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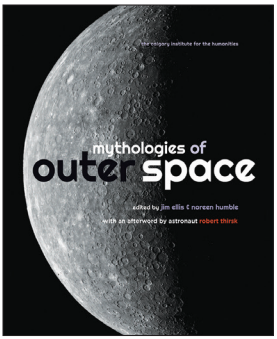

MYTHOLOGIES OF OUTER SPACE

Edited by Jim Ellis and Noreen Humble

ISBN 978-1-77385-588-2

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afterword

I have enjoyed a privileged career as an astronaut. Living and working in space for over two hundred days aboard three different spacecraft was the fulfillment of a childhood dream. My career did not entail solely the exploration of space, but also the exploration of oneself. The demands of the flights, as well as the rigours of training, regularly took me to my limits—physically, mentally, and emotionally. I enjoyed every minute of it.

I am, therefore, pleased that the Calgary Institute for the Humanities also deems the exploration of outer space to be a socially important issue and worthy of interdisciplinary discussion. In fact, during a daylong community forum in May 2022, the Institute convened esteemed scholars and citizens to celebrate and deliberate on a range of topics related to the final frontier. How gratifying!

And what an eclectic group of humanists, artists, and social scientists that gathered together! The contributors to the forum entitled *The Final Frontier: Mythologies of Outer Space* included, among others, a space archaeologist, an Indigenous astronomer, science fiction scholars, poets, and artists. Some contributors shared their love of astronomy and others their fascination with space flight. In this publication, which expands upon the forum deliberations, I have enjoyed reading how the ancient Greeks regarded space, and how more contemporary writers have imagined voyages to the Moon. I share the same sense of wonder and spirit of adventure.

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Of all human endeavours, space exploration must surely be one of the most all-encompassing. Everything that I have accomplished in my career as an astronaut has been based on collaboration—collaboration across disciplines, across cultures, and across international borders. While my own space travels were confined to low Earth orbit, I await upcoming explorations farther into our solar system by the next generation of astronauts. A return to the Moon is anticipated later this decade (*Global Exploration Roadmap* 2018). I hope to see astronauts walk on Mars within my lifetime.

My ongoing engagement in human space flight has often led me into lively debates on exploration with colleagues in a variety of settings—aboard orbiting spacecraft, as panelists at conferences, or over beverages at a neighbourhood pub. Being an engineer, physician, and astronaut, I tend to contribute technical, medical, and operational perspectives to these conversations. My colleagues add insights from their own particular backgrounds and experiences.

Participation from the humanities, the arts, and the social sciences in these sorts of discussions is especially valued. I admire my liberal arts colleagues for their abilities to ask the right questions and to examine technological matters through a lens of humanity. Positioning problems of societal importance within the context of a bigger picture and in relation to comparable events from the past is critical to addressing the complex, multi-faceted issues facing today's space program.

Similarly, there are insights from Indigenous ways of knowing that could guide humanity's future forays into the solar system. In addition to being the first explorers of Turtle Island (the continent of North America), Indigenous peoples uphold a resource-management mindset aligned with sacred beliefs and principles of stewardship. Their systems-engineering approach to life asserts that all living beings are part of an integrated and interconnected whole; nothing in our natural ecosystem operates independently (Stonechild 2024).

In many SciTech fora, the voices of the liberal arts, as well as of Indigenous and other communities renowned for clear and critical thinking, have been under-represented (Husbands Fealing, DeVeny Incorvaia, and Utz 2022). While I would never ask one of my non-technical friends for advice on how to rendezvous and dock a spacecraft, I seek their guidance when faced with contentious quandaries. Critical thinking skills are sorely needed to guide our space community through this present era of unprecedented dynamism and disruption.

It is a privilege to live and work in space—a realm of infinite majesty and mystery. Spacefarers understand that this privilege comes with a responsibility to the long-term welfare of space, our planet, and all its inhabitants. There is no place in space for the careless, the exploitative, the selfish, or the defiant. Beyond the concerns raised in this book by Alice Gorman, Hilding Neilson, and Chris Pak about terraforming (making planets habitable for humans), lunar mining, and colonial attitudes within some research circles, there are a litany of other looming issues with equally troubling consequences. For instance, a plethora of new entrepreneurs are now engaging in space affairs (Brown and Alabaster 2023, 13). Commercial ventures are being sparked by tectonic advances in rocket technology and subsequent reductions in the costs of launching payloads to space. While these remarkable innovations from companies like SpaceX are certainly welcomed, one has to ask whether the new players rushing in to seek profits from beyond Earth's atmosphere will treat the environment with respect. Will they be mindful of the repercussions of their actions? Or will space become another marketplace dominated by billionaire-backed multinationals with little consideration for the privilege of operating there?

Stewardship is not the only concern on my mind; I also worry about safety of flight. Emergency situations can arise in space at any time—from launch to landing or anytime in between. The harsh environment, the formidable power of rockets, and the hyper velocities of our spacecraft can be unforgiving and catastrophic when things go wrong. In the six-plus decades of human space flight, eighteen astronauts and cos-

monauts have died while serving aboard spacecraft. I lost seven dear colleagues in the Columbia disaster of 2003. Risk will continue to be an inherent part of any undertaking in space—human or non-human. All participants must understand this and regard safety as their top priority.

So, I am outraged when military forces of spacefaring nations feel compelled to test the operability of their anti-satellite systems in space, creating clouds of shrapnel in low Earth orbit. (Byers and Boley 2023, chap. 7). The resulting debris from these demonstrations persists for years and is a threat to the well-being of astronauts living there. Space flight is already dangerous enough (Byers and Boley 2023, fig. 2.2) without adding this deliberate man-made hazard.

Lessons have not been learned. As I write this afterword, the morally unthinkable is being considered. It is reported that a nuclear-armed anti-satellite weapon is being developed by a foreign state (Samson and Walton 2024). If deployed in space and triggered, such a weapon could destroy a wide array of commercial, civil, and military satellites and render low Earth orbit unusable—a tragic outcome for global society.

Human behaviour seems resistant to change (Fulgham 1988, chap. 1). We made similar mistakes in past centuries when settling former frontiers, exploiting public commons (Hardin 1968), and colonizing unceded territories. The transition of exploratory objectives from discovery to exploitation has historically not gone well, and I fear that when humans reach the Moon and Mars, we will behave the same.

You may ask whether there are international rules to enforce the necessary mindset. Yes, there are. The United Nations Outer Space Treaty (1967) is regarded as the Magna Carta of space law and provides the basic principles for the use of outer space. It was intended to curb unacceptable behaviour. However, this treaty was crafted in the Cold War era, when few nations could access space. Its original authors did not foresee the day when thousands of spacecraft would orbit our planet daily, when a rapidly growing global space sector would be worth over $469 billion, or when more people would fly to space as paying tourists than as government-trained astronauts (Brown and Alabaster 2023, 10).

Being outpaced by the speed of innovation, the Outer Space Treaty is not up to the task of regulating present-day activities. It states, for instance, that nations must pay regard to other nations' activities and not interfere with them (Outer Space Treaty 1967, art. IX). Unfortunately, the wording of the treaty is vague and does not impose either a clear legal obligation not to pollute space or a responsibility to clean up debris.

The follow-on Moon Treaty of 1979 is included in this publication as an appendix. While it states that activities that disrupt the lunar environment are prohibited, it has not been adopted by any of the major space nations that are currently vying to land on and exploit the Moon.

This is, therefore, an opportune time for the global space community to come together and reform existing, inadequate governance structures. I am not a governance guru and I have no expertise in policy, law, or diplomacy, but it seems to me that space governance should be a team sport with a diversity of players. To better address the novel challenges and uncertainties of the twenty-first century, governing bodies would be well served to double down on a commitment to cross-cultural, multidisciplinary, and international representation. The path forward should be decided by a spectrum of players broader than the traditional governmental and industrial stakeholders. The exploration of space is too important not to include all voices and not to balance all interests.

Yes, the opinions of those who regard space for military purposes must be heard. But they must be balanced by those who espouse space exploration as a means of peaceful collaboration. The industrialist who aspires to mine lunar resources must be heard, but so must the poet who looks to a full Moon in a midnight sky for inspiration, and the romantics who share a bottle of wine on a patio bathed in untainted moonlight. The voice of the capitalist who introduces broadband services to under-served corners of the planet must be balanced by the voice of the Elder who educates villagers on the constellations in Indigenous lore. Short-term returns on investment as espoused by corporate CEOs must be balanced by longer-term outlooks of youth intending to preserve outer space for the generations that follow.

The numerous boards, councils, and executive bodies entrusted to oversee space matters on the global stage as well as on regional and corporate levels would benefit from more diverse and inclusive memberships. Points of view and experiences from underrepresented communities could guide governing bodies in understanding the “why” of the problems to be solved before starting to work on the “how” (Argenti 2024; Mahroum and Ansari 2018).

Don’t get me wrong—I am not jaded. I believe that we live in exciting times and there are reasons to be hopeful. The exploration of space engenders hope for humanity because of the promise of global collaboration. Throughout my training and space flights, I found that the visions that united my crewmates and me were more powerful than any issues that divided us.

Yes, I am frustrated by misguided decision makers and some aspects of space governance, but I have many kindred spirits who are determined to explore space safely and sustainably, and with equity and peaceful intention.

The Artemis Accords, for instance, are a helpful stopgap measure. The accords are non-binding, bilateral agreements between the United States and other countries wishing to partner in NASA's Artemis program. While not universal and not without controversy (Green 2022), the accords do affirm the intent of the Outer Space Treaty and provide common principles, guidelines, and best practices to manage explorations of the Moon and beyond.

I enjoyed reading *Mythologies of Outer Space*. While highlighting the wonder and awe of space exploration, the essays contained in this volume also shine a critical light on environmental and ethical implications. The book reaffirms in my mind that the exploration of space cannot be regarded simply as a research and development undertaking. Yes, there are many technological and operational hurdles to be overcome, and these are best addressed by the rocket scientists and engineers. But this will be the easy part. The hard part of future exploration will be managing the spectrum of partners and the diversity of interests so that we can explore safely, sustainably, equitably, and peacefully. It won't be easy; it will be hard. It will measure the best of our energies and skills (Kennedy 1962, 3). And we will succeed because the exploration of the final frontier is too important to get wrong.

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