ABSTRACT BOOKLET

EXPLORING OTHERNESS ON EARTH AND BEYOND

BRIDGING THE GAP BETWEEN NATURAL SCIENCES, SOCIAL SCIENCES AND HUMANITIES

9-11 April, 2025

FU Berlin (Campus Lankwitz), Berlin, Germany

VENUE AND ACCESS

The conference will be hosted by the Freie Universität Berlin on the GeoCampus Lankwitz, Malteserstr. 74-100, 12249 Berlin, Germany, in building C. The building including access to lecture rooms has a free barrier entrance. The campus also has a free parking garage (entrance from Preysingstr.) open for guests.

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ROOMS:

C011	Lecture Room
C013	Meeting & catering room
C014	Meeting & break room

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Conference "Exploring Otherness on Earth and beyond: Bridging the gap between natural sciences, social sciences and humanities"

Freie Universität Berlin, GeoCampus Lankwitz, Malteserstr. 74-100, Building C, 12249 Berlin

Wednesday, 9 April 2025		
13:00 - 13:30	*Arrival and registration*	
13:30 - 14:00	Steffi Pohl & Lena Noack	Welcome
Session 1 "Other Life: Search for alien life" (I)		
14:00 - 14:20	Gerhard Kminek	Embracing otherness in planetary science
14:20 - 14:40	Ismael Román Moreno	How to redefine the concept of "life" based on the knowledge generated in the 21st century?
14:40 - 15:00	Pauli Laine	Other minds in the Universe?
15:00 - 15:30	*Coffee Break*	
15:30 - 16:20	Inge Loes ten Kate (Keynote Talk)	Biosignatures, falses, and public perception
16:20 - 16:40	Mouna Barkou	Aliens on Earth: How do astrobiologists studying early life on Earth relate to weird and unknown fossils?
16:40 - 17:00	*Coffee Break*	
17:00 - 17:20	Frank Postberg	Exploring the habitability of subsurface oceans on icy moons
17:20 – 17:40	Lena Noack	Habitability of rocky planets in and outside the solar system
17:40 - 18:00	Lee Grenfell	Assessing and interpreting atmospheric biosignatures
19:00	*Conference Dinner at "Ristorante La Montanara"*	

Thursday, 10 April 2025		
Session 1 "Other Life: Search for alien life" (II)		
09:00 - 09:50	Adrienne Kish (Keynote Talk)	Postcards from the Edge: How life in extreme environments on Earth can inform the search for life in the universe
09:50 - 10:10	Mickael Baqué	The space experiments BIOMEX and BioSigN to prepare for in situ life detection missions and habitability studies
10:10 - 10:30	Anna Steward	BioQuantum Record: Chiral Handshakes Between Terrestrial Extremophiles and Their Extraterrestrial Counterparts - An Arts-Science Collaboration
10:30 - 11:00	*Coffee Break*	
11:00 - 11:20	Stefania Kapsetaki	Barium chloride hit the bioelectrics of single- and communal-living flatworms: how did they respond?
11:20 - 11:40	Ana Clara Pelliciari Silva	Organic matter and ferric-ferrous minerals in Frutexites dubiofossils might support the search for life on Mars
11:40 - 12:30	Discussion Session 1	
12:30 - 13:30	*Lunch Break*	
Session 2 "Other Worlds: Colonization of Moon and Mars"		
13:30 - 13:50	Ebbe Bak & Kai Finster	Effect of saltation and abraded silicates on the survival of bacteria on Mars
13:50 - 14:10	Işık Su Yazıcı	Bridging Disciplines through Exploration: Anatolian Rover Challenge (ARC) and Its Role in Lunar and Martian Research
14:10 - 14:30	Jens Temmen	Make humanity a multiplanet species! (Multi)planetarity, Climate Change and North American Astroculture.
14:30 - 15:20	Michelle Hanlon (Keynote Talk)	The Ethics of Elsewhere: Governing Humanity's Cosmic Frontiers
15:20 - 15:40	Discussion Session 2	
15:40 - 16:10	*Coffee Break*	
Session 3 "Philosophical and theological views on otherness" (I)		
16:10 - 17:00	Evie Kendal (Keynote Talk)	"Moral Habitability" for human space exploration
17:00 - 17:20	Chelsea Haramia	Otherness and Global Justice in the Ethics of METI
17:20 - 17:40	Oskari Sivula	Our Cosmic Significance and Causal Powers
17:40 - 18:00	Jacques Arnould	Like his shadow. The question of the other in Giordano Bruno
18:00 - 18:20	Michael Waltemathe	Human Futures in Space. A theological analysis of possible scenarios between exploration, science and commercialization.
18:30 - 20:00	*Wine & Snacks*	

Friday, 11 April 2025		
Session 3 "Philosophical and theological views on otherness" (II)		
09:00 - 09:50	Carol Cleland (Keynote Talk)	How Anomalies Drive Scientific Discovery
09:50 - 10:10	Terry Kee	Are we "Othering" the Concept of Life through the Western Scientific View?
10:10 - 10:30	Marie-Luise Heuser	Improportionabiles (Cusanus) - On the Possible Incommensurability of Extraterrestrial Beings
10:30 - 11:00	*Coffee Break*	
11:00 - 11:20	Lorenzo De Piccoli	Ideas of the Universe. Perspectives on extraterrestrial life in modern European science
11:20 - 11:40	Discussion Session 3	
Session 4 "Communication science and psychology"		
11:40 - 12:30	Sven Engesser (Keynote Talk)	Uncertainty Communication and the Perception of Otherness
12:30 - 13:30	*Lunch Break*	
13:30 - 13:50	Erica Bisesi	Life in Extreme Environments: A proposal for bridging the gap between natural sciences, arts, perception and communication
13:50 - 14:10	Julina Pletziger	More than War and Peace: Analyzing museum's visitors' messages to extraterrestrials
14:10 - 14:30	Friederike Wolff	Interfaces of Knowledge and the Alien in the Room Next Door: A Space Project Manager's Daily Battle Towards Finding Common Ground
14:30 - 15:00	Discussion Session 4	
15:00 - 15:30	*Coffee Break*	
15:30 - 17:00	Sean McMahon, Steffi Pohl & Lena Noack	Summary, final discussion, and adjourn

OTHER LIFE: SEARCH FOR ALIEN LIFE

Embracing otherness in planetary science

Gerhard Kminek[1]

[1] *ESA, Head of Mars Science & Beyond Office, Directorate of Human and Robotic Exploration*

Otherness and alien can be at the same time scary and attractive – a juxtaposition that is very well entertained by the SciFi genre.

From a scientific point of view, otherness is good and useful. It provides opportunities to understand processes at a more fundamental level that otherwise would not be possible. It provides another set of data points in the solution-space of our natural world, in contrast to man-made situations or solutions. This is true for social sciences, medicine, but also natural science. There are two elements that are essential to embrace the opportunities that otherness offer:

1. Acknowledge that a difference exists.
2. Be ready to recognize the difference.

In terms of exploring our solar system and our Universe this means in practical terms acknowledging that for example Mars is not Earth, just a bit smaller and further from the sun. A realization that comes with every additional sample the NASA Mars 2020 Perseverance rover collects. It is the difference, however, that makes exploring Mars so valuable in terms of comparative planetology with consequences that go beyond understanding the formation of terrestrial planets in our solar system and will help to interpret data and models for Exoplanets.

Similarly, in the search for extraterrestrial life we have first to acknowledge the (expected) difference and tailor our methods to an agnostic life detection approach, avoiding the life-as-we-know bias to the maximum extend. The intelligent and informed use of machine learning in this context is so far not adequately exploited.

It is proposed to foster more collaborative efforts on comparative planetology, including the search for extraterrestrial life, in a stepwise approach:

- Open opportunities for co-funded Post-Doc positions.
- Establish a team at International Space Science Institute (ISSI) to develop a roadmap and key elements for a funding proposal.
- Participate in the new session on comparative planetology at the 46th Committee on Space Research (COSPAR) scientific assembly in Florence, 2026.
- Considering submission of a grant-proposal.

A more focused and organised approach in comparative planetology, including the search for extraterrestrial life, could benefit the scientific preparation and data utilisation for the Rosalind Franklin Mission (RFM) and the preparation of a potential joint NASA-ESA Mars Sample Return campaign.

How to redefine the concept of "life" based on the knowledge generated in the 21st century?

Fco. Ismael Román Moreno[1, 2, 3]

[1] *University of Granada (currently)*
[2] *Università degli Studi di Napoli Federico II*
[3] *Astromares Association*

The concept of "life" has been addressed since the earliest human civilizations. The Western heritage attributed to some Greek philosophers, such as Thales of Miletus, Pythagoras or Plato, has varied up to the present day. The assumption of the definition of the concept of "life" is influenced by the anthropic cosmological principle, which limits its comprehension due to the anthropocentric and confirmatory cognitive bias of our species, for this reason it is tautological; we can only observe the fossil remains of dinosaurs from 65 Ma ago. Travelling to the Origin of Life (OoL), Carl Sagan alluded to carbon chauvinism in 1973, hinting at the possibilities of the occurrence something that we do not know about. Under the above premise, the meaning of the concept of "life" goes beyond human consciousness. Applying the principle of parsimony, it can be said that, in a simpler way, life is the result of adaptation to the random and dynamic changes of the environment, transmitting through space and time the complexity of its functional self-organization of the different structures that compose it. It can be synthesized, accordance with Jacques Monod's proposal, that life is random (chance) according to the energetic and thermodynamic needs (necessity) of the cellular system. From another perspective, it can be summarized as a balanced conjunction between Darwinian genetic individualism (Richard Dawkins' selfish gene) and the cooperation and distribution of the functions of the different cellular organelles (Lynn Margulis' endosymbiotic theory). In the 21st century, great contributions have been made to knowledge that allow us to use this information as a tool to broaden and redefine the concept of "life". One example is the giant viruses (NCLDVs). Likewise, the Fermi paradox can be answered if the Drake equation is modified by incorporating, according to the Kardashev scale, the obtaining, harnessing and use of energy through the technological development of other civilizations. Finally, epistemological progress must go hand in hand with progress in technological complexity, which is why transhumanism and cyborgs open a new door to the concept of "life" and, furthermore, to space exploration.

Bibliographical references

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Prosdocimi, F. & Torres, S. (2021). Life and living beings under the perspective of organic macrocodes. BioSystems 206:104445.
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Other minds in the Universe?

Pauli Laine[1]

[1] *University of Jyväskylä*

The probability of the emergence of life is unknown. The probability of its way to more complex forms and into intelligence is even more unknown. Even the concept of intelligence is somewhat vague. We can see behavior in many animal species that can be described as intelligent. We can program computers to behave like intelligent agents. But none of these are capable for (or interested of) interstellar communication. Desire to communication outside our world is kind of extension to what started from need to communicate within small ancestor group. This need was a pressure what developed our abstract language, and what finally cumulated to telecommunication.

We do not know what possible evolutionary paths are there to intelligent society and technological culture. Does technology always come along when certain point in social or cultural evolution has been passed? What environmental, physiological and anatomical features are required for technical culture to emerge? In a way, this is a similar question than the origin of life. We have only one example of life and technological culture, and it is hard to imagine alternatives.

Fermi's paradox says that if there are other advanced civilizations in the Milky Way, then where are they? This is serious question to any claim about how life would eventually evolve to something that could make it more observable than just biochemically. Here I present new discipline called cognitive astrobiology that explores universal pathways to intelligent behavior and beyond.

[KEYNOTE TALK] Biosignatures, falses, and public perception

Inge Loes ten Kate[1]

[1] *Utrecht University*

The concept of a biosignature is widely used in astrobiology to suggest a link between some observation and a biological cause, given some context. This is the opening sentence of a paper we wrote in 2023. In this presentation, I will further discuss this concept and the philosophical aspects of this concept. I will include false positives and false negatives. The perception of biosignatures does not only play a role among scientists, but also importantly in how we communicate our finding to the public. Therefore, I will also discuss that it may feel that this philosophical approach may hinder the detection or rather the announcement of a detection of a biosignature, but why for the credibility of our field our cautious approach is important.

Aliens on Earth: How do astrobiologists studying early life on Earth relate to weird and unknown fossils?

Mouna Barkou[1]

[1] *University of Liège*

As the search for life's origin on Earth advances, scientists keep finding new traces of life in environments and periods previously thought to be inhospitable to life (Praet & Salazar, 2017:316). Now, life on Earth is known to have been present as early as 3.4 billion years ago (Javaux, 2019:1). However, because Earth is a dynamic planet and fossilization is a complex process, fossils from the early Earth are rare and often ambiguous (Javaux, 2019:1). During my master's thesis in anthropology, I spent three months in an astrobiology lab with scientists studying life's origins, its evolution, and its possibilities beyond Earth. These scientists included geologists studying some of the earliest traces of life on Earth, belonging to the Archean era, which ranges from 4 to 2.5 billion years ago. During my fieldwork, I realized that the geologists studying these fossils were often troubled by what they were finding. In the best case, they were able to assert the biological nature of the organism. But even then, questions remained about the type of organism it was, its purpose, and its behavior. They were thus facing organisms they could not explain and, as one of them told me once: "Working on this stuff is really cool because it's so old, it's almost alien." When studying life from the Archean era, scientists were looking at an Earth so ancient, it became alien to them.

The aim of this presentation is to show how scientists use affects and imagination to make sense of otherness. I use the concept of "resonance" developed by Lisa Messeri, which she defines as the way "the knowing and sensing subject detects and amplifies connections between discrete, distant objects and worlds" (2017:132). During my fieldwork, the weirdness of these organisms was emphasized by the scientists. Rather than being annoyed by the uncertainty, they actually enjoyed being surprised. As the author argues in her article, resonance is a source of excitement for the scientists since it provides them with an "impossible immediacy," a way to engage with a world that cannot be physically experienced (Messeri, 2017:133). Moreover, I want to show that the weirdness of the fossils was used by the scientists to think about extraterrestrial life. As they focused on the weirdness of life, these scientists were also thinking about "what life could be and the forms it might take," on Earth and beyond (Helmreich, 2015:15). Using the concept of "limit biology" by Stefan Helmreich, I explore how astrobiology pushes life as a concept to its boundaries, in my case through the concept of the weird.

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Praet, I. & Salazar, J. (2017). Familiarizing the Extraterrestrial / Making Our Planet Alien. Environmental Humanities, 9(2), pp. 309-324.

Exploring the habitability of subsurface oceans on icy moons

Frank Postberg[1]

[1] *Freie Universität Berlin*

Saturn’s icy moon Enceladus harbours a global ocean, which lies under an ice crust but has a rocky sea floor. Through warm cracks in the crust a cryo-volcanic plume ejects ice grains and vapour into space providing access to materials originating from the ocean. The Cassini spacecraft frequently carried out compositional in situ measurements of vapor and ice grains emerging from the depth of Enceladus and found habitable conditions including evidence for hydrothermal activity occurring at the ocean floor. After the end of the Cassini mission, we are now looking forward to explore the habitability of the subsurface oceans of Jupiters icy moons Europa and Ganymed with two major space mission, which are already en route: ESA’s Jupiter Icy Moon Explorer (JUICE) and NASA’s Europa Clipper.

Habitability of rocky planets in and outside the solar system

Lena Noack[1]

[1] *Freie Universität Berlin*

The still rather young field of exoplanetary research - increasing dramatically over the past three decades with by now more than 7400 exoplanets discovered - also strongly influenced the way how we think about the conncection between the interior of a planet and its surface, and especially its habitability potential. Within the solar system, while most information about interior properties and evolution stems from our own Earth, we do have access to limited information on the interior of several of our neighbour bodies in the inner and outer solar system (for example due to seismic measurements on the Moon and Mars, orbital characteristics, measurement of tidal deformations, observations of jets in case of Enceladus). For exoplanets, on the other hand, our observations are limited to very basic characteristical properties (mass, radius, age, orbit) and observations of the atmosphere/surface. A large effort of the community therefore developed in the direction to gain a deeper understanding of feedback cycles between core, mantle, lithosphere/crust, surface and atmosphere (and space). Especially for our goal to detect and characterize rocky planets that might truely be habitable, we need to consider the planet as a whole. Here I will especially highlight the links between the interior and the atmosphere via volcanic outgassing.

Assessing and interpreting atmospheric biosignatures

Lee Grenfell[1]

[1] *DLR – German Aerospace Center*

What are the relevant properties for a given signal to constitute a good atmospheric biosignature - and what are the pitfalls on the way? Clearly a central criterium is the so-called attributability, which denotes to what extent a signal arises from life alone, as opposed to arising from alternative, abiotic sources. There are however, additional important criteria: the extracted signal should have a strong signal-to-noise and should be unequivocal i.e. arising from a single species. I will discuss the above issues for some currently well-discussed examples in (exo)planetary science, including: phospine on Venus, methane on Mars, dimethyl sulphide on exoplanet K2-18b, and oxygen and ozone on Earth-like exoplanets.

[KEYNOTE TALK] Postcards from the Edge: How life in extreme environments on Earth can inform the search for life in the universe

Adrienne Kish[1] and the Exocube teams

[1] Molecules of Communication and Adaptation of Microorganisms (MCAM) laboratory, Muséum National d'Histoire Naturelle, Paris

Life on Earth serves as the only template we know of for the potential for life elsewhere in the universe. However, conditions on other planets are often far from the typical range of temperatures, pH, salinity, water availability, and pressures found on Earth. The closest approximation we have comes from extremophilic life, adapted to thrive in environmental niches far removed from conditions that humans can tolerate. Cellular and molecular studies of extremophiles have started to reveal the mechanisms behind their tolerances. These studies have also shed light on the nature the molecular limits of life as we know it and the co-evolution of life and planets, as well as provided hints about potential alternative life forms – "life as we don't know it". By combining field work, ground-based laboratory studies, and space-based experiments, a picture is starting to form of the molecular limits of life that is essential for interpreting potential biosignatures. Of particular interest for astrobiology are the effects of solar radiation, as well as water availability. As part of these efforts, the Exocube experiment will soon be exposed outside the International Space Station to perform the first in-situ measurements of living microorganisms (including extremophiles), as well as their component molecules and molecular structures such as cell membranes. The technologies developed for Exocube will be applicable to future space-based platforms planned to extend beyond Low Earth Orbit in lunar orbit and beyond enabling exposures to high energy solar radiation shielded by the Earth's magnetosphere. The data obtained contribute to the combined international efforts in astrobiology to understand why life is limited, what are the limits of life, under what circumstances can the limits of terrestrial life be surpassed, and how can we detect and interpret any potential biosignatures of microbial life forms (past or present) on other planetary bodies.

The space experiments BIOMEX and BioSigN to prepare for in situ life detection missions and habitability studies

Mickael Baqué[1], Jean-Pierre de Vera[2] and BIOMEX/BioSigN teams

[1] German Aerospace Center (DLR), Institute of Planetary Research, Planetary Laboratories, Berlin, Germany
[2] German Aerospace Center (DLR), Space Operations and Astronaut Training, MUSC, Köln, Germany

The search for life in our Solar System is at the centre of several current and future robotic missions to Mars and beyond, to the icy moons of Jupiter and Saturn. New instruments, in the context of space exploration, have been sent to Mars on recent rover missions, such as Raman spectrometers particularly suited for the fast and non-destructive identification of biomolecules embedded in minerals. International and national efforts have also been focusing on bringing samples back from Mars to be analysed with state-of-the-art laboratory instruments on Earth. And two missions en route to Jupiter will teach us more about the environment and potential organic content of another excellent target for finding life beyond Earth, Europa. However, little is known about the stability of putative biosignatures in the Martian or space environment. To support and prepare these current and future exploration missions to Mars, Europa and Enceladus, exposure experiments in low Earth orbit, using the International Space Station (ISS) are crucial. For instance, during the BIOMEX experiment (2014-2016), biomolecules and microorganisms were exposed for 16 months to a simulated Martian environment in LEO. This environment was provided in the EXPOSE-R2 module, outside the ISS and comprised of UV and ionizing radiation, a Mars-like atmosphere, extreme temperature cycles, and analogues of Martian regolith. Seven of those biomolecules were analysed post-flight using Raman spectroscopy all remained detectable. The next ESA space exposure experiment BioSigN (Biosignatures and habitable niches) will follow in the next few years extending the range of samples to icy moons relevant organisms and molecules. These experiments, and the international efforts required to achieve them, are crucial to advance our knowledge on the detectability of putative traces of life outside of Earth, and on the potential habitable conditions of our neighbouring planets and moons. To maximize the scientific outputs, the space experiments are always connected to the results obtained on ground from planetary analogue field sites and planetary simulation facilities.

BioQuantum Record: Chiral Handshakes Between Terrestrial Extremophiles and Their Extraterrestrial Counterparts - An Arts-Science Collaboration

Anna Steward[1, 2, 3]

[1] *Academy of Fine Arts Nuremberg*
[2] *CNRS-CBM (Centre Biophysique Moléculaire)*
[3] *ESAD Orléans (école Supérieure d'Art et de Design)*

BioQuantum Record is a speculative artistic project that explores how we might establish molecular contact with extraterrestrial microorganisms. Inspired by the Golden Record's legacy, the transdisciplinary project examines the implications of scientific advancements, contemporary cultural thought, and the possibility of microbial interaction across the cosmos.

I'm currently artist-in-residence at CNRS-CBM (Centre Biophysique Moléculaire) Orléans and ESAD Orléans (école Supérieure d'Art et de Design), collaborating with the "Exobiology" and "Synthetic Protein and Bioorthogonal Chemistry" teams on this arts-science project. The BioQuantum Record centres on the concept of microbial collectives as the most probable form of extraterrestrial life we may encounter, exploring the hypothesis of mirror life - where extraterrestrial organisms may have biomolecules with opposite chirality to life as we know it.

On Earth, life is homochiral - proteins are made from left-handed amino acids, and right-handed sugars are metabolised. Could extraterrestrial life be a mirrored version of life on Earth, using opposite chirality? This could be key to understanding how an interactive device might generate, receive, and respond to biological signals, enabling molecular communication between terrestrial and extraterrestrial microorganisms.

The BioQuantum Record serves as a speculative prototype for this microbial communication, housing extremophiles from the archaeal domain, specifically Metallosphaera sedula. This organism thrives in extreme environments, such as hot, acidic, metal-rich conditions, making it suitable for the harsh environments of Mars or other planetary bodies.

Drawing on the panspermia theory, which suggests life could be transported between planets via space debris, the BioQuantum Record proposes a meteorite-shaped device to send these extremophiles into space. This device acts both as a vehicle and a metaphor for life's potential cosmic journey, seeding extraterrestrial environments with life forms that could survive harsh conditions.

An experiment will be conducted to test if Metallosphaera sedula can metabolise L-glucose, a sugar with opposite chirality to what Earth life typically uses. If successful the chirality of sugars could be used as a means of microbial interaction between the terrestrial an extraterrestrial extremophiles.

The BioQuantum Record blends scientific inquiry with speculative storytelling, inviting discussions on the nature of life, planetary protection, and the future of space exploration.

Barium chloride hit the bioelectrics of single- and communal-living flatworms: how did they respond?

Stefania E. Kapsetaki[1], Tomer Landsberger[1] and Michael Levin[1]

[1] *Tufts University*

Chemical challenges happen throughout evolutionary history. Two ways of surviving these challenges is by being robust and resilient. Planaria show both robustness and resilience when exposed to barium chloride (BaCl2). They lose and then regenerate their head in BaCl2. Organisms live in societies. So do planaria. Does the planarian society help individual planaria become more robust and resilient to the BaCl2 challenge? To investigate this, we extracted RNA and performed RNA sequencing on individual full-body worms from five experimental conditions: (1) BaCl2-exposed worms living in groups that regenerated their heads; (2) BaCl2-exposed living on their own that regenerated their heads; (3) BaCl2-exposed worms living on their own that regenerated their heads; (4) non-BaCl2-exposed worms living on their own; (5) non-BaCl2-exposed regenerated fissioned tails living on their own. The highest number of differentially expressed genes (DEGs) was observed when comparing conditions 4 and 5, as well as conditions 3 and 5. Only two genes were differentially expressed in BaCl2-exposed loners versus groups-living worms. These genes suggest a potential trade-off where loners invest more energy in better cognitive functions than immune responses, whereas group-living worms invest more energy in immune responses than cognitive functions.

Organic matter and ferric-ferrous minerals in Frutexites dubiofossils might support the search for life on Mars

Ana Clara Pelliciari Silva [1] and Dominic Papineau [2]

[1] *University of Naples, Federico II*

[2] *UniversityCollege of London*

A habitable rocky planetary body must have a transitional phase in which prebiotic chemical reactions provide the favourable settings for chain reactions in the local chemistry potentially forming building blocks of life. Chemical gardens present flora-like micro and small environments, being formed from a mixture of inorganic molecules. These abiotic biomorphs can be created from minutes to hours, and can even leave their trace in the fossil record. To convert a lifeless planet to a microbial-rich planetary surface or subsurface, chemical gardens are thought to have voluntarily formed as an intermediary step. Amongst chemical gardens and similar structures we can mention chemically oscillating reactions (COR), i.e when mixing chemicals lead to change in colouration repeating itself periodically.

OTHER WORLDS: COLONIZATION OF MOON AND MARS

Effect of saltation and abraded silicates on the survival of bacteria on Mars

Ebbe Bak[1], Ralf Moeller[2], Per Nørnberg[1], Svend Knak Jensen[3], Jan Thøgersen[3], Mikkel Berghøj[3] and Kai Finster[1,4]

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[2] *Institute of Aerospace Medicine, German Aerospace Center, Germany*
[3] *Department of Chemistry, Aarhus University, Denmark*
[4] *Stellar Astrophysics Center, Department of Physics and Astronomy, Aarhus University, Denmark*

The Martian surface is a hostile environment for life, characterized by low water availability, low atmospheric pressure, and high UV and ionizing radiation. Furthermore, the hostile surface conditions are amplified by processes such as wind-driven saltation, which leads to the abrasion of silicates, the production of reactive surface sites, and triboelectric charging—resulting in electrical discharges and the concomitant production of reactive oxygen species.

While the effects of low water availability, low pressure, and radiation have been extensively studied in relation to the habitability of the Martian surface, the risk of forward contamination, and the preservation of organic biosignatures, the effects of wind-driven saltation have hitherto been ignored.

In this study, we investigated the effects of bacterial exposure to wind-abraded silicates and direct exposure to wind-driven saltation on Mars under controlled laboratory simulation experiments. Wind-driven saltation was simulated by tumbling mineral samples in a Mars-like atmosphere within sealed quartz ampoules. The effects on bacterial survival and structure were evaluated using colony-forming unit counts in combination with scanning electron microscopy.

The viability of vegetative cells of P. PUTIDA, B. SUBTILIS, and D. RADIODURANS in aqueous suspension was reduced by more than 99% after exposure to abraded basalt, while B. SUBTILIS endospores remained unaffected. Experiments with several B. SUBTILIS mutants lacking different components of their spore coat showed similar resistance to abraded basalt, indicating that spore resistance is not associated with any specific spore coat component. We observed a slightly reduced effect with abraded quartz and suggest that the stress effect of abraded silicates is induced by reactive oxygen species and hydroxyl radicals generated through Fenton-like reactions in the presence of transition metals.

Direct exposure to simulated saltation had a dramatic effect on survival, with only about 10% of B. SUBTILIS spores surviving after one hour of simulated saltation. The high susceptibility of B. SUBTILIS spores to wind-driven saltation suggests that both wind-abraded silicates and direct exposure to saltation represent significant stressors for microorganisms on the Martian surface. This may have hindered the origin of indigenous life, limited the risk of forward contamination, and contributed to the degradation of potential organic biosignatures.

Bridging Disciplines through Exploration: Anatolian Rover Challenge (ARC) and Its Role in Lunar and Martian Research

Işık Su Yazıcı[1]

[1] *German Aerospace Center (DLR), Institute of Planetary Research, Department of Planetary Geology*

Anatolian Rover Challenge (ARC) is an international rover competition organized by the Space Exploration Society (Uzay Keşif Topluluğu - UKET). It serves as an interdisciplinary platform that merges engineering, planetary science, and space exploration by engaging university students in the design and production of robotic rovers and encouraging innovative problem-solving, teamwork, and international collaboration. In ARC, Lunar and Martian surfaces are simulated, where student teams must develop rovers to perform complex tasks such as autonomous navigation, robotic arm control, sample collection, and in-situ analysis. Each year, Moon and Mars fields are focused on scientifically significant landing sites, such as the South Pole of the Moon, Eberswalde, Nili Fossae, and Oxia Planum of Mars.

The first ARC was held in 2022 at Istanbul Technical University, and since then, it has taken place annually at Middle East Technical University in Ankara, Turkey. During these three years, 63 teams from six countries (Turkey, Poland, Bangladesh, India, United Kingdom, and Mexico) have applied to compete in ARC.

ARC is structured around key mission objectives that reflect the challenges possible to experience in planetary exploration. These missions closely align with current and future robotic explorations led by major space agencies, providing students with hands-on experience in mission planning, systems engineering, and data interpretation. The Moon part of the challenge emphasizes resource utilization and settlement on the Moon, while the Mars part integrates scientific hypothesis developments and testing using rovers such as astrobiological investigations, subsurface exploration, and environmental monitoring to assess potential habitability.

Through these mission scenarios, ARC prepares students for careers in space science and engineering while fostering technological advancements applicable to Lunar and Martian colonization efforts. The inclusion of autonomous navigation and robotic arm operations mirrors the critical role of robotic systems in upcoming space missions, particularly in establishing sustainable human presence beyond Earth. As space agencies and private entities accelerate plans for extraterrestrial settlement, competitions like ARC serve as crucial training grounds for the next generation of scientists, engineers, and decision-makers. ARC contributes to space research and education, highlighting its role in shaping future explorations beyond Earth.

Make humanity a multiplanet species!: (Multi)planetarity, Climate Change and North American Astroculture.

Jens Temmen[1]

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The early 21st century has seen a reinvigoration of space exploration both by private and state actors that seek to explore, exploit, settle, and own outer space and its celestial bodies. According to scholars and scientists alike, this reinvigoration warrants labeling our time as the "Second Space Age". Key actors of this Second Space Age have framed the exploration and colonization of outer space as not only progressive and desirable, but also as inevitable to ensure the survival of humanity in face of the multiple crises of the Anthropocene (climate change, over/underpopulation, resource scarcity etc.). Within this "astrofuturist" framework, outer space has become a utopian space of projection that serves as a canvas for imaginaries of transformative posthuman experiences for all of humanity, for humanity's escape from its terrestrial limitations, for breaking with humanity's terrestrial history, and even for human immortality.

The way that outer space is a key ingredient for utopian vision of humanity's future highlights that outer space is a cultural construct negotiated in an interplay between science, technology and culture. These "astrocultural objects", which are central to ascribing meaning to outer space and to stirring the collective imagination, underline the cultural embeddedness both of outer space and our practices of exploring it. A critical engagement with space exploration must therefore go beyond questions of mere technological feasibility then, and instead also interrogate, for example, the prevalence of visions Mars colonization as a remedy for climate change, the politics of race/class/gender in privatized outer space, the continuities of capitalist-colonial structures in the private space industry, or the dominance of specifically US-American frontier discourses of renewal and expansion in allegedly utopian visions of humanity's future in space. Within this larger framwork, my paper will engage with the dicourse of "multiplanetarity", advocated by NewSpace oligarchs like Elon Musk, which argues that humanity must settle Mars and other planets as a way of avoiding collapse of human civilization and as part of a larger scheme to proliferate and expand human life across the galaxy. I will discuss how mulitplanetarity, rather than offering humanity a safe route beyond the anthropogenic polycrisis, challenges humanity's planetary entanglements and uproots humanity from what scholars have described as the "multitude of the planet" - so the unique and intricate web of relations that humanity are enmeshed in on Earth - and replaces it with a "multitude of planets" - so the idea that humanity can and must alienate itself from Earth and simply exist on other planets.

[KEYNOTE TALK] The Ethics of Elsewhere: Governing Humanity’s Cosmic Frontiers

Michelle Hanlon[1]

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In philosophy and social theory "other" often highlights difference, sometimes with a positive or neutral intent—like recognizing alterity—or as a critique of exclusion and marginalization. In everyday language, though, it can tilt pejorative if it implies alienation, inferiority, or dehumanization, like when someone’s labeled "the other" to distance or stereotype them. As humanity carves out habitats on the Moon, Mars, and beyond, this "other" gains a radical new edge. International treaties frame space not as a place, but as a legal construct—a regime where exploration and use are deemed "the province of all humankind." Yet the Outer Space Treaty, the cornerstone of space law, remains stubbornly tethered to the State. It declares that "the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries" and that "outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination." Where, then, is the human? Who counts as "other" in a framework so doggedly wedded to sovereignty? Can an "other" even exist when the State alone holds sway? This State-centric lens blinds us to non-human possibilities—microbial life, future settlers, or sentient entities—while ethical fault lines emerge: resource extraction and cultural erasure threaten to replicate Earth’s fractures among the stars. Can "all humankind" truly embrace not just the alien but a necessarily evolving human species without rethinking justice itself? This presentation probes how law and ethics might break free of terrestrial boundaries to shape a cosmic future that puts humanity over sovereignty. It will challenge you to reimagine identity, morality, and governance beneath the Treaty’s vast, uncharted canopy.

SESSION 3

PHILOSOPHICAL AND THEOLOGICAL VIEWS ON OTHERNESS

[KEYNOTE TALK] "Moral Habitability" for human space exploration

Evie Kendal[1]

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Space and science fiction both provide a testing ground for exploring alternative social realities and our ethical obligations to others. Whether we are considering new human off-world settlements or potential future interactions with other intelligent life, these spaces provide a rich site for thought experimentation. According to Charles S. Cockell, space is 'an inherently tyranny-prone environment', as all resources for survival can be arbitrarily withheld from a non-compliant citizen, including oxygen. It also represents an environment far from our regulatory bodies on Earth, posing a challenge for human rights and safety. Further, it is unclear if and how humanity should be represented in the event extraterrestrial life is discovered, in whatever form that takes. Some central questions this presentation will consider include: is there something special about members of *Homo sapiens* (philosophically or theologically) that justify our predominantly anthropocentric view of life on Earth? How might this view be retained or changed when translated to the space environment and interactions with non-human intelligence? And finally, what role can discussions about space, including in the realm of fiction, play in our conceptualisation of humanity's place in the universe and our ethical obligations to others?

Otherness and Global Justice in the Ethics of METI

Chelsea Haramia[1]

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'METI' stands for Messaging ExtraTerrestrial Intelligence. METI has been characterized by some as a tool that can be used in the scientific Search for ExtraTerrestrial Intelligence (SETI). SETI practitioners engage in scientific investigation aimed at detecting evidence of extraterrestrial life and its technology in the cosmos. Whereas SETI is largely considered a passive means of detection that does not require contact with extraterrestrial others, METI is different. Successful METI requires that extraterrestrial others detect and respond to humans' messages. Messages and thereby METI are inherently representative activities. The kind of representation on which I focus is the way in which METI messages speak on behalf of those they represent. With a given METI message, a subset of humanity effectively represents all other humans - as well as our planet and its other inhabitants - to alien others. And the potential audience for these messages include not only others who are aliens but also other humans. Insofar as intentional representation is core to METI activities, it raises challenging problems that fall squarely in the realm global justice - including Othering issues involving misrepresentation, cultural imperialism, ecological justice, intergenerational justice, and more. I show that these global, terrestrial issues are not only present in all messaging, but also that they comprise the most salient ethical questions in current messaging practices, give the present state of our scientific knowledge. I conclude that METI cannot be properly analyzed if the practice is divorced from actual messaging contexts, and the conditions under which messages are developed and transmitted are crucial for distinguishing between responsible and irresponsible cosmic messaging.

Our Cosmic Significance and Causal Powers

Oskari Sivula [1]

[1] *University of Turku*

Many have argued that humanity exhibits no cosmic significance because we are so tiny compared to the vast universe and we cannot make any significant impact beyond Earth. This lack of substantial causal powers is seen as detrimental to our hopes of cosmic significance. However, Guy Kahane argues that even if we have no causal impact beyond Earth, we can be of immense cosmic significance. According to Kahane, something is cosmically significant if it deserves attention from the widest evaluative perspective - the cosmic standpoint. Thus, cosmic significance can be understood in terms of the difference one makes to overall intrinsic value in the universe, compared to other things. Consequently, if we are alone in the universe, life on Earth is a beacon of value in the cold, empty and indifferent cosmos. Nevertheless, some insist that it is not enough to make a difference to the valence of the universe solely by existing. Instead, they argue that for cosmic significance a causal component is needed, and we lack such causal powers. I want to challenge the idea that we cannot be cosmically significant in the causal sense. I argue that in the foreseeable future, we may be significant in a way that matches both Kahane's and the causal understanding of cosmic significance. The suggested route to such vast significance is by seeding lifeless exoplanets with microorganisms also known as directed panspermia. Such seeding demonstrates causal powers beyond the Solar System and may significantly affect the overall intrinsic value of the universe or at least our galaxy. It gives a chance for new actors to emerge on the 'cosmic stage'. Thus, it merits attention from a cosmic perspective. The foreseeable possibility of exoplanetary seeding raises some interesting puzzles and implications for cosmic meaning. For example, seeding may entail an intergenerational trade-off by increasing the cosmic significance of individuals who contribute to it while decreasing the collective cosmic significance of potential far-future generations. As another example, some have argued that it is unlikely that disseminating life beyond our Solar System will benefit humans greatly. However, if directed panspermia is a way to become cosmically significant then humans have a direct interest in it to fulfil a deep collectively shared yearning for meaning.

Like his shadow. The question of the other in Giordano Bruno

Jacques Arnould [1]

[1] *Centre national d'études spatiales, Paris*

Heretic for some, martyr for others, Giordano Bruno occupies a singular place in the history of philosophy, science and the relationships that these fields maintain with each other. Among the multiple reasons for his condemnation by the Roman Church to be burned is his vision of an infinite universe and a plurality of inhabited worlds: for Bruno, others are legion. However, the Italian philosopher does not claim to know the nature of these beings - in general, his theory of knowledge, inspired for example by the Platonic myth of the cave, is based on the symbol of the shadow and on the conviction that we can only approach reality, ideas, truth and God himself through their "projection", that we cannot even touch them but only contemplate them.

Bruno's prudence and wisdom seem relevant when we question not only the existence of extraterrestrial beings (always hypothetical), but also the consequences of this existence on what we can say about God and ourselves.

Human Futures in Space. A theological analysis of possible scenarios between exploration, science and commercialization.

Michael Waldmathe[1]

[1] *Ruhr Universität Bochum*

As humanity ventures further into space, the intersection of exploration, science, and commercialization raises profound theological and ethical questions. This paper examines possible futures of human space endeavors, considering both the promise of scientific discovery and the challenges posed by privatization and geopolitical interests. The role of figures like Elon Musk and companies such as SpaceX highlights the growing influence of private entities in shaping space policies, often blurring the lines between technological ambition, economic interests, and political power. What does this shift mean for humanity's moral responsibility in space? Can religious and philosophical traditions offer ethical frameworks for space governance, resource utilization, and the search for extraterrestrial life?

[KEYNOTE TALK] How Anomalies Drive Scientific Discovery

Carol Cleland[1]

[1] *University of Colorado, Boulder*

This talk investigates the pivotal role of anomalies (phenomena that challenge entrenched scientific beliefs about the world) in the process of scientific discovery. I begin with a brief discussion of the history of philosophical thought about anomalies and their role in scientific practice. My focus is on the accounts of (Popperian) falsificationists, who viewed anomalies in terms of especially surprising, failed predictions, and Thomas Kuhn, who argued that anomalies can't be recognized as such in the absence of a scientific crisis or revolution. As will be discussed, neither of these philosophical accounts of scientific practice can explain the role actually played by anomalies in scientific practice and discovery; not all anomalies represent failed predictions and recognition that a phenomenon is anomalous does not require a Kuhnian crisis or revolution. This is especially true for (what philosophers have dubbed) the "special sciences" (e.g., astronomy, astrophysics, field geology, planetary science, field biology and astrobiology), whose theories and hypotheses are investigated in the messy, uncontrollable world of nature, as opposed to the sterile, artificial conditions of a laboratory. In the context of case studies from the history of science, the last half of the talk sketches a new account of how scientists identify, explore, and resolve anomalies. One of the goals of the propose analysis is to explore how to speed up the process of scientific discovery through accelerating recognition that a mysterious phenomenon poses an authentic challenge to current scientific beliefs about the world.

Are we "Othering" the Concept of Life through the Western Scientific View?

Terry Kee[1] and J. McCrum[2]

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[2] *University of York (UK)*

The concept of life has long been a source of human reflection, and much has been learned, especially about the mechanisms of operation of biological organisms. Two things that still elude us however are both a functional and encompassing definition for the concept of life and some foundational model upon which the idea of livingness can be based.

We argue here that one of the central challenges to developing such a foundational model lies within the implicit propositions that lie within Western scientific views of life. By effectively following such implicit propositions, we may have inadvertently, "othered" this concept we call life by separating what life "is" within the Western scientific view and what it is "is not".

These propositions effectively provide constraints or boundary conditions to our thinking about the concept of life which may not necessarily be helpful for us in teasing out more foundational principles. In this piece, we offer a critical reconsideration of three such implicit boundary conditions to the concept of life and that, when be dispensed with, an entirely different framework emerges. Within such a framework, these three implicit boundary conditions: (i) that life is a property of a system/organism or thing; (ii) that life is concerned only with biological systems and (iii) that life is a binary concept; systems can be either living or not-living; are replaced with three, different operational principles. (i) The concepts "life" and "processes of change" are synonymous; (ii) such processes of change are founded upon "interactions" and (iii) processes of change are recursive and integrative across any given set of boundary conditions.

This re-framing of boundary conditions to the concept of life is in fact not original at all and manifestations of it been understood to philosophers and spiritual thinkers over centuries. In this presentation we will review such a change in conceptual perception of life and look at where a revised concept intersects with previous thought and belief.

Improportionabiles (Cusanus) - On the possible Incommensurability of Extraterrestrial Beings

Marie-Luise Heuser[1]

[1] *Head of the "Space and Culture" expert committee of the German Aerospace Society (DGLR)*

In Cusanus' writing "De docta ignorantia" (1440), the cosmological trans-terrestriality goes hand in hand with an epistemological trans-terrestriality, i.e. with the transgression of given terrestrial systems of knowledge. According to Cusanus' epistemology, individual systems of knowledge are defined by "proportionally" related elements, similar to biological "species regions" or stellar "subworlds". Knowledge within a system comes about through comparison and the discovery of proportions to what is already known. It is not possible to transcend the respective knowledge systems logically and deductively. For Cusanus, knowledge about extraterrestrials cannot be gained discursively or by means of extrapolation on the basis of our terrestrial knowledge systems, as we lack any means of comparison. Even if we were able to make contact with them, it is not certain that we would understand them. For Cusanus, there is the incommensurable and the completely different. However, the pluralization and heterogenization of the universe only takes place at the level of the finite beings that have already come into being. The universe itself emerged from a unified origin, which we can recognize by means of a "visio intellectualis". In this origin, the opposites disappear in a "coincidentia oppositorum", from which all products of the universe have emerged. Cusanus thus achieves the feat of showing that even if there is something incommensurable and we on earth are not at the center of the world, there is still a unifying bond that can only be seen with a translogical view.

Ideas of the Universe. Perspectives on extraterrestrial life in modern European science

Lorenzo De Piccoli[1,2]

[1] *Università di Pisa*
[2] *Università degli Studi di Firenze*

While astrobiology and SETI are relatively recent additions to the landscape of science, the notion of extraterrestrial life is not a new one discussions and speculations regarding this topic can be found even in ancient thinkers, such as Plutarch. In early modern Europe, the new Copernican view of the universe prompted natural philosophers to rethink the relationship between humanity, the cosmos, and other forms of intelligent life. In my presentation, I would like to discuss four examples of how the topic of extraterrestrial life was conceptualised, examined, and argued about by different thinkers between the late XVII and early XX centuries.
The specific examples I will discuss have been selected in order to reflect a broad spectrum of different biographical backgrounds, scientific fields, and opinions regarding the topic two of the authors I will discuss, Christiaan Huygens (1629-1695) and Alfred Russel Wallace (1823-1913), are well known by historians of science, while two of them, Lorenzo Hervás y Panduro (1735-1809) and Jose Serrano (1740-1822), are more obscure and are included within the scope of my own original research as a PhD student. All these authors have in common the fact that they discussed the topic from two angles, one scientific and physical, one philosophical and theological. This demonstrates how the question of extraterrestrial life has always been deeply intertwined with the broader idea of the universe and humanity's place in it held by different thinkers at different points in time. Interestingly, all these authors used knowledge from other sciences to infer and speculate concerning extraterrestrial life, similarly to how modern SETI researchers and astrobiologists use data and models borrowed from other scientific disciplines (as well as the humanities) to direct their research. On the other hand, while the theological preoccupations of these authors may seem outdated or even irrelevant in this day and age, it should be noted that even contemporary SETI research has been shaped by questionable philosophical assumptions about the nature of the universe and the intelligence(s) that inhabit it, giving rise to the well-known and highly speculative debates concerning the Fermi paradox and its many proposed "solutions". I believe that critically analysing how thinkers in the past framed the extraterrestrial life question within their own view of the universe (one that was informed by Christian theology) could be helpful in better assessing contemporary debates and speculation.

During my presentation, I would like to attempt a sort of "dialogue" between the four aforementioned authors, comparing and contrasting their arguments in favour of or against the notion of extraterrestrial life while highlighting the relevance of their speculations, objections, and conceptualisations to the contemporary philosophical and scientific debate regarding research programs such as astrobiology and the search for extraterrestrial technosignatures.

SESSION 4

COMMUNICATION SCIENCE AND SOCIAL PSYCHOLOGY

[KEYNOTE TALK] Uncertainty Communication and the Perception of Otherness

Sven Engesser[1]

[1] *Technische Universität Dresden*

Understanding and navigating uncertainty is fundamental to both scientific inquiry and human experience. Whether in natural sciences, social sciences or humanities, our engagement with the unknown shapes how we construct and interpret otherness.

This talk will explore the role of uncertainty communication in shaping public and academic discourse, drawing on insights from communication science, psychology, and sociology. How does cognitive and affective processing of uncertainty influence the way we perceive what is “known” versus “unknown”? How do scientists and scholars convey uncertainty without undermining trust? I will introduce different concepts of uncertainty, describe psychological biases in uncertainty perception, analyze the effectiveness of uncertainty communication, and discuss the political instrumentalization of uncertainty.

This talk will highlight how uncertainty—often viewed as a challenge—can instead become a tool for fostering dialogue, ultimately enriching our understanding of otherness on Earth and beyond.

Life in Extreme Environments: A proposal for bridging the gap between natural sciences, arts, perception and communication

Erica Bisesi[1,2,3], Giovanni Asquini[3,4], Maria Vittoria Barrella[3,4], Nicola Baroni[3,4], Mauricio Dottori[3,5], Michele Maris[1,6] and J. A. Caballero[7]

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Inspired by the exhibition XTREME - Life in Extreme Environments (https://scienceinthecity2020.eu/en/2020/10/08/xtreme-life-in-extreme-environments/), which took place in Trieste in 2020, a multimedia show was set up and will serve as opening event at BEACON 2025 in Reykjavik on July 1st, 2025. Our production stems from reasoning about human conditions in the extreme environments of Caves, Antarctica and Exoplanets potentially suitable for hosting life, by attempting to answer the question of who we become, visiting a harsh reality where our sins, dreams and sense are heading to the better part of ourselves. Our target is threefold. As a premise, a novel exhibition will illustrate the main features of extreme environments and the conditions for life to thrive in hostile habitats, as well as for our species to adapt. The theme of the exhibition will be developed over the course of a multimedia show exploiting synergic interaction between a group of scientists, musicians, composers, a multimedia artist, and an actress and dancer. Such issues will be conceptualized in terms of conflict between Man and Nature, to which we proposed a possible solution in the dialogue between natural sciences, music/video and metaphors expressed through scientific and poetic narrations. The one-act performance is a storytelling about the history of the humankind: from the first inhabitants on Earth in the caves, through the quest and discovery of new lands in the 16th and 17th centuries - namely, expeditions to explore new continents as Antarctica, to nowadays space exploration questioning about the origin and distribution of life in the Universe. Both initiatives - the exhibition and the performance event - rest on current scientific research, which encompasses five main axes: natural sciences, sonification of physical phenomena, algorithmic and electroacoustic composition, music and video technology - dually intended as score-based offline work and gestural interactive form-bearing feedback. World-premiere music compositions have been inspired, among others, by Antarctica, caves on the Earth and on the Moon, and potential habitability on exoplanets orbiting around M stars. Such scenarios are exacerbated through conflictual interplay between the cello (representing the Earth) and the piano (representing the Human) (I futuro in ogni istante), and further developed by capturing artists' performance actions on stage in a contrasting fashion with overall electroacoustic responses (Crossing Rhapsody), sonification of scientific data (Le grotte della Luna/Infinity 428; "Exoplanets" Suite), and resort to extramusical elements and extended instruments (U sào as neves d'antào? Antartide). The entirely programmable software Touchdesigner - a novel technology enabling 2D/3D interaction between shape, color, sound and images/videos - will be exploited to make contextual graphic material responsive to sound through real-time capture and processing. As pointed out by Oscar Schlemmer, cofounder of the Bauhaus School: "The stage is the arena for successive and transient action", a main space for the dynamic confrontation of different artistic approaches and the living evaluation of theories and relationships. The purpose of this presentation is to illustrate the rationale behind our multi-stage-project, and propose a novel approach to outreach by offering the audience a multimodal experience which integrates hearing, sight, embodiment and rational thinking.

More than War and Peace: Analyzing museum's visitors' messages to extraterrestrials

Julina Pletziger[1], Niklas Döbler[1] and Claus-Christian Carbon[1]

[1] Otto-Friedrich-Universität Bamberg

The study observes 605 messages proposed to be sent to potential extraterrestrials, which were created as audio recordings by anonymous visitors of a German museum. Using a multi-method approach that encompasses quantitative as well as qualitative procedures, prevalent themes and recurring patterns in the messages are explored and compared to a timeline of political and natural events during the exhibition period. The results reveal a remarkable diversity in message contents and approaches, with affiliation and informational themes being the most prevalent ones. The dataset suggests a general content stability that is independent from current geopolitical conflicts. Anthropocentric and media-influenced portrayals of extraterrestrials are discussed. The study's findings reinforce the necessity of integrating the humanities and social sciences into the broader framework of the Search for Extraterrestrial Intelligence (SETI).

Interfaces of Knowledge and the Alien in the Room Next Door: A Space Project Manager's Daily Battle Towards Finding Common Ground

Friederike Wolff[1]

[1] Deutsches Zentrum für Luft- und Raumfahrt, Institut für Planetenforschung / German Aerospace Center, Institute of Planetary Research

The body of human knowledge has expanded in a breathtaking manner over the last centuries, a development which has enabled incredible improvements in the understanding of the world we live in as well as in the quality of our lives. But the vastness of our shared knowledge comes at the price of increasing specialization, and the increasing complexity of endeavors to push the boundaries of knowledge are more and more limited by the ability to communicating across different areas of expertise. Space exploration provides good examples of projects that, in terms of technical as well as human complexity, are on the borderline of impossibility. Achieving progress on a question as seemingly simple as "Why did Venus evolve so differently from Earth?" necessitates a community of thousands of people that devise new concepts for space missions, develop technologies, build systems of incredible reliability and performance and finally operate spacecraft on their journey of unbelievable distances though the solar system. The scope of knowledge required for this kind of endeavor ranges from planetary science, atmospheric modelling, engineering expertise in mechanical, electrical, thermal engineering, software development as well as systems engineering and managerial skill to coordinate huge numbers of people working in various types of organizations, from universities to for-profit companies, towards a remote but common goal. This talk is a case study of the challenges in research and development in the domain of planetary exploration: to ensure convergence of all the necessary areas of expertise that are required to make such projects successful, one must on a daily basis find a way to establish shared understanding of scientific and technical concepts, encourage the willingness to accept that different roles are bound to follow a different and sometimes contradictory logic and foster sufficient humility to acknowledge that every contribution is indispensable in a different way. Sharing knowledge is a non-trivial task but the essential foundation to enable any project that aims at progress on a grand scale.