; experiments in suspending and reanimating life for ultra-long-distance travel; prototypes for solar sails that coast through space on the momentum of microwaves released from the Earth. With these ventures, private companies and entrepreneurs have the potential to outpace NASA as the leaders in a new space race.

Combining expert knowledge of astronomy and avant-garde technology, Chris Impey guides us through the heady possibilities for the next century of exploration. In twenty years, a vibrant commercial space industry will be operating. In thirty years, there will be small but viable colonies on the Moon and Mars. In fifty years, mining technology will have advanced enough to harvest resources from asteroids. In a hundred years, a cohort of humans born off-Earth will come of age without ever visiting humanity's home planet. This is not the stuff of science fiction but rather the logical extension of already available technologies.

Beyond shows that space exploration is not just the domain of technocrats, but the birthright of everyone and the destiny of generations to come. To continue exploration is to ensure our survival. Outer space, a limitless unknown, awaits us.

Beyond: Our Future in Space Details

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From Reader Review Beyond: Our Future in Space for online ebook

Martyn says

Having been fascinated with the idea of space travel and astronomy in general pretty much most of my life, this book was immediately on my list when it came out.

Chris Impey manages to capture the wonder of exploration, from humanity's earliest wanderings, to the idea of leaving our solar system, with ease and clarity. As he moves from the development of the first rockets, through the space race, and onto the future of how we'll attempt to travel the vast distances to other planets, you're never overawed by the science involved, as he deftly explains theories and the challenges ahead in an engaging way.

Highly recommended to anyone who has looked up at the stars and thought 'I wonder....'

J.M. Hushour says

Space is awesome, but exploring it is a singularly wasteful endeavor given the myriad social and environmental problems facing us here on Earth. Still, though, Impey makes a good argument for continuing to dump money into it, his weird ADD-causing gene argument aside. Because it's there isn't enough, but resources and as the same sort of population pressure release are good grounds. Plus, we waste so much money on war we could provide for the world numerous times over and still have more than what we have now for space if we quit killing each other.
But who cares about the reality of it all? Revel in Impey's look at the future of space exploration and the concomitant technological advances that might lie ahead. Theoretical propulsion, nano swarms sifting through the galaxy, living on Mars--all that fun shit is here. Impey makes an argument for putting tech development into the hands of private industry, using the Internet as an example of a initially government-funded research dilly that went into private hands, probably the worst example he could have chosen, but oh well. There's some good bits on people like Elon Musk and space tourism, which, in the end, is meaningless except as an impetus for the scientific side of things.
There's some odd factual errors (the Soviet Venera 9 probe was actually the first photo sent back form the surface of another planet), but since the book is wacky-speculative, who cares!

Chris says

A great book for anybody interested in space and wondering what we are doing in space, how, why, and what the next few decades and centuries might bring.

I had anticipated that this book would cover ground that I was already familiar with, and topics that have been covered elsewhere – whether by Buzz Aldrin, Robert Zubrin, or various other authors (in books like

The Case for Mars: The Plan to Settle the Red Planet and Why We Must, or Entering Space: Creating a Spacefaring Civilization, or Mission to Mars: My Vision for Space Exploration). I had likewise expected the historical sections would rehash information from previous books I'd read like This New Ocean: The Story of the First Space Age, ...the Heavens and the Earth: A Political History of the Space Age, and especially Cosmos, all of which are essentially mandatory for anyone fascinated and inspired by space. However, Impey summarizes many of the main points of these other books, and gives a great survey of the field, but does so in a way which is efficient, insightful, and inspiring.

I had to take issue with some few points, but only because I am a specialist in a few certain areas that Impey touches on. He briefly discusses space law (namely, the international law applicable to space, including the 1967 Outer Space Treaty), which I happen to know very well, and work with on a regular basis. Impey writes: *"Countries own anything they put into orbit or launch into space, but they're responsible for any damages caused by those objects. The utopian ideal encapsulated by the Outer Space Treaty is that space exists for the 'common heritage of mankind.'"* (pg. 146). This is close, but wrong on a very important point which requires blunt correction.

Article 1 of the 1967 Outer Space Treaty states that *"The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."* (http://www.unoosa.org/oosa/en/ourwork...)

The phrase is that is not the "common heritage" of mankind, by the "province" of mankind. Additionally, it is the the "exploration and use" of outer space, and not outer space itself. Consequently, it is the activity of exploring and using outer space, rather than the physical domain of void space and celestial bodies, which is the province of mankind. This must always be remembered and emphasized, for a number of reasons: 1) "common heritage of mankind" is a diplomatically problematic and embattled concept which some think necessitates the sharing of all benefits across nations and peoples, while "province" of mankind is less well-defined and problematic; and 2) it is the activity, rather than the domain itself, addressed in this treaty article, while Article II subsequently mandates that outer space is not subject to *"national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."* These distinctions may appear trifling and petty, but international space lawyers understand the large stakes which hinge upon their correct recitation and understanding. For being correct on the rest of his space law, I give the author a passing grade.

In a later section, I was surprised and very pleased to see him quote my former professor and the current president of the International Institute of Space Law, Tanja Masson-Zwaan, discussing future prospects like Mars One and aspirations for humans to live permanently on Mars: *"I assume at some point these settlers will become more detached from Earth, and will live by their own rules."*(pg. 199).

Divided into four sections, the book explains the past, the present, the near future, and then speculates into the far-flung future of space exploration and use. Middle sections of this book also highlight some current visionary personalities in the space field, including Burt Rutan, Richard Branson, Peter Diamandis, and Elon Musk, and discuss commercial space tourism, transportation, and commercial astronauts, as well as commercial space stations, asteroid mining, and resource use on celestial bodies. Impey also discusses the division in using robots or humans to explore, and how they can actually compliment each other in exploration and the sciences. Later sections speculate what the next few decades will bring, including the potential technological advances in computational size and sophistication, and what these advances offer. Final sections of the book are even more speculative and visionary, so I will leave that for curious readers to investigate for themselves.

This book could, and should, be assigned reading to high schoolers or college students. It is educational, inspiring, and thought-provoking, and gives a vision of a better future which we so often need reminding of.

Jafar says

If too many sci-fi movies have made you think that interstellar or even inter-galactic travel may not be too far off in the future, consider this: At our best current technology, it would take 80,000 years just to get to Alpha Centauri, our closest neighboring star and a mere 4.4 light years away, and this is with ignoring the question of the fuel. If we have to use chemical energy, as we do now, to power the spaceship, all the mass in the universe in the form of rocket fuel will not be enough to take us to Alpha Centauri! Even if we develop the technology to power a spaceship with nuclear fusion energy, we would need 10-to-the-11th kilogram of fuel to take us to Alpha Centauri in a "reasonable" time of one thousand years. It's hopeless, isn't it? But it's so much fun to fantasize about space travel, and so exciting to do the little things that we can do, like sending a tiny probe to Mars to send back pictures.

Maire Slater says

The Hub is the only zero-g place in the station; all the living and working quarters are around the rim of the wheel, spun to two-thirds g, which avoids the worst problems of bone loss and physiological adjustment. (59)

..it takes light or radio waves anywhere from four to twenty-one minutes to reach Mars from Earth, depending on where the two planets are in their orbits...commands that are separated by a half hour or more to allow for the round-trip signal time...planets rotate and shadow the orbiters, so there are dead times when no communication is possible...(67)

space race
US based Space Adventures
Orbital Sciences Corporation
Space X - Elon Musk
Virgin Galactic - Richard Branson
Space Adventures
Robert Bigelow - Budget Suites hotel chain
Blue Origin - Amazon founder Jeff Bezos

The full set of physiological effects would give any potential space-farer pause. A lack of gravity causes body shape to morph. Astronauts get 2 or 2.5 inches taller, but that extension (and subsequent compression when they return) is quite painful. Internal organs drift upward, faces get puffy, waists and legs shrink, and the result is a cartoonish image of a strongman. But this is an illusion; without gravity to fight against, muscles atrophy and bones get thin and brittle. Astronauts work out for two or three hours a day to combat these effects. The heart also weakens, and blood pressure may lower to the point where a person occasionally can pass out. Immune systems weaken in space, and the upward migration of body fluid leads to congestion and headaches. Glucose tolerance and insulin sensitivity vary wildly in space.
Since they're not shielded by the Earth's atmosphere, cosmic rays cause low-level brain damage, and they may accelerate the onset of Alzheimer's disease. Eyes suffer, too; Russian cosmonaut Valentin Lebedev

suffered progressive cataracts and went blind after spending eight months in orbit. (115)

Its beryllium and carbyne laminate is designed to quench cosmic rays and stop meteorites up to the size of a pea. (133)

Ark 1 is competing deployment of its solar sail. The gossamer-thin membrane has unfurled on all sides to span a square kilometer; the spaceship is dwarfed by it like a stick of charcoal on a silver carpet. The sail will harness the solar breeze to accelerate the ark to the edge of the Solar System and then pulsed fusion of hydrogen atoms snatched from space will propel it to its destination. (135)

...the NASA plan to lasso an asteroid and put it into a lunar orbit so that it can be mined.

D.L. Morrese says

About 25% fiction, 25% history, 25% science & technology, and 25% speculation, this is kind of a mixed bag. There's really nothing new here and a few minor errors. (e.g. Pg. 10 - Apes are not 'our most recent ancestors'. They are our distant cousins with whom we share a common ancestor about 6 million years ago. Pg. 52 - Viking 1 did not provide 'the first image ever returned from the surface of another planet.' That honor goes to the Soviet Venera 9, which returned pictures of Venus a year earlier. Pg. 68 - Helium is not the lightest gas. Hydrogen is. There were a couple others where the error, such as it was, was simply a matter of needing qualifications that were not provided.) I don't mean to sound pedantic, but the editors should have caught these. The general theme of the book, though (with which I agree) is that humanity must reach beyond Earth and our solar system, not only to learn but to survive. A stronger and more inspiring argument for this could be made than is provided here.

Jessie B. says

Written in a clear manner and makes several difficult concepts easy to understand.

Mal Warwick says

A colony on Mars? Really?

Some of us grasp the existential crisis humanity faces today, and fear that global climate change, an asteroid collision, a super volcano, a viral pandemic, or some other easily imaginable catastrophe could put an end to the human project — if not the human race — by the beginning of the next century. By contrast, congenital optimists foresee a glorious future for humanity among the stars. Here, for example, is astronomer Chris Impey, writing about Our Future in Space: “the space industry may be where the Internet was in 1995, ready to soar. . . Leaving Earth may soon be cheap and safe enough that it becomes an activity for the masses rather than the experience of a privileged few.” Others take a similar view — Stephen Hawking, for instance, who asserts that “the human race doesn’t have a future unless it goes into space.”

So, if you’re wedded to a gloomy view of our species’ destiny, you probably won’t enjoy this book. For my part, there’s just enough of the optimist left in me to find Chris Impey’s vision intriguing. Not totally

convincing — I'm still wringing my hands over climate change and a possible pandemic — but well argued and totally grounded in a deep understanding of science.

Here is Impey's thesis: "The itch that led our ancestors to risk everything to travel in small boats across large bodies of water like the Pacific Ocean is related to the drive that will one day lead us to colonize Mars." This "itch," Impey argues, arises from our DNA. Today, hardly more than 500 human beings have left our planetary home to venture into space, most of them barely so, in orbital and sub-orbital trips. Tomorrow — by mid-century, Impey believes — tens of thousands will have had that experience and dozens will be setting up our first permanent home on Mars.

Don't think for a minute that Impey is some starry-eyed fantasist: first and foremost, he's a scientist. Our Future in Space is laid out in three parts: Present, Future, and Beyond. At each level, the author grounds his story in facts. He describes the origins of the US space program in Wernher von Braun's V-2 rockets and the arms race with the USSR. In discussing the challenges of the next several decades, he is unrelentingly honest: "traveling into space is four hundred times more dangerous than flying but only twice as risky as driving." This is not a throwaway line; Impey cites the statistics to prove this. In fact, he draws on a fount of fascinating numbers, explaining that today's spacecraft are "mostly just hauling fuel around: the actual payload was 4 percent for the Saturn V and 1 percent for the Space Shuttle." Even in Beyond, where Impey ventures far into a possible future among the stars, his feet remain firmly planted on terra firma. Though he draws analogies from Star Trek and science fiction novels, he never leaves the reader in any doubt that he is fully aware it's all speculation.

Chris Impey is a University Distinguished Professor and Deputy Head of the Department of Astronomy at the University of Arizona. He's also a prolific author. Our Future in Space is his eighth book.

Gendou says

This book is more about our past in space than our future. It surveys the history of space science exploration from Anaxagoras to the modern day Kepler exoplanet-finding telescope. None of these topics are explored in depth. Nothing new or original is presented. You might as well just spend a couple hours on Wikipedia. The second half of the book does go over some speculative technologies like space elevators, and again profoundly lacks depth.

Worst is the author's attitude. Reading this book is like reading a child's homework assignment. One confidently-presented misunderstanding after another. Skip this book.

Thom says

This excellent book surveys the recent past, present, and future efforts of space exploration, then goes Beyond, to examine the future of humanity. Chris Impey has a refreshingly optimistic outlook and this well written book was a joy to read.

Each of the four parts has many interesting points, some of which I had not encountered. In the first section, the information about the explorer gene was particularly interesting, and in the present his comparison of near-future space travel to the early Internet is especially good. Each major section is preceded by a few

paragraphs of fiction, imagining the world of young pioneers, soon headed for space.

The illustrations were mostly small and a few were difficult to read, but all were sourced in the back of the book. This, plus the excellent end notes for each chapter, allowed me to track down additional information. The index in this book is also well done.

Reading this, I was favorably reminded of an earlier book, Colonies in Space by T.A. Heppenheimer, which I read over 30 years ago. In both cases, authors who were very savvy in their fields extrapolated, piece by piece, on future of humanity in space. While precious little of the earlier book has come to pass, I hope that Impey's prediction of the future is closer to the mark.

Beyond is beautifully written, well sourced and a pleasure to read. I would recommend this book to everyone.

Ev says

I LOVE this book. I love love love it. Did I mention I love it?

Bill says

Interesting, but ultimately disappointing

While I found parts of this book interesting, it was mostly just a rehash of the same tired old information that would already be known by the kind of people who would be interested by it in the first place. It also failed to discuss in any detailed way actual proposals to explore and expand into space.
Additionally, the book could use some judicious editing. It directly contradicts itself in places, the grammar is occasionally rough, and rather than flowing smoothly, it tends to meander and double back on itself, often repeating previous information or imparting facts and anecdotes that seem to have little to do with the subject at hand.
Finally, I was disappointed by the length of the book. The book proper ends at 65 percent, with fully 35 percent dedicated to footnotes, bibliography, and acknowledgments. This ratio seems a little skewed to me.
This book is not without merit, but this diamond in the rough needs a lot of polishing.

Thomas Salerno says

The past ten years have been the doldrums for manned space flight. At the same time, unmanned missions such as the Mars Curiosity rover and the recent New Horizons mission to Pluto have met with unparalleled success. But the retirement of NASA's Space Shuttle with no replacement readily available, has lead many to believe that the best years of manned space exploration may already be behind us. Author Chris Impey challenges that pessimistic outlook in his new book *Beyond*, which chronicles the storied history, challenging present, and promising future of mankind beyond Earth.

The book is divided into four parts. Part One is a page-turning history of man's fascination with exploration and with space flight. However, the first chapter actually deals with the controversial hypothesis that *Homo*

sapiens possess an "explorer gene" that conferred a selective advantage on our ancestors and allowed them to spread across the globe, often at the expense of other closely related human species. It is thought by some that this gene is most strongly expressed in modern-day thrill seekers, entrepreneurs, and indeed astronauts. The details of the controversy surrounding this idea are outside the scope of this review. What I will say is that whenever the author turns from explaining concepts he is well-versed in, such as astronomy and physics, and touches upon issues in anthropology and human evolution he often gets basic facts wrong. I majored in anthropology in college and studied human evolution extensively, so I found these elementary errors very glaring and they often distracted me from an otherwise enjoyable read.

My favorite chapters were the ones that covered the history of spaceflight, all the way from early experiments in rocket technology, to the Nazi V-2 rocket program, the launch of Sputnik 1 and the space race, through the Apollo Program, up until the Space Shuttles and the losses of Challenger and Columbia. I learned a lot of things that surprised me about these storied events and the people who made them possible. The book covers all of this history in a cursory way but, luckily for the interested reader, additional resources that go into specific events and historical figures in more detail can be found in the endnotes.

The meat of the book's case for the future of space flight is actually found in Part Two, which covers the present sate of affairs. Impey argues that the development of manned spaceflight technology is on a similar trajectory to that of the Internet. After an initial period of pioneering development by individual researchers the technology is appropriated by the military-industrial complex. The military and private research laboratories collaborate and compete to make huge advances in the technology until it becomes more widely accessible to the general public. At that point, massive private commercial investment spurs a period of explosive innovation and growth. We have already seen the Internet develop from the secretive military project known as DARPANET to (for good or for ill) an indispensable part of modern life. Impey believes we are on the cusp of the commercial era of manned spaceflight. While he freely admits that space tourism and asteroid mining are currently too technically and monetarily expensive to be very profitable, he has confidence that these ventures will continue to become more cost effective as technology advances and that the lure of space as an untapped frontier will spur investment and innovation (particularly by those with the "explorer gene").

Part Three deals with the possibility of colonizing the Solar System and the technological challenges involved therein. I was actually disappointed that the author did not go into more detail about how the experience of living off-Earth would be like. Most of the chapters of the book are relatively short and cover their topics in a cursory way. I guess this is to be expected, since *Beyond* is a book written for a popular audience, but I still would have appreciated more detail even if it made the book a longer read. The most fascinating topic in this section for me was the possibility that future distinct populations of off-Earth humans might undergo genetic drift and diverge from ordinary Earth humans. They would evolve as any population of organisms, and adapt to whatever extraterrestrial environment they encountered. But, again this section was so short that is left me disappointed and wanting more.

Part Four involves the most "out there" sci-fi concepts such as interstellar travel, extraterrestrial contact, the multiverse, and the idea that we are all inhabiting some kind of simulation ,a la *The Matrix*. Those last two topics are so speculative that I question whether it was even necessary to discuss them in the context of this book. They are interesting on a philosophical level, but they seem to have little to do with the future of manned spaceflight.

Each of the four parts of the book opens with a sci-fi vignette that follows the life of a future space explorer on a colony ship headed for a planet around Proxima Centauri, the closest star to our own. While these interconnected stories were neat and i enjoyed them, I found them unnecessary to the book as a whole.

Further, the story ends just as it's getting good, which was a bit of a letdown.

Overall, *Beyond* provides an interesting and optimistic overview of the history, present, and future of human exploration of outer space. I found it to be average for a nonfiction popular science book. Consider reading it if you are a fan of astronomy and space exploration or want to learn more about those topics. I hope that books like these can help in some small way to reinvigorate the public's interest in the space program.

Jennifer says

This is an overview book--Impey covers the history of rocketry and space exploration and many of the major figures in that history before delving into current progress on the space exploration front. All of that was fairly familiar territory. It gets more interesting in the latter half of the book, which discusses more of what the future might hold if we send missions with actual people beyond the moon, but if you're fairly conversant with the subject already, there probably isn't a lot here that will surprise you.

John Gribbin says

This is a slightly different version of a review I wrote for Wall St Journal. The use of "Mr" follows their house style.

Chris Impey is an optimist. His glass is at least three-quarters full, and he sees an extended and glorious future for humankind in space. I confess that I do not agree with him (although there was a time when I shared this view), but he has written an entertaining and informative book making as strong a case as it is possible to make that I, and those who think like me, are wrong. He has also produced one of the most accessible accounts of the history of rockets and space travel, well worth the price of admission whatever your views about our future in space.
The theme is set by a brief opening chapter in which Mr Impey explores the human restlessness that drove us out of Africa and across the world. This outward urge, he argues, must in due time (not very much due time) take us off the planet. As he explains later in the book, there is genetic evidence that the human population was reduced to no more than two thousand people by some catastrophic event (perhaps the explosion of a supervolcano in Indonesia) some time more than 60,000 years ago. As a result there is less genetic variety – less variation in the DNA -- among the entire seven billion of us alive today than there is among the members of a single band of a few dozen chimpanzees. So any genetic predisposition to move on over the horizon among those two thousand would have spread among their descendants. Not that those descendants would have set out with the idea of crossing the globe; rather, if in each generation of an expanding population a few individuals moved over the next hill to get away from the neighbours, it would have taken less than 60,000 years for people to spread all the way to Europe, Asia, and across the land bridge where the Bering Strait now is into the Americas.
Is it the same urge that led pioneers such as Konstantin Tsiolkovsky and Wernher von Braun to develop rockets? Von Braun always claimed to be apolitical and solely interested in getting in to space; but Mr Impey accurately recalls his willingness to dress up in uniform, join the Nazi Party, and turn a blind eye to the slave labour used in striving for that end. Mr Impey also, though, makes one howler which for personal reasons I cannot ignore. He describes V2 rockets “screaming out of the sky at four times the speed of sound”. At that speed, of course, the rockets arrived silently, followed by the sound; my grandparents recalled to me that the

real terror of these weapons was that they exploded without any warning.

There are a couple of other slips worth mentioning. The claim that the Viking probes of the mid-1970s carried out the “first and only” tests for life in the Martian soil ignores the landers currently on the surface of the red planet, and hydrogen, not helium, is the lightest gas. These are quibbles. But a greater lack of understanding of the background to the space age is provided by the author’s surprise that President Eisenhower should have warned of the dangers of “the military-industrial complex” having too great an influence on developing space technology. “It’s ironic that this five-star general and two-term president”, says Mr Impey, “issued such a clarion call against concentration of influence within and around the government.” On the contrary! President Eisenhower was exactly the right man in the right place, and with the right experience, to make such a warning. The result was a civilian agency, NASA, that took the lead in the American space effort.

Fascinating though the history is, the meat of this book concerns present day developments, in which private enterprise is beginning to take over from national and international agencies such as NASA and ESA, and the projection of this trend into the future. Private enterprise is certainly needed. It is embarrassing enough for Americans to know that until very recently launching astronauts and supplies to the International Space Station entirely depended on Russian technology and Russian goodwill; but it is positively frightening to realise how old that Soviet-era technology is. The rockets are essentially the same as the one that fired Yuri Gagarin in to orbit in the 1950s. Would you drive a 1950s car? One Russian engineer is quoted here as saying that updating this technology is like trying to upgrade a steam engine. “You equip it with a computer . . . You equip it with air conditioning. You put a locomotive driver with a university degree in the cabin, and it will still be the same stream locomotive.” But just recently a few supply trips to the ISS have been made by private companies hired by NASA. Surely the shape of things to come.

Beyond sketches the stories and personalities of the entrepreneurs involved in these developments -- Burt Rutan, Richard Branson, Peter Diamandis, and Elon Musk. Their visions range from sub-orbital space hops to colonies on Mars founded by volunteers with a one-way ticket. All this is certainly achievable using developments of present-day technology, with bigger question marks concerning the ability of human beings to cope with the physical and mental problems of long space voyages. But Mr Impey looks beyond to future developments such as the idea of a “space elevator”, a cable stretching from the surface of the Earth out into space to connect with a space station in geostationary orbit. He also contemplates the vast number of planets now known to exist in our neighbourhood of the Milky Way and the possibility of travelling to them.

Aware that this sounds like science fiction, he has broken up his book with fictional vignettes between each section, describing the experiences of an astronaut training for and then departing on a voyage to the stars. Usually, I hate these gratuitous bits of (usually bad) fiction in non-fiction books. But for once, it works. Indeed, it works so well that I would like to see Mr Impey develop it into a full-blown book.

But perhaps this is because I am convinced that such a possibility really is fiction. The spaces and timescales involved are too great for me to take seriously the idea of people travelling to the stars. After all, there is, as Mr Impey also acknowledges, an alternative. Unmanned spaceprobes have been hugely successful in exploring the Solar System. Even now, one is orbiting a comet, another is in orbit around the dwarf planet Ceres, and a third is closing in on Pluto. It is very easy to see us developing the ability to send future probes to planets orbiting other stars, and to get back information from them. All of which raises the question, if it is easy, why has no other civilization done it? Why are there no alien spaceprobes signaling their presence to us? This is part of the puzzle of the Great Silence, suggesting that we may be alone in the Universe.

We may never resolve that puzzle, or at least, not for a long time. But Beyond sketches a timescale for the immediate future:

2035, a commercial space industry operating, with orbital flights frequent and affordable to the middle classes.

2045, colonies on the Moon and Mars.

2065, mining asteroids and the Moon.

2115, children born off-Earth and who have never been “home” come of age and agitate for self-government.

Ambitious and optimistic, and highly debatable. But on one point I am in full agreement with Mr Imney: “Space travel, however, will never be our top priority. There are poor people to feed, diseases to cure, wars to resolve, and a bruised planet to heal.”

John Gribbin is a visiting Fellow in astronomy at the University of Sussex
And author of
Alone in the Universe: Why our planet is unique (Wiley)