Books & arts

Far sight and flotsam

Two books explore how humans are both probing and polluting outer space. **By Meg Urry**

Dr Space Junk vs The Universe: Archaeology and the Future
Alice Gorman
MIT Press (2019)

Handprints on Hubble: An Astronaut's Story of Invention
Kathryn D. Sullivan MIT Press (2019)

The space age erupted with a flurry of satellites. The first two Soviet Sputniks launched in 1957, soon followed by the US Explorer I and Vanguard I. In 1959, spurred on by cold-war tensions, NASA selected seven men as astronauts for its Project Mercury programme. (Thirteen women who passed the same hurdles, courtesy of a private, parallel programme, were vetoed.) Barely a decade later, NASA's Apollo astronauts walked on the Moon.

The dawn of space exploration was all about the now. It was daring and risky, punctuated by engineering miracles and an air of invincibility. It wasn't, however, focused on the long term. Now, six decades on from Sputnik, old spacecraft are displayed in museums, robotic missions regularly reveal secrets from throughout the Universe and private companies such as SpaceX are planning colonies on Mars. And the rich, crowded future of space is the focus of two books, one by space scientist and oceanographer Kathryn Sullivan, the other by space archaeologist Alice Gorman. Both make us think more deeply about how we, as humans, ought to fit into the cosmos.

In *Handprints on Hubble*, Sullivan, a former NASA astronaut who helped to launch the Hubble Space Telescope in 1990 and has been involved in updating its capabilities since, highlights the importance of planning for new instruments and infrastructure. Gorman, meanwhile, applies an archaeologist's perspective to space-related materials and activities in *Dr Space Junk vs the Universe*.

Hubble has made more than one million observations of stars and galaxies, and probed dark matter and the history of the Universe itself, over nearly three decades. I worked for many years at the Space Telescope Science Institute in Baltimore, Maryland, which runs Hubble's science operations for NASA. I was there for the launch, the discovery of a flaw in the primary mirror and the astonishing fixes that astronauts repeatedly pulled off. Yet Sullivan's book makes clear how much I hadn't known. Hers is a first-hand story, from conception to today, of the first space mission for which in-orbit maintenance and repair were integral from the start.

Sullivan brings alive the strenuous challenges of space mechanics. Replacing entire instruments or — much harder — parts deep inside them during long, arduous spacewalks demands custom-designed tools. For example, Sullivan explains the evolution of the foot anchors that keep astronauts in place. Without these, turning a screw one way would make the astronaut and/or the spacecraft rotate in the opposite direction. This is the kind of detail that underscores the complexity of the job.

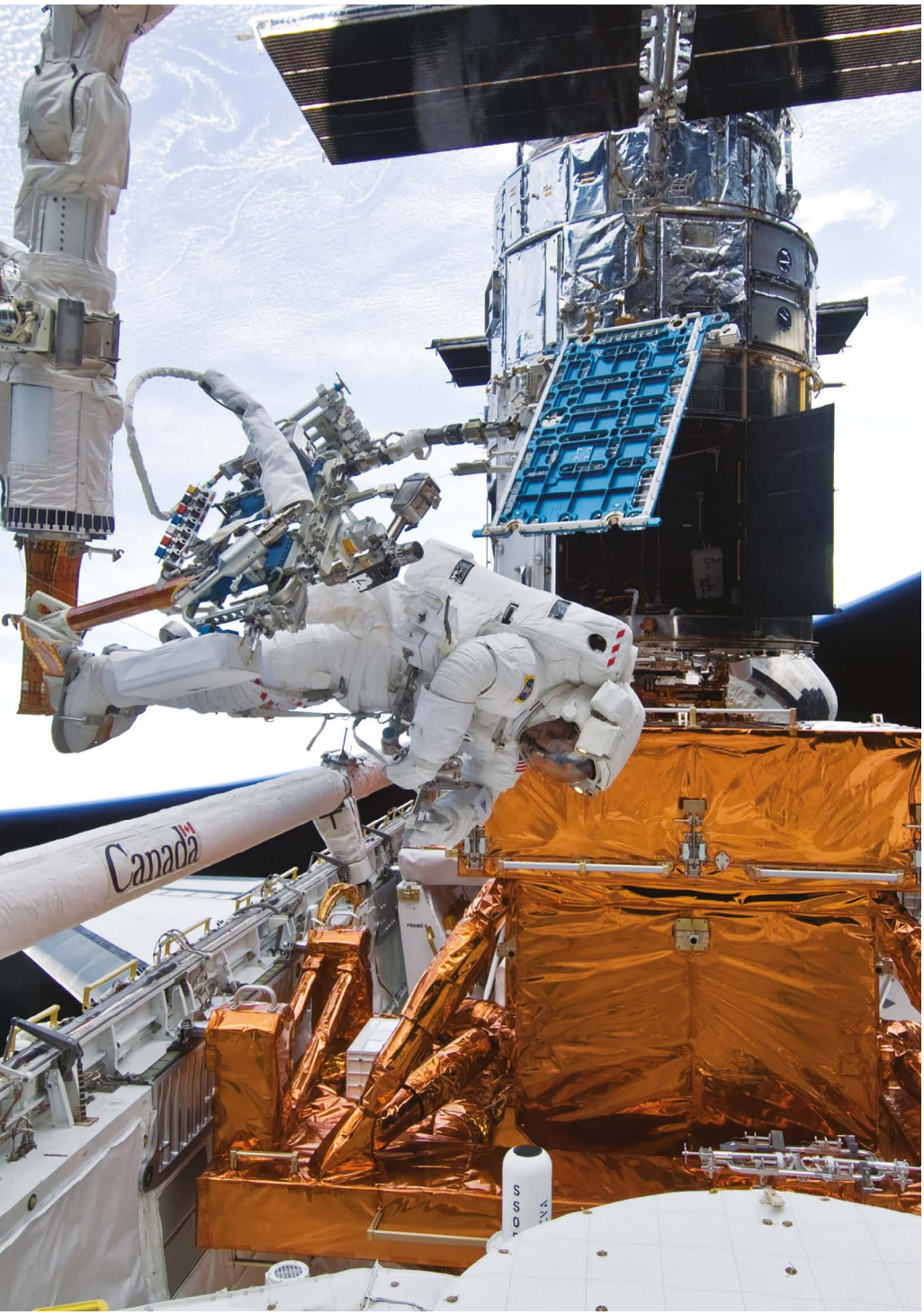
Every step needs forethought. Once removed, a screw will float away if not caught, creating dangerous space junk that could damage other craft, as Gorman discusses. Sullivan and her colleagues spent hundreds of hours testing tools and procedures on a simulated Hubble in an underwater tank, with scuba-diving gear standing in for unwieldy spacesuits.

The meticulously planned servicing missions are what have kept Hubble at the leading edge. Its first set of instruments was selected in 1978. By today's standards, the technology was impossibly crude and the computer storage limited. After the first servicing mission in 1993, new optics compensated for the flaw in the mirror, the workhorse camera had improved detectors and the spacecraft had new solar panels and other vital infrastructure. There have been four more such missions. The ultraviolet spectrograph (COS) installed in 2009 is up to 20 times more sensitive than the previous ones. That is equivalent to increasing the mirror diameter from 2.4 metres (the largest that could fit inside the Space Shuttle bay) to more than 10 metres (larger than any telescope yet built).

Like Sullivan, Gorman was fascinated by space as a child, inspired by dark skies over the Australian countryside. But in common with many women at the time, she was discouraged from becoming an astrophysicist. Instead, she earned a PhD in archaeology and worked as a consultant documenting Indigenous heritage sites in her home country. But her gaze

JSC/NASA

© 2019 Springer Nature Limited. All rights reserved.



Astronaut Michael Good works on maintaining the Hubble Space Telescope.

frequently turned skywards. Eventually, she applied her training to space exploration, regarding even the lowliest "space junk" as an important part of the historical record.

As the "Dr Space Junk" of her book's title, Gorman writes about how we should protect our space legacy. She describes the reef of orbital detritus around our planet, including satellites, alive and dead, embedded in a sea of discarded hardware and debris from space collisions (deliberate and otherwise), as well as receding planetary probes and equipment abandoned on the Moon.

She draws parallels between archaeological investigations that find ancient artefacts on Earth and missions to catalogue objects that are merely decades old circling above it. At times, her ideas can seem fanciful – as when she discusses shadows left by footprints on the lunar surface, or speculates about future civilizations finding spacecraft beyond the Solar System. But for the most part, the book made me think fresh thoughts.

Gorman reminds us how fragile our access to space is. Orbital debris alone poses a risk to every newly launched spacecraft. She warns of the need for nations to cooperate in preserving and protecting the space environment, and points out the moral responsibility of space-faring nations to deal on an equal basis with those that are not.

Both Sullivan and Gorman envision a future in which astronauts, and possibly ordinary citizens, live and work in space regularly. In that world, it will be normal to site telescopes in stable orbits at L2 (the second Lagrange point, which circles the Sun in tandem with the Earth–Moon system) and to upgrade them regularly. Hubble has seen a few monster galaxies as they were early in the evolution of the Universe. In future, more sensitive instruments, such as the James Webb Space Telescope, might see much smaller early galaxies and possibly even the first stars.

"Both Sullivan and Gorman envision a future in which astronauts live and work in space regularly."

To read these two books is to marvel at what we have achieved in our nascent efforts to inhabit space, and to recognize that we have barely begun that quest. Many popular treatments of space travel, including the films *Apollo 13* (1995) and *First Man* (2018), have framed it as competitive derring-do. Sullivan and Gorman focus more on our common interests, as humans, in knowledge and cooperation. They invite us to think anew about the legacy and the future of space.

Meg Urry is Israel Munson professor of physics and astronomy at Yale University, and director of the Yale Center for Astronomy and Astrophysics in New Haven, Connecticut. She uses the Hubble, Chandra and Spitzer space telescopes in her research on black holes.
e-mail: meg.urry@yale.edu

© 2019 Springer Nature Limited. All rights reserved.