Preface

Two lights for guidance. The first, our little glowing atom of community, with all that it signifies. The second, the cold light of the stars, symbol of hypercosmical reality, with its crystal ecstasy. Strange that in this light, in which even the dearest love is frostily assessed, and even possible defeat of our half-waking world is contemplated without remission of praise, the human crisis does not lose but gains significance. Strange, that it seems more, not less, urgent to play some part in this struggle, this brief effort of animalcules striving to win for their race some increase of lucidity before the ultimate darkness.

Olaf Stapledon

This book is about robotic exploration of the nearby stars and the prospects for achieving this within the next century. In particular, we will focus on the propulsion technology that will be used to accomplish such an ambitious objective. This is so called 'game changing' technology that goes beyond conventional chemical rockets, using exotic fuels and more efficient engines for the purpose of an interstellar mission. This includes ideas for engines based upon harnessing the emitted energy of the Sun, using fusion reactions or even tapping the energy release from matter-antimatter annihilation reactions. This book serves as an essential primer for anyone new to this field who wishes to become familiar with the ideas that have already been developed and how to attain the necessary theoretical tools to create similar ideas for themselves. If, by the end of this book, you are thinking of your own ideas for how machines can be propelled across the vastness of space, then this book will have been successful in its ultimate aim.

At the dawn of this new millennium we can look back on the previous century with pride, knowing that humanity took its first steps into space and even walked upon the surface of the Moon. We have collected a wealth of data on the many planets and moons of our Solar System, and our robotic ambassadors are still pioneering the way so that one day humans may hope to follow where they lead. The Moon and Mars are the current focus of human ambitions in space, and this is

right for the short-term goals of our species. But in the long term, missions to places much further away will become not just aspirations but vital to our survival.

From the outset of this text, we must be truthful and admit that the technology to enable human transport to other stars is currently immature. The physics, engineering and physiological requirements are unlike anything we have ever encountered, and this unique problem demands our full attention if we are to ever cross the enormous gulfs of space that separate the stars in our galaxy and become a truly spacefaring civilization. But if we are bold and eventually attempt this, the scientific, economic and spiritual rewards will be many, and our civilization will become enriched for the attempt. Until then, we must be content with robotic exploration and to push that technology to its limit. We must continue to launch missions to the outer planets of our Solar System to explore those cold but interesting worlds. Eventually, our robotic probes will break through the termination shock of the solar heliosphere and pass out into the Kuiper Belt to explore many strange new dwarf planets, some perhaps yet undiscovered. Then they will be sent to much further distances out into the Oort Cloud to investigate the myriad of comets that orbit our Solar System in large period trajectories. Finally those same robots will enter the outer reaches of the interstellar medium, the diffuse nebula of space that is dispersed between the stars, and for the first time in history a human made machine would have fully left the gravitational cradle of our Sun.

By this time, the technology performance of our machines should have improved by many orders of magnitude so that missions to the nearest stars will become possible and scientific data return will become common. What will those probes discover? Perhaps unusual planets with oceans made of materials thought impossible where life might be swimming among its depths. The astronomical knowledge gained will be highly valuable; the chance to be so close to another star and its orbiting worlds will enrich our knowledge of the universe and give us a better understanding of its structure, evolution and origin.

A few moments spent thinking about the interstellar transport problem quickly leads to the realization that there are two main extremes to reaching the stars. We can build very lightweight vehicles with a limited payload size in the hope that their small mass allows for large speeds, such as a solar sail. Alternatively, we can build massive vehicles the size of small moons, which will move slowly and take perhaps thousands of years to reach their destination; these are so called world ships. For any form of human exodus to another world, clearly the latter option is the only credible approach. However, as one digs into the interstellar literature we find that there are approaches to this problem that lay between these two extremes. We find that physicists have invented clever theoretical (and some practical) means of allowing a large mass scientific payload to be delivered to a destination at a speed of a few to tens of percent of light speed, thus getting to the target within decades. It is then just a matter of the engineering technology progressing to an acceptable readiness level. Many of these schemes are discussed in this book.

In reading this book it will be clear that the author favors the nuclear pulse propulsion approach for interstellar missions. This is along the lines of the historical Orion and Daedalus concepts. It should be noted that this is not because of a belief

that other concepts do not meet the requirements for interstellar missions. In fact the opposite is true, and technology such as solar sails, laser sails and microwave sails in particular do offer great potential for near term demonstration. However, it is a personal belief that nuclear pulse technology is nearly ready for use now, if not already available in some form, and is the most appropriate route for an interstellar flight. Power is what will take us to the stars, and sending something there fast requires powerful engines as provided by the nuclear pulse options. In the end, it is likely that the first interstellar probe will be a combination of propulsion technologies – a hybrid design utilizing nuclear electric, sails and nuclear pulse to augment different parts of the mission. When this happens, all of the individual efforts over the decades of research that have gone into making each of these technologies ready will have been worth the effort.

Another personal view that has been taken by this author is that Mars should be the next destination for human exploration. This will push our technology forward while also beginning the establishment of a human colony on another world. Contrary to some claims, the exploration of Mars is not prohibitively expensive if done in a manner similar to the proposed Mars Direct plan. National and international space agencies need a common focus and a common goal – Mars is the logical candidate and a clear springboard upon which a full program of interstellar exploration may begin. Indeed, there are no technological reasons preventing us from starting direct colonization of Mars today.

Many people believe that interstellar travel, even robotic exploration, is so difficult and the obstacles so unsurpassable that it will be many millennia before we can attempt it. However, it is the hope of this book to demonstrate to the reader that not only is interstellar travel perfectly possible, it is within our grasp, and the first unmanned mission will likely be launched by the end of the twenty-first century (a bold prediction) and certainly by the mid twenty-second century. As will be shown, many feasibility design studies have already been undertaken historically, often involving teams of physicists and engineers, producing study reports that demonstrate the engineering problems and potential solutions. These people are among a growing network of optimists that share in a single vision that the human destiny in space lies not just with the Moon and nearby planets, but much further to other worlds around other stars. History will show which one of these concepts becomes the true template for how our robotic ambassadors first enter the orbit of another star and achieve this seemingly impossible and long desired ambition.

Berkshire, UK K.F. Long

http://www.springer.com/978-1-4614-0606-8

Deep Space Propulsion
A Roadmap to Interstellar Flight
Long, K.F.
2012, XXI, 367 p. 73 illus., 22 illus. in color., Softcover
ISBN: 978-1-4614-0606-8