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CHAPTER 33

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Introduction

The International Space Station (ISS) is a modular habitat that orbits the Earth at a speed of 7.66 kilometres per second relative to the Earth's surface at an altitude of around 400 kilometres. This means it orbits the Earth roughly every ninety-three minutes, around 15.5 times a day. It comprises modules that interconnect, reflecting international cooperation between five space agencies: NASA (United States), Roscosmos (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada). The space station was initially launched in 1998 and has seen a series of developments and additions. It reached its fully operational size supporting six crew members in 2009. More than two hundred astronauts, cosmonauts, and civil participants from nineteen different countries have visited the ISS, which has allowed a range of activities from scientific research to media engagements, teaching exercises, and even the shooting of a feature film. The station cost an estimated $150 billion to develop and build with operations expected to run until around 2030 (Sheetz 2021). NASA has described the station as "one of the greatest technological, geopolitical and engineering achievements to benefit humanity" (Nixon 2016: 29). The NASA 2019 *International Space Station Benefits for Humanity* book states that the ISS has seen over 2135 scientific works published from the research carried out on board, representing the work of over five thousand scientists. It notes that the impacts of this research are predominantly in the fields of chemical, mechanical, and civil engineering, health and disease, electrical engineering, computer science, and medical research.

This unique extraterrestrial environment has received little attention from mainstream anthropology. Whilst, as this volume attests, there is a significant and growing interest in the social and anthropological study of outer space (see Dickens and Ormrod 2016; Messeri 2016; Olson 2018; Valentine, Olson, and Battaglia 2009; Battaglia, Valentine, and Olson 2015), there has been little direct attention on the ISS as a sociocultural object of ethnographic inquiry. Gorman and Walsh's (Gorman and Walsh Forthcoming; Gorman 2009) work on the archaeology of gravity and the material culture of the ISS is a notable exception to this, but their disciplinary approach differs from the ethnographic. This chapter outlines the approaches of the ETHNO-ISS team, who are conducting a multisituated, large-scale anthropological study of the ISS. The five-year project, running from 2019 to 2024, is funded by the European Research Council, and it partners with a number of associated academics with funding from other sources (see Acknowledgements). This

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chapter outlines the approaches taken by each of these contributing academics. In doing so, we present the ways in which such a study can be approached methodologically, and how an ethnography of the ISS talks back to core theoretical concepts and ideas in anthropology.

Each ethnographic contribution to the ETHNO-ISS project explores distinct and individual anthropologies that stand alone as contributions that both build upon and further the discipline through a focus on the ISS. However, the ethnographies compose a purposeful partnership, unified through the shared practice of 'worlding'. It is this concept of worlding, taken from Martin Heidegger, that positions the ETHNO-ISS research agendas as able to highlight the ways in which people attune to the fabrics of society in constant dialogue with the social and material worlds around them. The ISS presents a milieu in which the standard terms of engagement between the bodily and the material, the intimate and far-reaching, are reconvened. One's relationship with one's body, and with one's cosmology, are recalibrated to make new affective natures, in what Kathleen Stewart (2014) refers to as senses of "legibility" (p. 119), particularly as they relate to the widely diverse scales of habitation and gravity that are at play between the Earth and low Earth orbit. As she writes, "Some assemblage of affects, effects, conditions, sensibilities, and practices throws itself together into something recognisable as a thing. Disparate and incommensurate elements … cohere and take on force as some kind of real, a world" (p. 119). Martin Heidegger himself refers to such worlding processes as nothing short of the "uprooting of man" (cited in Oliver 2015: 152), implying that Earth has both a physical and social soil from which the human figure drinks nutrients and knowledge. Cultural practices, knowledges, and movements, and the theories and analytics the anthropological discipline has developed to understand them, can then be understood as also deeply earthbound and terrestrial.

The ISS as a 'nexus' enables this form of metaphorical anthropic gardening, challenging us to think through the ways in which the ISS and human activity in outer space may provide disruptions that either pull up established roots of our being or make new fertile ground from which humans can construct their worlds. The ETHNO-ISS project shows how such disruptions and newness that outer space provides seep into all the colourful foundations of being human that have so long fascinated anthropology: cosmology and religion; biology and well-being; a sense of home and a sense of belonging; what it means to be local and what it means to be global; freedom, individualism, collective behaviour, and the nature of control. These human conditions and frameworks of knowing are made anew in lower Earth orbit—sometimes powerfully, and sometimes subtly, and often in ways unanticipated and unexpected, what Debbora Battaglia has partly referred to as "exo-surprise" (2012). The ETHNO-ISS mission is to systematically trace this worlding.

Lastly, in presenting these ethnographic explorations, ETHNO-ISS asks its readers to return this 'sense of legibility' to their earthbound worlds. It furthers the Anthropocenic call to challenge the notion of the Earth as a concrete and stable stage upon which actors carry out life and enact their social milieu, what Stefan Helmreich has described as a form of qualitative weight (2011: 1236). Ethnographies of the ISS illustrate and evidence, perhaps ironically, the principles of what Buckminster Fuller (1963) famously referred to as "Spaceship Earth", our terrestrial world itself as actor and agent providing nurture, movement, and a sense of home more fragile than it is often given credit. In doing so, the ethnographies ultimately highlight these processes of attunement that are central to living on and constructing any world, and which are always in the making.

When telling people that we are undertaking an ethnography of the ISS we often meet with some version of a now-familiar joke: "How big is your travel budget?!"[1] or "So you are going to space then!?" The jokes highlight two things. First, space is an incredibly difficult and expensive place to which to travel. Second, as a disciplinary practice, social anthropological fieldwork is traditionally considered as an exploration of the 'other', conducted in places peripheral to the anthropologist. The anthropologist must travel, dwell amongst the ethnographic 'other', and return to

their home. Many anthropologists are able to state that they do fieldwork in *a* place with *a* people, that is, they study a particular cultural group that is located in a specific place. Many methodological trends in ethnography in the last decades have challenged this anthropological orthodoxy, including principles of multisited ethnography (Marcus 1995), in which the researcher's field site is defined by mobility, fluidity, and lines of flight which the ethnographer must 'follow'. This methodology creates new freedoms for its practitioners, and freedoms as well for the people and places of its study, though these methods are not without its analytical dangers and limitations (see Van Duijn 2020). Because of a biographical emphasis on objects, material culture studies anticipated these trends in its emphasis on 'following the object', and that subdiscipline continues to push the boundaries of ethnographic method (Carroll, Walford, and Walton 2021). As our project is situated in both cutting-edge material culture studies and social anthropology, we employ both traditional and recent methods to engage with the cultures of lower Earth orbit. Our study starts with an eponymous object and is attentive to the multiple communities that have significant relations with the ISS as an object. As such, the groups of people with whom we engage and the social relations we study are wide and varied, incorporating, among a great many things, notions of religion and transcendence in Russia, materiality and utopia in the United States, or enthusiasm and energy in online communities. The commonality here is the ISS itself and its novel position as an extraterrestrial habitat that facilitates particular modes of social relations.

As Buchli (2020) states, the ISS presents new methodological challenges for fieldwork. Taking a lead from anthropological studies of social media and digital cultures, Buchli argues that communities such as mission controls in Moscow, Houston, and Tsukuba, or Orthodox Christians tracking relics on the ISS, or enthusiasts monitoring rocket launches are all coterminous with the ISS site, "simultaneously constituting and occupying the same 'field' of co-presence" (2020: 18). As Anne Beaulieu (2010) argues, an emphasis on co-presence produces different formulations of the anthropologist to the field site more than a focus on co-location does. Beaulieu asserts that the "field is constituted in the interaction" (p. 463). So, whilst we may not be spending all (and then some) of our grant on a ticket to the ISS, we are able to feel its effect, and be attentive to the ways in which it produces social relations through the practices of the communities that relate to the ISS. As this chapter will demonstrate, such attentiveness relies on traditional ethnographic participant observation as well as innovative methodologies involving online or dispersed communities. The chapter considers each researcher's work in turn, leading us through anthropological issues of the body in space, rapid manufacturing technologies and novel materialities, notions of universal humanity, utopia, the apocalypse, God, transcendence, and more.

We start with the work of the principal investigator, **Victor Buchli**, whose work examines the new manufacturing economy and material culture of low Earth orbit (LEO) aboard the ISS. The terrestrial locus of this research is Silicon Valley and its wider communities. Buchli, through his participant observation with a number of companies and communities of makers involved in the development of 3D printing and other forms of manufacturing aboard the ISS, examines the ways in which microgravity is exploited as a resource in the creation of a new and distinctive extraterrestrial material culture and its novel scales. The methodology involves following an artefact as it is designed, rendered, coded, provisioned, and printed and further how it is used, talked about, and employed in not only a utilitarian way but as an object that elicits narratives of exciting and expansive futures and the creation of new terrestrial communities and the materialisation of novel moral orders. The 3D-printed objects are used in education and public outreach as they are perceived to symbolise a potential for a future where the conditions of manufacturing and making are radically different as well as creating the basis for new desired forms of democratisation. But alongside, the research also examines how new forms of exclusion are suggested both terrestrially and extraterrestrially as they emerge within this new manufacturing economy in microgravity.

In particular, Buchli's research examines the relationship between this new manufacturing economy with its terrestrial and extraterrestrial uses and the new communities and diverse emergent oecumenes it strives to engender. It examines how the extraterrestrial manufactured object is to be integrated into terrestrial daily life and how this suggests challenges to our understanding of the terrestrial body and the very conditions of terrestrial daily life itself.

One of the emerging issues of this research is the role of the 'extreme' that characterises the extreme environment of LEO and how this notion of the 'extreme' is instrumental in producing a distinctive manufacturing economy in LEO and in particular new understandings of extraterrestrial craftsmanship and their geographies and attendant moral orders as they emerge in LEO. Alongside the manufacturing case studies examined, the research is positioned to understand ethnographically and historically the transition from centralised state-sponsored and developed space technologies and their communities to decentralised commercial technologies that characterise the historical shift taking place at present in the transition from nation-state–sponsored space sectors to commercial ones. This current moment, seen as a 'tipping point' within manufacturing communities, is examined historically against the backdrop of Alexander MacDonald's (2017) proposal of a "long space age". Tensions between state and private interests going back to the nineteenth century and earlier and in particular in relation to the invocations of settler narratives of expansion and infrastructural development are echoed in current narratives of commercial space communities as they emerge in Silicon Valley and its wider penumbra.

Aaron Parkhurst approaches the ISS as a medical anthropologist and a scholar of the anthropology of the human body. The human body, with its biological limitations and needs, its sociality and materiality, and its politics, serves as a profound ethnographic nexus that brings together and entangles cultures of medicine, ecology, technology, and well-being. The human body in space is no different from the body on Earth in this regard. Yet, low Earth orbit, and the vast potentials and challenges of other worlds, provide novel conditions and contexts within which one can test, witness, and challenge the parameters of the body and the ways in which it moves through complex systems of social relations.

Parkhurst's research broadly explores the social anatomy of the human body as it is constructed and envisioned by extraterrestrial living and space futurism. It is, at first, anatomical—in as much as its starting points are the biological structures and material of the human body and form, and the challenges that the complex material ecology of outer space creates for human biology. However, the anthropological purpose of charting this anatomy is threefold. Such an ethnographic project affords the opportunity to chart new trajectories for biosocial thinking, and to continue to develop work in "medical materialities" (Parkhurst and Carroll 2019) and material culture studies. In addition, however, the body in space, and life-science research conducted on the ISS, positions the study of human anatomy and biological processes as analogues for the future of human exploration of the cosmos. Embedded in such science and research are, ultimately, the complex systems of social, medical, political, and economic relations on Earth which flow through and emanate from the human body. Parkhurst's research demonstrates how the body, medicine, and life-science research on the ISS is as much an analogue of Earth itself as it is for off-world living on the Moon, Mars, and beyond.

Parkhurst is conducting ethnographic fieldwork on bodily practice and research on the ISS, with grounded partner institutions and laboratories that run experiments and collect data on medical and life-science projects on board the station, and with industry and culture that finds itself intersecting with the human body in space in complex and often unpredictable ways. These laboratories focus on cognition, nutrition, adaptation to gravity, smell and taste, cell biology, arthritis, lung function, and other bodily functions and activity in space. Parkhurst's research takes particular purchase in Scheper-Hughes and Lock's (1987) important prolegomenon on the mindful body. A study of the human body in space offers new directions and challenges for this

call. The effects of space exploration on the human body are profound. There is an extensive field of aerospace medicine that focuses on the extensive physiological and neurological effects of long-term space travel. Similarly, life-science research on the ISS offers a future for medicine on Earth and interventions on the human body. An anthropology of the body places the human figure in space as central to the cultivation of systems of social relations. However, the relationship between these systems and the body is reciprocal. That is to say, a study of the parameters of the human body, indeed even its anatomy and medical needs, informs the environment of the ISS, just as the ISS itself cultivates and makes the human body. The prolegomenon, and its attention to "the body politic", reminds its readers of this partnership. The affective turn within anthropology and geography of the last few decades is also challenged and furthered by the context of outer space living. Parkhurst and Jeevendrampillai (2020) have begun to answer this challenge in what they frame as an "*anthropology of gravity*", showing how the ISS offers "a unique vantage point through which to consider the human relationship to emotion, cognition, and the curation of social relations via experiences of the body in different gravitational environments". In this way, Parkhurst's research borrows and extends Valerie Olson's framework of *ecobiopolitics* (2010), testing these ideas further through a study of space medicine, space psychology, and analogue curation.

Finally, Parkhurst's research aims to further the interdisciplinary dialogue between medical anthropology and material culture studies. There are many potential aspects of this dialogue to explore, not least because of the hybrid forms of living that arise between the human body and the built environment in space, but also because of the way the human body on the ISS is captured in data and countless research projects within life sciences and then transformed into applications, politics, and economic activity back on Earth. In this regard, the body aboard the ISS undergoes complex transformations, movements, and disjunctures as it weaves through systems of social relations on Earth. Through methodologically 'following the object', Parkhurst's ethnography charts and follows these movements to uncover the gambit of social interactions and productivities that might arise. Parkhurst's ethnography is, then, at its core, a social life of the spacefarer's body.

Giles Bunch's work considers the labour undertaken by ground teams supporting operations on the ISS. Bunch's ethnography follows the training programme for ground support personnel (GSP) and analyses the organisational cultures at two key European human spaceflight centres: the European Astronaut Centre in Cologne and the Columbus Control Centre in Oberpfaffenhofen, Germany. Bunch's ethnography is analytically focused on two core processes. The first seeks an understanding of how GSP working on the Columbus project (Europe's main contribution to the ISS) are trained to support the operations and science conducted within this module of the ISS. The second seeks to develop an organisational ethnography of the culture of European human spaceflight projects.

Bunch is currently conducting ethnography within ESA training centres and control rooms operated by DLR (Deutsches Zentrum für Luft- und Raumfahrt, the German Aerospace Centre), participating in training events, observing simulations, and learning about the lives of the trainees and instructors. Employing participant-observation methods, Bunch is following the journey taken by GSP trainees from their recruitment to learning about spaceflight systems and operating procedures, participating in simulations and role-plays, and finally their certification, from a trainee's perspective. This data, taken alongside surveys and interviews with trainees and experienced GSP, will illuminate the training processes within the elite world of human spaceflight and consider them through anthropological lenses of learning and practice and themes of games and play, role-play, and care.

For example, Bunch participated in classes that gamified the training process. These events relate to sociological arguments on the nature of games and play such as those found in Caillois (2001), which have also been developed by Woodcock (2019). Aligning with Caillois's description of play as consisting of elements of choice, uncertainty, rules, and separation from other forms

of work, these gamified simulations complexify such elements when 'play' becomes a means for delineating and reinforcing desired behaviours in training events. The study speaks to recent scholarship on practice and material culture (Mohan and Douny 2020), in its examination of the ways that GSP's engagement with control-room equipment, understanding of 'procedures', communication 'over the loops' (a term applying to the method of voice communication between console positions, operations centres, and the ISS), and understanding of each system changes over the course of a training cycle. Further, Bunch's fieldwork is conducted in the second year of the Coronavirus pandemic and provides details of how national, organisational, and personal protective measures altered GSP training into what his informants call an "off-nominal" state. His informants describe the diminishing of what Hutchins and Klausen name as "distributed cognition", where "intersubjective understanding" (1996: 23) would otherwise be fostered through gesture and nonverbal cues both in training settings and in control rooms.

The second key theme in Bunch's study takes his experiences of GSP training at the European Astronaut Centre and Columbus Control Centre as a point of entry for developing an organisational ethnography of human spaceflight in the European context. This aspect of the study adapts methods of the workers' inquiry (Marx 1880; Woodcock 2014) to analyse the social composition and labour relations within and across the different centres. Recent debates in organisational anthropology (Caulkins and Jordan 2013) and recent sociological accounts of spaceflight projects in the United States (Vertesi 2020) are developed in the European context to better understand how organisational cultures shape the material and political qualities of mature and future human spaceflight projects.

This two-fold ethnography examining the GSP training processes for ESA's human spaceflight project and the organisational culture of the centres in which this takes place addresses a gap in the literature. Recent scholarship looking at the European spaceflight project has focused on the Moon as a target for future exploration (Alvarez 2020) or on the astronaut and the work of control rooms (Patarin-Jossec 2021). Bunch's ethnography contributes to this work through its close examination of a training cycle for teams working on a mature project, as well as attending to the organisational cultures of the centres in which this activity takes place.

Adryon Kozel's work considers how the ISS is constituted through its wider publics, particularly through social media channels and enthusiast groups. While the ISS is inhabited by a small group of astronauts and cosmonauts in constant contact with the respective mission controls of the ISS, the station is also experienced vicariously through social media platforms by a large and diverse online public. Many millions of individuals follow the combined social media feeds of astronauts, cosmonauts, and agencies on Instagram, Twitter, YouTube, and other platforms on a daily basis. Participatory social media events, such as livestreams, 'watch parties', amateur radio contacts, and astronaut Q&As occur around such things as launches, spacewalks, and dockings. In these events, large terrestrial populations of space enthusiasts are co-present and co-temporal with the inhabitants of the ISS even if they are not co-local.

Through such events, the ISS is felt through social energy, shared enthusiasm, and emotional experiences. Kozel's work is attentive to how enthusiasm is generated, sustained, and experienced in these more attenuated forms of inhabitation of the ISS. Considering how the ISS may be conceptualised through such experiences, which are deeply emotional, corporeal, and social, expands our conception of inhabitation of the ISS in ways that consider wider publics and social imaginaries. This develops existing work in the social sciences, particularly the research of geographer Hilary Geoghegan (2008, 2013) on technology enthusiast groups and emotional geographies, demonstrating how enthusiasm moves beyond a biological 'feeling' for something and becomes intentional and measurable through such practices as collecting, curating, communicating, and performing enthusiasm in social settings. This harnessing of enthusiasm through social and cultural practice has also been explored in studies of fandom communities (Jindra 1994;

Shefrin 2004) and of national space programmes, including the Mexican Space Agency (Johnson 2020, this volume), NASA (Launius 2017), the European Space Agency (Detsis and Detsis 2013), Roscosmos (Siddiqi 2011), and the Indian and Chinese space programmes (Abraham 2020).

Kozel has embedded herself in space-enthusiast organisations and communities of media producers both online and offline. Her fieldwork involves extended field visits to sites of rocket launches such as Cape Canaveral in Florida and the SpaceX launch facility in Boca Chica, Texas. From here Kozel works with key influencers to trace how the experience of witnessing rocket launches is captured, curated, and circulated through social media to wider public. Inspired by Durkheim's writings on the forms of social energy, or "collective effervescence", generated around particular events and gatherings of people (2008 [1912]), this methodology traces forms of social energy from the event of the launch through various media to wider publics. These publics, who are predominantly but not exclusively North American, are able to form common bonds and affiliations through shared experiences and excitement about common space futures.

Further to social media influencers and launch events, Kozel will also consider the social media of astronauts and space agencies in terms of how such outputs are received, engaged with, and generative of enthusiasm, or not, amongst a wider public and space communities. Enthusiasm for ISS-related events is contextualised within a wider lineage of enthusiasm about space inhabitation that looks forward to habitats on the Moon or Mars, for which the ISS is often seen as a stepping stone.

In its engagement with dispersed communities that rely predominantly on polymedia outputs, the work builds upon an existing body of work in digital anthropology and participatory digital methods (Madianou and Miller 2012; Gubrium and Harper 2016). This research investigates how online communities of enthusiasts develop around scientific events and projects such as rocket launches and analogue missions, and intersects with wider discussions in the social sciences about how space science generates and engages with particular demographics and publics, and in doing so, advances narratives of inclusion, participation, and democratic accountability (cf. Messeri 2017).

In his consideration of the implications of the ISS for notions of territory, belonging, and humanity, **David Jeevendrampillai** engages with another group of space enthusiasts who call themselves the 'Overviewers'—people who advocate for the widespread public engagement and shared experience of the 'overview effect'. Frank White, the journalist who coined the term, defines the overview effect as the theory that an astronaut's experience of spaceflight fundamentally changes their worldview (1998). The overview effect is premised on an embodied response to seeing Earth from space. It is understood as consisting of a psychological shift in thinking via a realisation and recalibration of relations to the planet, to other humans, and to existence brought about through seeing from a particular perspective—outer space.

A lineage in this form of perspectivism can be drawn back to the early images of Earth from space, namely from the Apollo mission. On 24 December 1968, NASA astronaut Bill Anders, aboard Apollo 8, captured NASA image AS08-14-2383, a photograph popularly known as *Earthrise*. The image shows the three-quarters-illuminated Earth rising over the Moon's surface. It was described by nature photographer Galen Rowell (1999) as "the most influential environmental photograph ever taken". The image is perhaps only matched by NASA image AS17-148-22727, or *The Blue Marble*, an image of the whole Earth from eighteen thousand miles away, captured by the crew of Apollo 17 on 7 December 1972. These images of Earth are purportedly the most widely circulated and viewed photographic images in history (Poole 2008). Bill Anders (2018) himself has stated that "we set out to explore the Moon and instead discovered the Earth". Today, imagery of the Earth from space is everywhere—as desktop backgrounds, in advertising, featured in movies. Seeing the Earth from space has gone from being a novel experience to an ingrained part of the popular imagination. Staring at the Earth from the ISS cupola window is reportedly the favourite pastime of the crew aboard the ISS. A recent study of crew photography of Earth showed

that around 84.5% of the almost two hundred thousand photos taken over eight expeditions on the ISS were taken by the crew in their free time (Robinson et al. 2011).

Historian Benjamin Lazier (2011) argues that imagery of the Earth from space has filtered into the popular imagination and given rise to new scales of social relations. This can be seen in what he calls 'globe talk'. Here, a global sense of relation to other humans is carried by concepts and conversations around such things as globalisation, global climate change, global citizenship, cosmopolitanism, and the Anthropocene. The planetary scale of social relations that perspectives of Earth from space enable are central to the concerns of the Overviewers. The group's members have various projects such as working with schools, releasing public media such as podcasts, books, blogs, VR experiences, and art projects that foreground the overview effect in order to bring about a particular relationship to the planet and humanity. The influence of such imagery on planetary imagination has been written about by geographers (Cosgrove 1994; Jazeel 2011), philosophers (Chakrabarty 2021; Oliver 2015; Sloterdijk 2014), and many others. However, Jeevendrampillai's work offers an ethnographic tracing of how concepts such as global cosmopolitanism, utopian space futures, and ecological planetary thinking inform a sense of planetary subjectivity within the Overviewers, brought about through a direct engagement with the visual cultures of spaceflight.

Whereas Jeevandrampillai examines a secular ideology of spaceflight, **Jenia Gorbanenko** is interrogating a religious perspective on the ISS and space exploration. Of the religious traditions in space, those of the Russian Orthodox Christians are particularly prominent, and they are the focus of her work. Cosmonauts travel on rockets that are blessed by Russian Orthodox priests from the temples near cosmodromes. Icons and saints' relics are regularly sent up to the ISS together with cosmonauts or cargo. Frequently appearing in photographs of the ISS, the space icons have been examined systematically by the International Space Station Archaeological Project (ISSAP) (Salmond, Walsh, and Gorman 2020). In LEO, these icons and relics orbit the Earth in what some consider a religious procession called a *krestnyy khod* (Rus., lit. cross procession). Historically, these processions have taken place on foot to mark significant celebrations or to pray in times of hardship. More recently, with the development of new technologies of mobility, the processions have also been taken on cars, motorbikes, and planes. Now the ISS allows for a procession around the entirety of the globe. Most icons and relics are eventually brought back down to Earth after a few months of a continuous *krestnyy khod*. Consequently, they are either returned or gifted to terrestrial Russian Orthodox communities or individuals. For instance, the newly built temple in Star City, where cosmonauts train and the Russian ground control centre is located, hosts many of these religious objects returned from space. Cosmonauts attend services there, and some of them even assist in the altar.

In the social sciences, the question of the relationship between space exploration and religion is most frequently discussed from the standpoint that treats and critiques space exploration as akin to religion (Bjørnvig 2018; Geppert 2018; Harrison 2013; Siddiqi 2008, 2010; Traphagan 2014, 2016). Gorbanenko, in contrast, follows in the steps of a growing group of anthropologists of religion in space looking at the dialogue between space exploration and religion (Bialecki 2020; Bielo 2020; Weibel 2019) and new space religious practices (Weibel 2015, 2016, 2017).

Gorbanenko's ethnographic research traces the objects, people, and sites that tie the ISS to the Russian Orthodox terrestrial communities. She considers how through religious practices, religious material culture in space, and new religious sites the Church initiates a dialogue between the scientific and the religious cosmology. She explores how they function as interfaces that invite the cosmonauts, space scientists, engineers, and other members of the space community to contemplate their space and scientific pursuits from within the perspectives of religious cosmology.

As part of this project, Gorbanenko seeks to unpack how the Church foregrounds the primacy of religious cosmology over the scientific. In his autobiography, Yuri Gagarin—a Soviet cosmonaut and the first human in space—described how upon his return home he was asked by the

villagers if he had seen God in the skies and how he had to disappoint them (Gagarin 1961). Over the years, many variations of the phrase "Gagarin flew to space and didn't see God there" have been used for Soviet scientific atheism propaganda. Today, rather than disputing the claim that Gagarin did not see God in space, Russian Orthodox voices often quote Gagarin's contemporary, Iosif Chernyy, a metropolitan of Alma-Aty and Kazakhstan, for saying that Gagarin could not have seen God there, but "God saw him. And blessed him" (Koroleva 2012). With this simple perspectival shift—and other religious practices that Gorbanenko observes in the field—the Russian Orthodox Church underlines the constraints of the human condition and the unknowability of God, thus emphasising the limits of the scientific way of knowing.

The scientific and technological discoveries of the space age prompt the Church to respond to the changing times, in some cases incorporating them into religious practices, such as *krestnyy khod*. Russian Orthodoxy is neither a static nor a homogeneous religious tradition, and there have not been any top-down directives on the Church's position with regard to space exploration yet, so this incongruous, slowly creeping process of adjustment is uncentralised. It is mostly the clergy and laypeople, at the interfaces between religion and the space community, who interrogate the space age on religious terms. In her work, Gorbanenko is focusing on these discursive practices through which the Russian Orthodox dispel with beliefs deemed outdated and incorporate modern inventions.

Space debris has been a much-discussed topic and problem in LEO (Damjanov 2017; Gorman 2019; Rand 2019; Reno 2020). **Makar Tereshin**'s work examines a little-known aspect of the space economy revolving around terrestrial communities in Kazakhstan who make their living by salvaging space rocket boosters discarded after the launches from Baikonur Cosmodrome. In particular, Tereshin examines the communities and economies that form around the space debris and the manner in which salvaging links scavengers within the wider nexus of space societies. At the heart of this project is the relationship of modernising national space narratives, both Russian and Kazakh, that literally 'touch down' in these marginal communities and the way in which space debris and hazardous waste shape these terrestrial communities between Earth and LEO. Here utopian ideals of spaceflight come into stark contrast with these emergent practices.

For those who live in the vicinity, the rocket debris fallout zones present a profoundly ambiguous landscape, which simultaneously threatens their health and well-being through invisible pollution and offers the means to sustain one's household by salvaging rocket boosters or making health claims on the state. After the dissolution of the Soviet Union and the abrupt state restructuring that followed, local communities have had to rely on precarious formal employment and state subsidies, coupled with seasonal work and other informal economic activities. In this context, the space debris complements the villagers' attempts to navigate their lives amidst social and political uncertainty. At the same time, as they encounter the debris, scavengers have to negotiate their exposure to the toxic fuel residuals. Although it is certain that some boosters were fuelled with highly toxic heptyl, it remains unclear whether propellant residuals in the salvaged wreckage are heptyl or kerosene. These toxic exposures often transform communities' subjectivities and engage them in ongoing political and ecological debates between Kazakhstan and Russia.

Tereshin's research explores how local communities inhabit and negotiate such indeterminate borders, spaces, and materials, and what such edgework can tell us about the larger polities to which they belong. Post-Soviet crisis and uncertainty are intensified in the fallout zones where the edges of imperial histories, nation-states, outer space, and pollution coalesce (cf. Stoler 2008). Space debris points to the material, ecological, and technological processes that support the work of the ISS and creates the possibility for critiquing the reliance of space exploration on waste and sacrifice of lands. Bringing the focus of space exploration back down to Earth demonstrates that outer space's frontiers are also firmly grounded in geopolitical borders. Space infrastructure is typically built in lands that are geographically and politically marginal—or made so through

processes of evacuation and ruination (cf. Lerner 2010; Redfield 2000; Mitchell 2017). This provides us with a chance to investigate if and how such space materials and technologies mediate different moral-political projects at different scales: advancing space exploration, subjecting remote communities to systematic inequality and environmental injustice, and providing a livelihood. Through a focus on scavengers' encounters with the space debris within fallout zones one can consider space exploration through the analytical lenses of modernity, mobility, ecology, and pollution, as well as forms of spatial, political, and ecological alienation.

Conclusions

The work presented here outlines the ongoing research conducted by the core ETHNO-ISS group and its associates. Dr. Jo Aiken, an earlier member of the core team, examined the organisational culture of NASA at the Johnson Space Center and how the ISS in LEO is integrated within the terrestrial infrastructure at Johnson. She continues with the project now as an Honorary Research Fellow while working as a Senior Researcher for Google. Paddy Edgley has also contributed to the project's research community through his work on his LAHP[2]-funded PhD project, which considers the ways in which amateur astronomers in London engage with the cosmos, the ISS, the city, and the Earth through stargazing. Soon, Aliça Okumura-Zimmerlin, building on her current doctoral research as embedded anthropologist on JAXA's Hayabusa 2 mission, will join the team as a postdoctoral researcher based in Tsukuba examining JAXA's Kibo module and the way in which JAXA and its affiliates shape the future beyond LEO at the ISS.

Whilst no researcher is aboard the ISS in person, many are co-present with it through studies of its emergent material economies, whether through manufacturers with their independent 'mission controls'; the ways in which the ISS challenges conceptions of the body; how it is understood and engaged with by its staff and controllers; its publics and social media image; the communities that engage with its contributions to the visual cultures of Earth; the way it intersects and affects religious practices and the economies of debris; and related positions of state and subject formation. Overall this is a study of the ways in which the ISS has exerted, and continues to exert, influence over terrestrial social life and expands it. The ETHNO-ISS project does not claim to be an exhaustive study of the ISS; rather we aim to refract the phenomenon of the ISS to show the multitude of ways in which the ISS can orientate rich ethnographic engagements with the forms of social relations that emerge from outer space activity. In this regard, the project works within an exciting lineage and burgeoning field of space anthropology which has seen rapid growth over recent years, in particular, due to influential works from authors such as Lisa Messeri (2016), Valerie Olson (2018), Deborah Battaglia (with Valentine and Olson 2015), Janet Vertesi (2015, 2020), David Valentine (with Olson and Battaglia 2009), and many more (see references). However, our perspectives are heavily influenced by our location and training at UCL anthropology. In particular, we have a strong analytical focus on material culture, the digital, the body, and infrastructure. Through teaching, we have spawned a range of master's dissertations and projects that go to demonstrate the breadth of opportunity that thinking about the anthropology of space, as an understudied anthropological region, can provide.

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Notes

1 Our travel budget falls rather short. At the time of writing, one 'night' in the ISS costs a tourist 35,000 USD. The bulk of the cost is the taxi ride: travelling with SpaceX costs US$55 million.
2 London Arts and Humanities Partnership: https://www.lahp.ac.uk/student/patrick-edgley/.

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