

Lonely Minds in the Universe by Giancarlo Genta, Copernicus Books (imprint of Springer Science+Business Media, in association with Praxis Publishing), New York, 2007, pp. xxv + 289. Scope: monograph. Level: professional and general reader.

Giancarlo Genta asks the age-old question “Are we alone in the Universe”, i.e. are humans the only intelligent, conscious, self-aware forms of life anywhere? In attempting to answer it, he paints the fullest possible picture of the evidential background, considers every idea and its ramifications in painstaking detail, and carefully outlines the counter-argument to every argument. It is an absolutely fascinating subject, but one where most writers seem to be pursuing an agenda of their own, using their article or book to advance a particular theory – so that the reader has to be constantly on their guard. Not so with the present book. It is scrupulously fair, even to ideas that (to this reviewer) seem self-evidently dotty such as UFOs and abductions by aliens. In each case, the evidence is carefully weighed and analysed. Often, it quickly becomes clear that an explicit opinion from the author would be otiose. In a minority of cases, he sums up a discussion of some particularly vexatious question by expressing his own cautious judgement.

The main material is divided into five chapters, an Interlude and an Epilogue. They range widely in content, covering evolution, prehistory, history, philosophy, religion, cosmology, astrobiology, the on-going active search for extraterrestrial intelligence (and stupidity), the possibility of contact and its potential consequences. The author is Professor of Mechanics in the Politecnico di Torino and also Director of the Italian SETI (Search for Extraterrestrial Intelligence) Study Centre.

Genta points out that the ancients in all cultures had no doubts about the correct answer to the above question. Their world pictures were crowded with intelligent beings, usually with magical powers, and often living aloft in heavens that did not relate directly to the physical universe. It was completely obvious to them that humankind is not alone. Since then, with the advent of science, the outlook has changed to the point where it is a matter of strong contention whether we are alone or not. The first chapter sets the context with succinct accounts of the relevant features of ancient and mediæval philosophy, the Renaissance, and the birth of modern science. It also describes some of the first proposals for communication, in the era of the telescope but prior to the discovery of radio. In 1820, Gauss suggested communicating with the supposed inhabitants of the Moon by planting trees in Siberia in the form of a right-angled triangle with squares on all three sides. He also proposed using $100 \times 1 \text{ m}^2$ mirrors. As an alternative approach, von Littrov

suggested digging a huge trench in the Sahara in some geometrical shape, filling it with oil, and lighting it. These and other similar proposals assumed that mathematics is a universal language, and that our evident understanding of geometry would convince extraterrestrials that the Earth was inhabited by intelligent beings. Genta also describes the famous *canali* that Schiaparelli and other astronomers thought they observed on Mars, and their seasonal changes, as well as Lowell's exaggerated social interpretations of the observations. Of course, it is now known that these were just artifacts created by the eye's tendency to try to make sense of random arrays of dots when operating at its limits of sensitivity: with better telescopes, later, the channels simply disappeared. And in recent decades space probes have shown Mars to be a desolate place where intelligent life could not be expected (though the possibility of bacteria still remains open).

Genta provides a relatively short second chapter on the religious perspective, addressing the question of whether the existence of extraterrestrial life should be regarded as a threat to religion. In doing so, he considers Hinduism, Buddhism, Judaism and Islam as well as Christianity where he addresses potential problems created by the doctrines of original sin and redemption. He quotes Teilhard de Chardin on the possibility of other biospheres, in addition to that of Earth. He also looks at the growth of creationism and its relationships to fundamentalist religious beliefs, on the one hand, and to reality on the other. His implicit conclusion is that there need be no conflict between religion and the existence of extraterrestrials except in the case of fundamentalists who do not accept scientific method (nor, perhaps, reality) in any case.

The real meat of the book comes in chapters 3 and 4. The former deals with astrobiology but, in order to do so effectively, it first gives an account of our current scientific understanding of the origins of the Universe, Galaxy, Solar System, planets, Earth, Moon, and life on Earth. Many details of this picture are obviously important to an estimate of the probability of life appearing elsewhere. Of course, the definition of life itself is a conundrum that cannot be avoided. After some discussion of the difficulties, Genta suggests: "Life is a self-sustained chemical system capable of undergoing Darwinian evolution", but hastily emphasises that this and all other definitions must be labelled as applying to life "as we know it", or "of the terrestrial type". He repeatedly and wisely cautions that it may be extremely difficult to recognise other kinds of system as being either living or intelligent. He provides an extensive discussion of how life may have originated on earth, ruminates at length on the likelihood of the event, and carefully weighs the evidence for/against panspermia (life coming to earth from elsewhere, e.g. on a mete-

orite) as first proposed by Kelvin in 1871. The fact that life seems to have appeared very soon after the early Earth was capable of supporting it (perhaps 3.5 billion years ago, though the evidence is indirect) suggests either that the spontaneous appearance of life in a chemical broth has a high probability, or that life came to earth from elsewhere. The author accepts both ideas as sound hypotheses, but feels there is insufficient convincing evidence to come down on either side. Once there is life (at least approximately as we know it), we can expect mutations to produce variety and Darwinian evolution to select fitter individuals and to move (perhaps) in the direction of greater complexity. So it is in a way surprising that there was apparently little change for a billion years or more after life appeared on Earth, but just bacteria. The first appearance of the eukaryotic cells (with a nucleus), of which all plants, fungi and animals are made seems to have occurred about two billion years ago – and it remains unclear how probable/improbable an event it was. Given the much greater variety of structures possible with eukaryotic cells as compared to bacteria (prokaryotic cells), this event may have been an essential precursor for the evolution of higher animals and thus for intelligent life on Earth. Among a huge number of other relevant topics, Genta also discusses catastrophes and mass extinctions, the Anthropic Principle, extrasolar planets, conditions needed for the development of life, and the possibility of life on Mars and elsewhere in the solar system, as well as outside the solar system.

If the definition of life is difficult, so also is the definition of intelligence. Chapter 4 is devoted to the search for extraterrestrial intelligence. So problems of intelligence, consciousness, self-awareness, and language, are unavoidable. Genta tackles them head-on, and provides a very interesting discussion. He argues persuasively, though with his customary caution, that the onset of consciousness was probably not an on/off process but more likely evolved gradually. He provides a nice perspective on how the early humans developed, the extinctions they caused, the place of the Neanderthals (not *Homo sapiens sapiens*, but human nonetheless) and others, and the importance of culture and technology. He goes on to discuss the expansion of intelligent life, and the expected propagation of humans and their culture throughout the Universe. He points out that the set-backs to manned space exploration of the last few decades are just transient and that, on an evolutionary timescale, the process has hardly started yet. He discusses various practical ways of dealing with the enormous timescales of interstellar travel, considering speed (near c to cause time dilatation), hibernation, “space arks” with perhaps a million people, and additional possibilities. Assuming that there might be extraterrestrial creatures

heading our way, how can we hope to communicate with them? Genta first discusses the likelihood of this, introducing Drake's equation and pointing out its uncertainties, and then considers the possible means of communication.

After a short Interlude (on the Search for Extraterrestrial Stupidity which, actually, is much more than just a joke), Genta discusses the possibility of contact in Chapter 5. He opens with a discussion of what is known as the Fermi paradox (though the ideas were first enunciated by Tsiolkovsky), which asks (in effect): space travel is obviously possible; one expects there to be older and therefore technologically more advanced species in the Universe; so why are they not already here, visiting us? This is where the UFO-ology comes in, because some suggest that the visitors are already here, but the evidence is weak to say the least. It is also possible that extraterrestrial intelligence does not exist, or that interstellar travel is actually impossible. And then there is the zoo hypothesis, in which our potential visitors are standing well back while they watch with interest to see what happens to us. Genta considers all of these, and many other possible answers, and carefully evaluates each of them.

Although, in his Epilogue, Genta concludes that it is currently impossible to give a definitive answer to our opening question, the reader will have gained a very clear and rounded understanding of the on-going debate and of the main points of contention. It is a solemn, scholarly, and intensely serious book, carefully and very well-written in English (though with recognisably Italian prose style). The sweep of the subject matter is on a truly vast scale, covering many different sciences as well as the relevant history, philosophy, theology, and history of science at the beginning. Every reader, even those who are not especially enthused by the prospect of extraterrestrials, is likely to appreciate this splendid portrait of humankind's cosmic origins and of how we fit into the grand scheme of existence.

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