Workshop on

"Advancement of Scientific Thought"

Thursday, March 6th, 2025

Organized by:

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Venue:
Bibliotheksaula/Library Hall
University of Salzburg,
Hofstallgasse 2-4
5020 Salzburg

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I. PROGRAMME

08:30-09:00 Registration

Session 1 – Chairperson: Marko Robnik

09:00-09:05 Opening by EASA President Klaus Mainzer

09:05-09:10 Marko Robnik, Class IV, (CAMTP, University of Maribor):
Introduction to the theme of the workshop

09:10-09:40 Willibald Plessas, Class IV, (University of Graz):
From observation to insight, to explanation, to knowledge, and thought

09:40-09:45 Discussion

09:45-10:15 Markus F. Peschl (University of Vienna):
Redefining knowledge creation, creativity and innovation in a radically disruptive world – novelty from co-becoming and engaging with future potentials

10:15-10:20 Discussion

10:20-10:50 Anastasios Bountis, Class IV, (University of Patras):
Curiousness, inspiration, and education in scientific research

10:50-10:55 Discussion

10:55-11:20 Coffee, Tea

Session 2 – Chairperson: Anastasios Bountis

11:20-11:50 Andreas Windisch (Joanneum Research, Graz):
The evolution of learning machines: From foundations to future innovations

11:50-11:55 Discussion

11:55-12:25 Klaus Mainzer (EASA President and TU Munich):
Impact of artificial intelligence on science and society

12:25-12:30 Discussion

12:30-12:45 Luca Salasnich, Class IV, (University of Padova):
ChatGPT for Theoretical Physics

12:45-13:00 Matej Avbelj, Class V, (New University, Slovenia):
The constitutional challenges of AI in an algorithmic society

13:00-13:15 Stefan Wölfl, Class IV, (University of Heidelberg):
Engineering life: Synthetic biology and artificial intelligence in basic and applied life-sciences research

13:15-14:00 Lunch

Session 3 – Chairperson: Klaus Mainzer

14:00-14:30	Rainer Blatt, Class IV, (University of Innsbruck): Expectations from quantum computing
14:30-14:35	Discussion
14:35-15:05	Marko Robnik, Class IV, (CAMTP, University of Maribor): Unpredictability in nature
15:05-15:10	Discussion
15:10-15:25	Antoine Reserbat-Plantey (Université Côte d'Azur): Sound quanta: Bridging past theories and future perception
15:25-15:55	Reiko Yamada (ICFO and ESMUC, Barcelona): Can the arts truly inspire the scientific mind? A composer's journey in a physics institute
15:55-16:00	Discussion
16:00-16:15	Peter Herrmann, Class V, (Central South University of Changsha): Arts and sciences – inspiration or condition
16:15-16:30	Violeta Dinescu, Dean Class III, (University of Oldenburg): Vuza rhythmic canons as a musical form
16:30-16:50	Coffee, Tea

Session 4 – Chairperson: Willibald Plessas

16:50-17:20	Ioannis Liritzis, Dean Class IV, (University of the Aegean): History of scientific research and automation
17:20-17:25	Discussion
17:25-17:55	Kristin De Troyer, Class VII, (University of Salzburg): From data to text: How data influence the reconstruction of the biblical text
17:55-18:00	Discussion
18:00-18:15	Regina Radlbeck-Ossmann, Class VII, (Martin Luther University Halle-Wittenberg): Advancement of scientific thought and booming traditional religious positions: A critique on "Illness as a punishment of God"
18:15-18:30	Lenart Skof, Class VII, (Science and Research Centre of Koper): Respiratory paradigm shift and environmental humanities
18:30-18:45	Zhuo Zhuang, Class VI, (Tsinghua University): Progress of AI-assisted personalized design and treatment of bone defects in China
18:45-19:00	Yue Zhao (Universitätsklinikum Cologne): Women's health care in the digital age

19:00-19:15 Gheorghe Duca, Class IV, (Moldova State University):
Artificial intelligence, scientific management, and interdisciplinary collaboration for advancing knowledge and sustainability

19:15-19:30 Georgi M. Dimirovski, Class VI, (Saints Cyril and Methodius University of Skopje)
Aristotle’s philosophical theories on categories, logic, and reasoning drive AI developments

19:30 Closing

II. ABSTRACTS KEY NOTES

Rainer Blatt, Class IV, (University of Innsbruck):

Expectations from quantum computing

A few decades ago, researchers realized that the principles of quantum physics could revolutionize computing, enabling new capabilities far beyond those of classical machines. Since all computations, whether performed by humans or devices, rely on physical processes, harnessing quantum mechanics opens the door to a fundamentally different way of processing information. Quantum computing technology centers around quantum bits (qubits) to store quantum information, quantum gates for processing it, and quantum algorithms to solve problems in novel ways.

This talk provides an overview of the current state of quantum computing, with a focus on the implementation of qubits using strings of trapped ions. These ion-trap systems serve as quantum registers in quantum information processors, demonstrating both analog and digital quantum simulations. The discussion will also explore strategies for scaling ion-trap quantum processors, offering insights into the challenges and opportunities that lie ahead in advancing quantum computing technology.

Anastasios Bountis, Class IV, (University of Patras):

Curiousness, inspiration, and education in scientific research

In this presentation, my aim is to illustrate the topics of Curiousness, Inspiration and Education in Scientific Research, using myself as an example, to emphasize the role that these concepts have played in my own life. Thus, I believe my message will be better understood and appreciated by the audience.

First, I emphasize how important curiousness was for me, as a young boy in High School, and later as a university student. I stress how inspired I was by my professors. How enthusiastic I felt when I began to understand the importance of science in helping us better understand the world around me, using Physics and Mathematics, as vehicles to explore the natural laws that shape the universe and our existence.

Next, I speak about the inspiration I received from my teachers, who encouraged me to pursue my goals and contribute to new directions that were being developed in the fields of nonlinear dynamics, chaos and fractal geometry. At the same time, I realized that my success and impact in science would not be complete, if it were not made accessible to the younger generations. This is where in my life Scientific Research and Education came together into a single entity!

I, therefore, began a long journey to share my knowledge and achievements with students in Greece and internationally, through a series of Summer Schools and Conferences, that continue to this day. The culmination of these efforts was that we were able to contribute to the new science of Complexity, which has not only given us new ideas to understand our material world; it has also allowed us to appreciate the connections between Sciences and Arts, which is one of the fundamental endeavors of our Academy.

Kristin De Troyer, Class VII, (University of Salzburg):

From data to text: How data influence the reconstruction of the Biblical text

Before any exegetes can start working on and interpreting a Biblical text, the text itself needs to be determined and reconstructed. For the Hebrew Bible, commonly called the Old Testament, there are different options: most editions are based on the text of Codex Leningradensis, a medieval Masoretic manuscript. This manuscript is the oldest complete Hebrew Bible manuscript. Another option is to reconstruct the text as it should have existed in either the sixth or first century BCE or even the first or second century CE. The problem lies in how to define the text: is the Biblical text, the text as it was brought (back) to Israel or Judah from the Babylonian exile, or the text as it was used during the Hasmonean times, or as it existed during the Roman times or the beginning of the rabbinic times? Then, there are the multiple witnesses to use for the reconstruction: the medieval manuscripts, the Dead Sea Scrolls, the so-called Samaritan Pentateuch, or can one use the reconstructed underlying text of the old Greek translation, which was produced between the third and the first century BCE? And what about the versions of the Biblical texts that are even one step further removed from a possible Hebrew original text, such as the Latin, the Coptic, the Georgian, the Armenian, the Ethiopic, the Slavonic — all these seem to be dependent on the Old Greek text. And what to do with the Aramaic and Syriac, or Jerome’s Vulgate?

In current research lot of attention is given to both the Dead Sea Scrolls and the Old Greek text as these texts can be dated to the last centuries BCE.

In this talk, I will show how the usage of specific data, the prioritization of texts and the reconstruction of a specific layer of text, influences how the Biblical text looks like. Indeed, the very interdisciplinary research of the different versions of the Biblical text, especially the Old Greek text as well as the Dead Sea Scrolls, has advanced the field of Biblical studies in multiple ways.

Ioannis Liritzis (EASA Dean Class IV and AMEU Maribor):

History of scientific research and automation

In our brief journey we shall present, in a picturesque way, the long-term timeline of technological advancement from the distant past to our lifetime and the further future with following repercussions. The evolution from manual inquiry to modern AI is an amazing achievement of the human mind and of human resilience. The developments evolve either by improvements of existing technologies (optimization), making them more effective and profitable, or by invention of completely new technologies (innovation)

We shall browse to the roots of ancient civilizations (Egyptian, Babylonian, Indian, Chinese, Minoan, and Greek) by considering their advancements in technological devices, especially for astronomy and mathematics, e.g., calendar, prediction of feasts, compass, gunpowder, papermaking, printing, early drones etc. A special mention is devoted to the Greek golden era of science and technology (geometry, rational induction, automatic devices, …), which started as early as 2000 BC with the Minoans, was continued by the Mycenaeans and from the apogee of classical Hellenistic-Roman era was transmitted to the western civilization.

The early technological achievements were then adopted in the Scientific Revolution (with contributions by Copernicus, Galileo, and Newton), with intriguing consequences for observation, experimentation, and deduction.

The first steps to automatization (in Greek αυτόματος – self-moving) from Early Heron of Alexandria to the first calculators (e.g., the Antikythera mechanism from about the 2nd/1st century BC) lead to the further developments of the Abacus and the mechanical calculators by Blaise Pascal and Charles Babbage. This was followed by the Industrial Revolution with mechanization of tools and introduction of steam power. The impact on data collection and scientific instrumentation is identified, where the industrial revolution transformed society via large-scale automation of manufacturing. To reach the Age of Electrical and Digital Innovation and moving even faster from Computing to Cognitive Systems (starting with early AI pioneers, such as Alan Turing, neural networks, initial models in the 1950s to machine learning breakthroughs in the 1990s and 2000s). Science and technology are transforming today in many ways, e.g., robotics in laboratories, high-throughput screening, AI in data analysis, drug discovery, climate modeling, to integration of AI in scientific instrumentation.

The reaction to such developments raises questions of balancing progress and responsibility, ethics, peace, and more. We may think of quantum computing and its potential in research, fully autonomous laboratories powered by AI, interdisciplinary approaches leveraging big data and automation possibly leading to a smarter bliss or an extinguished tomorrow.

Klaus Mainzer (EASA President and TU Munich):

Impact of artificial intelligence on science and society

Artificial Intelligence (AI) has become an incomparable challenge in science and society. In everyday life, chatbots are already used to simulate all kinds of human abilities. Powerful AI/IT companies do not only dominate economy and politics, but become the driver of AI research. But what does AI mean? This talk argues for a serious explanation of what AI-algorithms can do nowadays, and what not. After an analysis of the logical and computational foundations, the impact of AI-tools in science (physics, medicine etc.) is considered. It turns out that AI-algorithms in science are restricted to well-defined problem classes. In economy and society, different infrastructure needs different platforms of AI-tools to handle the increasing complexity. All this requires an enormous consumption of electricity and energy. AI and IT will be the biggest energy consumers in a few years' time. Therefore, this talk argues for sustainable computing as an AI of the future, which is orientated towards the energy efficiency of natural brains (e.g., neuromorphic computing). Energy efficiency is a dramatic claim in times of environmental and climate challenges which should consider the sustainability goals of the United Nations (UN). However, on the other side, Europe is in global competition with tech giants world-wide. Europe must therefore increase its innovative power in science and technology. But the European way of life also requests to defend legal and ethical standards. This is the only way to achieve responsible AI in the end.

K. Mainzer
Artificial Intelligence. When do machines take over?
Springer: Berlin, 2nd edition, 2019
(Chinese translation: Tsinghua University Press: Beijing 2022)

K. Mainzer, R. Kahle
Limits of AI – Theoretical, Practical, Ethical
Springer: Berlin 2023 (German edition 2022)

K. Mainzer
Artificial Intelligence of Neuromorphic Systems. From Digital, Analogue, Quantum, and Brain-Oriented Computing to Hybrid AI
World Scientific: Singapore 2024

K. Mainzer (Ed.)
Handbuch Künstliche Intelligenz
Springer: Wiesbaden 2024.

Markus F. Peschl (University of Vienna):

Redefining knowledge creation, creativity, and innovation in a radically disruptive world — novelty from co-becoming and engaging with future potentials

This presentation reimagines knowledge creation, creativity, and innovation by shifting the focus from traditional cognitivist approaches and a perspective of (re-)combining knowledge to the dynamic relationship between creative agents (such as scientists) and their material and social environments. More recent so-called 4E approaches from cognitive science (Ward et al., 2017) regard cognition as being embodied, embedded, extended, and enactive; they bring about an alternative understanding of creativity and knowledge creation.

An engaged epistemology is proposed (De Jaegher, 2021). It emphasizes the need for cognitive systems to be deeply intertwined with their surroundings for effective sense-making and knowledge creation. By focusing on concepts such as co-becoming, correspondence (Ingold, 2022), resonance, and the (creative) agency of the world (Peschl, 2024), it will be shown how future potentials can guide the creative process by identifying, actualizing, and transforming them into purposeful novel knowledge and innovations.

Situated within the framework of futures literacies—anticipatory sense-making—we will also consider implications for education, focusing on the skills, mindsets, and practices required to foster meaningful, future-oriented creativity and innovation.

De Jaegher, H. (2021)
Loving and knowing: reflections for an engaged epistemology.
Phenomenology and the Cognitive Sciences 20 (5), 847–870

Ingold, T. (2022)
Creation beyond creativity.
In T. Ingold (Ed.), Imagining for real. Essays on creation, attention and correspondence, pp. 15–28. Abingdon, Oxon; New York, NY: Routledge

Peschl, M.F. (2024)
Human innovation and the creative agency of the world in the age of generative AI.
Possibility Studies & Society 2 (1), 49–76
https://doi.noclick_org/10.1177/27538699241238049

Ward, D., D. Silverman, and M. Villalobos (2017).
Introduction: The varieties of enactivism. Topoi 36 (3), 365–375

Willibald Plessas, Class IV, (University of Graz):

From observations to insight, to explanation, to knowledge and thought

We assume observations to be the first step in the creation of knowledge, even though they might not be unique nor objective. Observations may be affected, e.g., by prejudices from culture, learning, interpretations, statistics, etc., nowadays even by so-called artificial intelligence (machine learning). In natural sciences, especially in physics, the building of theories relies on experimental observations as the least questionable basis. Under well-defined conditions experiments should yield – or at least are assumed to yield – the same results at all times and all locations in space. Thereby they are expected to lead to the most comprehensive understanding of the phenomena in question.

From collecting all available insights it remains the task of a theory to provide explanations of the subject matter under consideration. In science this amounts to identifying the premises (e.g., by setting axioms) and deriving by logical reasoning all possible predictions for the pertinent observable phenomena. Theories remain acceptable as long as they are not contradictory or falsified. Such criteria have sometimes been questioned, as explanatory deductions along logical rules might not always be possible. Evidently statistical results from stochastic processes usually refrain from clear-cut counter-arguments. Consequently, causal explanations could get eluded or even be made impossible. Reliable knowledge is thus endangered in principle, even more though if dependent on learned/learning algorithms, for instance in dealing with complex phenomena. On the contrary, constitutive/metaphysical explanations must be rejected in any case.

As a result, scientific thought though steadily progressing is affected by explanations and knowledge that miss absolute reliability. This is true even for the best established theories in natural sciences (notably also in physics). There is a variety of questionable sources starting from perceiving observations, via their interpretations, clarifying corresponding insights, identifying and deriving explanations of results, producing general knowledge and finally creating thought. As a consequence, trust in scientific achievements is also endangered to crumble away. In view of the historical experiences among all of these aspects it appears practically impossible to predict any future developments, especially if human intelligence is about to get competition by learning machines.

In this presentation we shall content ourselves with identifying various caltrops in the processes leading from observations to common scientific thought, without proposing definite guidelines, except for a necessarily careful intellectual approach.

Marko Robnik, Class IV, (CAMTP, University of Maribor):

Unpredictability in nature

It was one of the fundamental findings in the classical science of the 20th century, namely in classical physics and mathematics, that deterministic systems, governed by the precise laws of motion, can behave in a chaotic, i.e. erratic way. It is the sensitive dependence on initial conditions which is at the origin of chaotic behavior: a tiny change of the initial conditions, such as position and velocity, can

result in macroscopic chaos after a finite time, of the order of the so-called Lyapunov time. The divergence of nearby trajectories is of exponential form.
This is the celebrated butterfly effect: the motion of a butterfly here can cause a storm at the same or another place. Beginning with the historical works of the French mathematician Henri Poincaré in the early 20th century the intriguing and complex phenomenon of chaos has been uncovered, but its studies were only continued in the late 1950s and onwards, and later on, especially thanks to the employment of ever more powerful computers.
In the classical science of 20th century – disregarding special and general theory of relativity and development of quantum mechanics and all its consequences – there was a triple revolution of scientific thought:
(1) The discovery of chaos in deterministic systems (without external influences and any kind of noise).
(2) The discoveries of Kurt Gödel and Alan Turing that unprovable theorems and uncomputable numbers exist that cannot be computed by a finite algorithm.
(3) That self-organized systems exist, giving rise to ordered structures, including life.
It is a fundamental discovery that (1) and (3) can occur only in nonlinear systems, and that chaos has the properties of (2). The conclusions – even on the philosophical level – are that determinism in the sense of precise prediction in nature is not possible, and moreover, order of any kind in any system always costs energy. If on top of that we include the quantum theory describing the microscopic world, with its statistical interpretation, we must conclude that in general nature is not predictable. It can be predictable only in special cases, in so-called integrable systems. In general, to control immanently chaotic systems and to create order in such systems in nature or society, in civilization, requires significant energy input.

Andreas Windisch (Joanneum Research, Graz):

The evolution of learning machines: From foundations to future Innovations

Artificial Intelligence (AI) and Machine Learning (ML) have evolved from theoretical concepts to powerful tools affecting many aspects of human life. In this talk we explain the foundational principles, key milestones, and major breakthroughs in the development of learning machines. We start from early theoretical concepts, including Turing’s vision and the birth of neural networks, followed by the mathematical foundations that underpin modern AI. We then address the resurgence of deep learning, the role of data in machine learning, and the technological breakthroughs that have driven AI’s rapid growth. Finally we aim at conveying a deeper understanding of how learning machines have developed recently, where they stand today, and what the future may hold.

Reiko Yamada (ICFO and ESMUC, Barcelona):

Can the arts truly inspire the scientific mind? A composer’s journey in a physics institute

Can the arts genuinely spur scientific innovation, or are their contributions to the scientific mind overstated? This talk explores the intricate relationship between art and science through a unique lens: that of a music composer who has spent the past five years as a postdoctoral researcher at a physics institute

(www.reikoyamada.com). Does artistic creativity truly influence scientific breakthroughs, or are these domains simply parallel expressions of human curiosity? Drawing from personal experiences at the intersection of music and physics, as well as historical examples and contemporary research, the talk questions whether the skills cultivated in the arts – imagination, observation, and abstraction — can tangibly impact the scientific process.

III. ABSTRACTS CONTRIBUTIONS

Matej Avbelj, Class V, (New University, Slovenia):

The constitutional challenges of AI in an algorithmic society

This presentation examines the theoretical and practical challenges to constitutionalism arising from the profound technological changes influenced by artificial intelligence (AI) in our emerging algorithmic society. The unprecedented rapid development of AI technology not only renders conventional theories of modern constitutionalism obsolete, but also creates an epistemic gap in constitutional theory. This calls for a new, compelling constitutional theory that adequately accounts for the scale of technological change by accurately capturing it, engaging with it, and, ultimately, responding to it in a conceptually and normatively convincing way. To this end, the presentation will describe and contextualize the nature of the constitutional challenges posed by AI; it will examine existing theoretical approaches to the complex of problems and, in preliminary conclusion, look to the future of a reformed constitutionalism.

Georgi M. Dimirovski, Class VI, (Saints Cyril and Methodius University of Skopje):

Aristotle’s philosophical theories on categories, logic, and reasoning drive AI developments

This contributed discussion explores how the combined backward-chaining–forward-chaining reasoning scheme following Aristotle’s theories of categories and of logic-deduction versus logic-induction principles has yielded stability existence theorems for the supervisory control-integrated complex multi-networks with locally stabilized nonlinear-node dynamical systems, which emerge of paramount importance in studies of cybernetics. By assumption, the investigated class of multi-network systemic structures is assumed to be endowed by adequate communication networks, in which clear distinction is made among intra-node and out-node inter-connections. In turn, coincidence and confluence parallels between Siljak’s coordinator and Chen’s random-pinning supervisory controls emergent in multi-networks operating at control-stabilized steady-state orbits (hidden isolated equilibrium or oscillation) of its node systems, possibly even faulty interconnections may occur. It is therefore claimed that Aristotle’s philosophical theories on Categories, Logic, and Reasoning in fact drive the AI methods and models.

Violeta Dinescu, (EASA Dean Class III and University of Oldenburg):

Vuza rhythmic canons as a musical form

I present the music I composed according to the mathematical theory of Dan Tudor Vuza on rhythmic canons. The compositions that have been written so far according to Vuza's mathematical theory took into account as unit of time - the pulsation, a steady pulse, in different tempos.

In the simplest form, a Vuza canon is played by a number of voices, of different vocal or instrumental colours, all having the same rhythmic structure, but translated; the result should contain no overlapping voices and no moment of silence; the rhythmic cell, of a length of M entries, should not have any periodicity modulo M. From this description it is already clear that finding structures of this type is not at all trivial.

In such a structure I took as an entry not a single pitch, but a short “melody”. This way a musical form comes into being. My path in writing Vuza canons was, looking a posteriori, a struggle to gain liberty degrees. I will very briefly present the stages defined by myself so far and I will give one musical example.

Gheorghe Duca, Class IV, (Moldova State University) and Jiuping Xu (Chihuan University):

Artificial intelligence, scientific management, and interdisciplinary collaboration for advancing knowledge and sustainability

The evolution of scientific thought has been shaped by interdisciplinary collaboration, technological breakthroughs, and effective research management. In recent years, Artificial Intelligence (AI) has emerged as a transformative force in science, enhancing research capabilities, automating data analysis, and optimizing problem-solving in fields ranging from medicine to environmental sciences. AI-driven models facilitate pattern recognition, accelerate discoveries, and contribute to sustainability efforts through predictive analytics and intelligent decision-making.

However, scientific progress is not solely determined by technological advancements – it also depends on efficient management in education and research. The ability to integrate AI into scientific administration, optimize research strategies, and improve academic decision-making plays a crucial role in the sustainability and impact of scientific innovation. We exploit the expertise of Jiuping Xu in scientific decision-making models, operations research, and system engineering, which provides valuable insights, how AI-powered management tools enhance interdisciplinary collaboration and research efficiency.

This presentation will explore:

- The role of AI in driving scientific innovation and sustainability.
- The application of AI in scientific management and research optimization.
- Case studies of AI-driven interdisciplinary projects in education and science.
- The impact of AI-based leadership and decision-making on knowledge dissemination.

By examining successful models from Moldova, China, and international collaborations, this talk will demonstrate, how AI and advanced management

strategies can enhance research productivity, improve strategic planning, and drive the future of scientific thought.

Peter Herrmann, Class V, (Central South University of Changsha):

Arts and sciences – inspiration or condition

While in general terms arts and sciences are perceived as two distinct spheres, it is proposed to start from the commonality, given by their shared goals: *Understanding the world with different means, while being guided by asking, analyzing, observing, and creating.*

The contribution aims at both, developing a deeper understanding of such an approach and searching spaces for practicing this commonality.

Regina Radlbeck-Ossmann, Class VII, (Martin Luther University Halle-Wittenberg):

Advancement of scientific thought and booming traditional religious positions: A critique on “Illness as a punishment of God”

Free Pentecostal churches are the fastest growing religious community in the world. They put forward positions that are presented in contemporary forms, but gain their appeal precisely because they offer a complementary counterpart to the developments of late modernity. These churches present charismatic leaders to a world trapped in real or perceived constraints. In a world determined by reason, they create a balance in an emotionally charged religiosity. They contrast the complexity of an overwhelmingly pluralistic world with simple, emphatically traditional answers. It can now be observed how these positions are spreading with their religious communities and gaining social significance. Political attitudes, family and gender images are influenced, as are fundamental issues such as health and illness. The article takes an exemplary approach. It focusses on the latter field and sheds light on positions that portray "illness as God's punishment". It offers a critique of this idea that is not only theologically motivated. In contrast, reference is made to the Judeo-Christian tradition, which holds valuable potential for a modern understanding of health and illness.

Antoine Reserbat-Plantey (Université Côte d’Azur) and Atac Imamoglu (ETH Zurich):

Sound quanta: Bridging past theories and future perception

Sounds, as mechanical vibrations, span art, physics, and physiology, influence communication, emotion, and environmental monitoring. Yet, at the quantum scale, the pertinent vibrations — phonons — remain beyond our direct auditory perception. Humans exhibit some sensitivity to quantum phenomena (e.g., single-photon vision), but high noise floors and limited frequency ranges usually conceal the fundamental quantum state of sound. In this brief talk, I will introduce the historical roots (1) of “sound quanta”, from ancient atomist philosophies to early modern science. Building on that foundation, I will discuss how auditory perception intersects with quantum mechanics (2–4) and review

recent experiments investigating mesoscopic mechanical systems in the quantum regime (5, 6). Finally, I will explore emerging strategies to develop a ‘quantum sound interface’ that may enhance our perception of quantum states of vibrations and provide insights for cognitive science or real-time experimental monitoring.

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3. W. Bialek, A. Schweitzer, Quantum Noise and the Threshold of Hearing. Phys. Rev. Lett. 54, 725–728 (1985)
4. R. Nold, C. Babin, J. Schmidt, T. Linkewitz, M. T. P. Zaballos, R. Stöhr, R. Kolesov, V. Vorobyov, D. M. Lukin, R. Boppert, S. Barz, J. Vučković, J. C. M. Gebhardt, F. Kaiser, J. Wrachtrup, Quantum Optical Microphone in the Audio Band. PRX Quantum 3, 020358 (2022)
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6. A. D. O’Connell, M. Hofheinz, M. Ansmann, R. C. Bialczak, M. Lenander, E. Lucero, M. Neeley, D. Sank, H. Wang, M. Weides, J. Wenner, J. M. Martinis, A. N. Cleland, Quantum ground state and single-phonon control of a mechanical resonator. Nature 464, 697–703 (2010).

Luca Salasnich, Class IV, (University of Padova):

ChatGPT for Theoretical Physics

I will discuss some specific cases where the use of ChatGPT can help the teaching and the research in Theoretical Physics. Advantages and limitations will be highlighted.

Lenart Skof, Class VII, (Science and Research Centre of Koper):

Respiratory paradigm shift and environmental humanities

For the ancient cultures of the world living in the natural environment of breathable, air was regarded as sacred and known under denominators such as ruaḥ, aér, pneûma, prāṇa, qi/ki, ik’, mana, or sila, among others. With the demise of ancient cosmological schemes especially in the West, material and elemental denominators such as “psyche”, “air” and “breath” quickly solidified into new metaphysically underpinned concepts of “soul” and “spirit”. These shifts downplayed breathing as a fact of human and other bodies and the forgetting of breath became one of the main features of Western philosophy. More recently, the discussions around the breath and breathing have become increasingly pertinent within the current global environmental, social, and health crises. The effects of atmopolitics are visible in weather events that characterize the present-day climate change crisis (wildfires and dust storms),

bad air, polluted atmospheres (dust, smog, environmental toxicities …), but also found expression in concerns with aerosol dynamics during COVID-19 and racial police repression (as in I can’t breathe campaigns). In Terror from the Air (Luftbeben, 2002), Peter Sloterdijk is elaborating on suffocating events of the 20th century – such as gas warfare, mass gassing and mass extermination, aerial bombing attacks and new aerial (and nuclear) weapons. As based on Timothy Choy’s thesis on the unevenly constituted planetary medium for respiration, our lecture will point to the unfortunate forgetting of breath in Western philosophy and modern culture and argue for a new path towards respiratory equality in environmental humanities – thus importantly infusing the contemporary environmental science with a new humanistic paradigm.

Stefan Wölfl, Class IV, (University of Heidelberg):

Engineering life: Synthetic biology and artificial intelligence in basic and applied life-sciences research

Synthetic biology and artificial intelligence (AI) are revolutionizing basic and applied research across all fields of the life sciences. Together with technological innovation in bioanalytical equipment our basic understanding of life and its underlying principles is vastly growing.

Combined, general technological innovation, data driven computational analysis of biological systems, and easily accessible genetical manipulation are transforming biomedical research leading to breakthroughs in gene therapy, regenerative medicine, and disease modeling. Thus, the interdisciplinary convergence of biological and biomedical research with technology-driven computational and analytical science is not only expanding our understanding of life but also paving the way for innovations in biotechnology and biomedicine, raising important ethical and regulatory considerations.

Yue Zhao (Universitätsklinikum Cologne):

Women’s health care in the digital age

The digital age has transformed women’s healthcare, offering solutions like telemedicine, wearable devices, and AI-driven health apps to empower women in managing their health. These innovations improve access to care, especially in underserved areas, and provide personalized approaches to reproductive health, mental well-being, and chronic disease management. Addressing challenges such as data privacy and inclusivity is vital to fully realize the potential of these tools, advancing equitable and person-centered women’s health promotion. We shall share the outcome of an EU project (EQUALS-EU) and should like to discuss potential solutions in this topic.

Zhuo Zhuang, Class VI, (Tsinghua University):

Progress of AI-assisted personalized design and treatment of bone defects in China

In recent years, in collaboration with millions of human periarticular bone defect, the AI-assisted personalized design and treatment of bone defects are processed in China. Data driven micro-CT and clinical-CT images are used to obtain the characteristics of cancellous bone structure and graphics. The experimental technology and numerical method are developed for predicting the mechanics parameters. The constitutive model of heterogeneous anisotropy of bone tissue is established and the parameters are deduced by numerical simulation and specimen experiment. The digital triplets with physical environment scanning CT image, virtual environment equivalent modulus and additive manufacturing lattice design are created to guide the clinical treatment of personalized bone defects. This work has been demonstrated in some clinical applications to the benefit of patients.