Working Group on Philosophy of Physics
Arbeitsgruppe Philosophie der Physik (AGPhil)

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Overview of Invited Talks and Sessions

(Lecture hall HS XVII)

Plenary Talk of Michel Janssen

PLV IX	Fri	9:00– 9:45	HS 1+2	**Building the Cathedral of Quantum Mechanics** — •Michel Janssen

Invited Talks

AGPhil 3.1	Tue	11:00–11:45	HS XVII	**Is there a mechanism that produces many parallel worlds?** — •Meinard Kuhlmann
AGPhil 4.1	Tue	14:00–14:45	HS XVII	**History and Philosophy of Physics in Physics Education** — •Oliver Passon
AGPhil 9.1	Thu	14:00–14:45	HS XVII	**Waves in a turbulent sea: controversies over gravitational waves** — •Henrique Gomes

Invited Talks of the joint Symposium Quantum Science and more in Ghana and Germany (SYGG)

See SYGG for the full program of the symposium.

SYGG 1.1	Tue	11:00–11:05	WP-HS	**Welcome Adress** — •Birgit Münch
SYGG 1.2	Tue	11:05–11:20	WP-HS	**Quantum Education in Ghana** — •Dorcas Attuabea Addo
SYGG 1.3	Tue	11:20–11:45	WP-HS	**Mathematical and Computational Physics Research In Ghana: To Cultivate a Knowledge-Based and Sustainable Development Economy** — •Henry Martin, Henry Elorm Quarshie, Mark Paal, Francis Kofi Ampong, Eric Kwabena Kyeh Abavare, Matteo Colangeli, Alessandra Continenza, Jaime Marian
SYGG 1.4	Tue	11:45–12:10	WP-HS	**Forecasting the Economic Health of Ghana Using Quantum-Enhanced Long Short-Term Memory Model** — •Peter Nimbe, Henry Martin, Dorcas Attuabea Addo, Nicodemus Songose Awarayi
SYGG 1.5	Tue	12:10–12:40	WP-HS	**Quantum Technology with Spins** — •Joerg Wrachtrup
SYGG 1.6	Tue	12:40–13:00	WP-HS	**Renewable Energy Technologies for Rural Ghana: The Role of Appropriate Technology for Tailored solutions** — •Michael Kweku Edem Donkor

Invited Talks of the joint Symposium Foundations of Quantum Theory (SYQT)

See SYQT for the full program of the symposium.

SYQT 1.1	Wed	11:00–11:30	HS 1+2	**Against 'local causality'** — •Guido Bacciagaluppi
SYQT 1.2	Wed	11:30–12:00	HS 1+2	**Philosophy of Quantum Thermodynamics** — •Carina Prunkl
SYQT 1.3	Wed	12:00–12:30	HS 1+2	**Can quantum information be the underpinning of quantum physics?** — •Paolo Perinotti
SYQT 1.4	Wed	12:30–13:00	HS 1+2	**Spin-bounded correlations: rotation boxes within and beyond quantum theory** — Albert Aloy, •Thomas Galley, Caroline Jones, Stefan Ludescher, Markus Müller

Prize and Invited Talks of the joint Awards Symposium (SYAS)

See SYAS for the full program of the symposium.

SYAS 1.1	Thu	14:30–15:10	HS 1+2	**A journey in mathematical quantum physics** — •Reinhard F. Werner
SYAS 1.2	Thu	15:10–15:50	HS 1+2	**Precision Tests of the Standard Model at Low Energies Using Stored Exotic Ions in Penning Traps** — •Klaus Blaum
SYAS 1.3	Thu	15:50–16:30	HS 1+2	**Controlling light by atoms and atoms by light: from dark-state polaritons to many-body spin physics** — •Michael Fleischhauer
SYAS 1.4	Thu	16:30–16:35	HS 1+2	**Quantum history at your fingertips: Launch of the DPG's Quantum History Wall** — •Arne Schirrmacher

Sessions

AGPhil 1.1–1.4	Mon	14:30–16:30	HS XVII	**Foundations of Physics I**
AGPhil 2.1–2.4	Mon	17:00–19:00	HS XVII	**Foundations of Physics II**
AGPhil 3.1–3.3	Tue	11:00–12:45	HS XVII	**Foundations of Quantum Mechanics: The Measurement Problem and the Many Worlds Interpretation**
AGPhil 4.1–4.3	Tue	14:00–15:45	HS XVII	**Integrated History and Philosophy of Quantum Mechanics**
AGPhil 5.1–5.5	Wed	14:00–16:30	HS XVII	**Foundations of Quantum Mechanics I**
AGPhil 6.1–6.5	Wed	17:00–18:15	HS XVII	**History and Philosophy of Physics**
AGPhil 7	Wed	18:30–19:00	HS XVII	**Members' Assembly**
AGPhil 8.1–8.4	Thu	11:00–13:00	HS XVII	**Foundations of Quantum Mechanics: Bohm and Hidden Variables**
AGPhil 9.1–9.3	Thu	14:00–15:45	HS XVII	**History and Philosophy of General Relativity**
AGPhil 10.1–10.4	Thu	17:00–19:00	HS XVII	**Foundations of Quantum Mechanics II**
AGPhil 11.1–11.4	Fri	11:00–13:00	HS XVII	**Philosophy of Particle Physics and Quantum Field Theory**
AGPhil 12.1–12.4	Fri	14:00–16:00	HS XVII	**Foundations of Classical and Quantum Mechanics**

Members' Assembly of the Working Group on Philosophy of Physics

Mittwoch 18:30–19:00 HS XVII

- Bericht
- Planung 2025/26
- Wahlen
- Verschiedenes

AGPhil 1: Foundations of Physics I

Time: Monday 14:30–16:30 Location: HS XVII

AGPhil 1.1 Mon 14:30 HS XVII

Gravity and the bag model — •Hristu Culetu — Ovidius University, Constanta, Romania

The bag model from nuclear physics is used to show that, on the grounds of some gravitational arguments, a proton seems to behave like a microscopic black hole, with de Sitter spacetime as the inner geometry and a regular Schwarzschild spacetime outside it [1].

The basic idea is to assume that, for masses m smaller than the Planck mass, the Newton constant G may be given by $G_s = c\hbar/m^2$, where m is the mass of the physical system under consideration, s subscript means 'strong', c is the velocity of light and $\hbar$ stays for the Planck constant.

If m represents the Higgs mass $m_H \approx 125GeV/c^2$, we get $G_s = c\hbar/m_H^2 = 10^{27}$ in CGS units, the same value obtained by Onofrio [2], who considers weak interactions as short distance manifestation of gravity.

1.H. Culetu, , Int. J. Theor. Phys. 54, 2855 (2015). 2.R. Onofrio, Mod. Phys. Lett. A 28, 1350022 (2013).

AGPhil 1.2 Mon 15:00 HS XVII

Is quantum mechanics real or complex? — •Shu-Di Yang — 322-6 Oroshi, Toki, Gifu 509-5202

It has been long debated whether quantum mechanics is real or complex. Local experiments have been carried out confirming the complex nature of quantum mechanics in the standard formalism. Nevertheless, recent theoretical work demonstrated that in a closed universe, quantum mechanics is real. We discuss the philosophical implications of whether quantum mechanics is real or complex.

AGPhil 1.3 Mon 15:30 HS XVII

It from Knit — •Tim Gough — Unaffiliated - Studio F Whitacre Mews Stannary Street London SE11 4AB UK

This paper will present a coherent philosophical position regarding the foundations of quantum physics with the following characteristics: **In line with the intuitionistic maths of Gisin, that physical reality is indeterminate, that time is real (no block universe), and therefore that something new (unpredictable from the past) happens quite often **In line with Rovelli*s relational quantum mechanics, that the foundations of reality are relational, not material **In line with Ladyman, that every thing must go **In line with Simondon, that physical reality is transductive (in his meaning of the word: a relation where the terms of the relation do not pre-exist that relation) **In line with Derrida, that at the foundation we find différance **In line with Deleuze, that the main question philosophy asks is: how is the production of the new possible? **That, in line with general systems theory, every thing is systemic, quantum theory being a (rich and extreme) subset of systems-oriented thought **That ontology is flat and immanent, but nonetheless not materialist **That maths is unreasonably effective **That the hard problem of consciousness disappears **That material stuff is an emergent property of relations

Not it from bit but it from knit.

AGPhil 1.4 Mon 16:00 HS XVII

Compositeness and spatial extension of fundamental particles justified by introducing a dual space concept — •Hans-Dieter Herrmann — Berlin

The assumption that organisms consist of cells and molecules consist of atoms is not analogously applicable to fundamental particles. Compositeness of leptons and quarks in space-time is excluded by experiment. We propose a dual space concept in particle physics, which complements space-time by an extra space, fixed to an individual particle as an 'eigenspace'. The eigenspace of a particle resembles the space spanned by body-fixed coordinates of a satellite, a drone or a spinning top. The body-fixed coordinates complement the lab-fixed or earth-fixed coordinates of a moving object, which define the common space-time. The twofold existence of natural systems in two spaces is investigated at different levels of reality. At the level of subatomic particles we identify space-time as the 'common space', however the 'eigenspace' of fundamental particles is missing. An inaccessible cylindrical 'eigenspace' is proposed where fundamental particles appear composited and spatially extended. Intrinsic properties of a particle such as invariant energy, spin, and magnetic moment have its origin in the eigenspace. The consequences of the dual space concept for the cosmic inflation and the nature of dark matter are discussed. A conjecture on the emergence of space-time caused by the emergence of fundamental particles from sub-particles is developed.

AGPhil 2: Foundations of Physics II

Time: Monday 17:00–19:00 Location: HS XVII

AGPhil 2.1 Mon 17:00 HS XVII

Are four levels of multiverses enough? — •Phillip Helbig[1] and Maura Cassidy Burke[2] — [1]Maintal, Germany — [2]Freudenthal Institute, Utrecht University, Netherlands

Tegmark classified multiverses into four levels: I: regions in our Universe but outside our particle horizon and hence not (yet) observable by us; II: independent Level I universes in the context of eternal inflation and/or with different laws of physics; III: many universes corresponding to the many worlds in the many-worlds interpretation of quantum mechanics; IV: Tegmark's mathematical multiverse in which every mathematical object actually exists. We suggest that Tegmark's Level II multiverse actually refers to two distinct concepts and propose a change in the terminology in order to take that into account.

Levels II and III are the types of multiverse usually discussed, and the definitions of the levels other than II are clear. Level II is most often thought of as consisting of various universes within the concepts of eternal inflation, the string-theory landscape, or brane-world cosmology, but at the same time as universes with different values of physical constants or even different laws of physics. On the other hand, such theories clearly depend on some fundamental laws of physics which must be common to all universes in such a multiverse, thus a distinction is needed. We thus see a need for a level higher than what is usually thought of as the Level II multiverse, which of all of the levels also most closely corresponds to historical multiverse concepts.

AGPhil 2.2 Mon 17:30 HS XVII

Spacetime Functionalism and T-Duality — •Christian Airikka — IFIKK, University of Oslo

Spacetime has been reported missing, last observed close to the Planck scale. Philosophers are investigating the case. One suspect, String Theory, is accused of eliminating spacetime through dualities. Dual theories posit different ontologies but imply the same physics. According to the common core interpretation, anything the duals disagree on is surplus structure. As the duals disagree on facts about their fundamental spaces, it follows that spacetime must be emergent.

A popular account of spacetime emergence is Spacetime Functionalism (SF). SF follows the Ramsey-Carnap-Lewis method of functional reduction. According to SF, spacetime is to be identified with whatever fundamental entities that realise the functional spacetime roles.

I demonstrate the innocence of String Theory. In applying SF to dual theories, one replaces troublesome terms with bound variables, stripping them of interpretation. I show, using a toy model, that the relevant spacetime functions will be realised by identical structures in each dual. It then follows as a matter of logical deduction, according to SF, that they are identified - both with aspects of spacetime, and each other. According to SF, the duals are not in disagreement. Spacetime never was lost! I conjecture that, since dual theories are isomorphic, such identifications follow in more complicated cases as well.

Conclusions: SF, as an account of emergent spacetime in String Theory, is self-undermining. On the other hand, SF might offer a flat-footed realist account of the ontology of String Theory.

AGPhil 2.3 Mon 18:00 HS XVII

The Probabilistic Turn across Physics: From Classical to

Quantum Physics and from Psychophysics to AI — •Ken Archer — Linkoping University, Linkoping, Sweden

The meaning and interpretation of probability within quantum physics is illuminated in this paper by identifying parallels in the probabilistic turn across multiple areas of physics. The probabilistic turn from classical physics to statistical mechanics has important parallels with the probabilistic turn from classical physics to quantum physics. Critically, this paper shows these same parallels within another probabilistic turn in a field whose association with physics is controversial - the probabilistic turn from psychophysics to artificial neural networks (ANNs) that are the basis for AI.

In all three fields, probability enables physical models to account for stability. Just as statistical mechanics accounts for the stability of fields and quantum mechanics accounts for the stability of matter, ANNs enable cognitive models to account for the stability of cognitive capacities across heterogenous and even damaged neural networks. Furthermore, this role of probability across physics points to another common feature - the absence of pre-given distributions (Gaussian, binomial, Bayesian, etc) such that softmax in ANNs plays an analogous role as Born's Rule in quantum mechanics. In both cases, the particular mathematization of the phenomena is the theory - there's no deeper human intuition about the phenomena to leverage in a pre-given distribution, as probabilities emerge naturally from the mathematical formalism.

AGPhil 2.4 Mon 18:30 HS XVII

On the theory-ladenness of theorising — •Radin Dardashti — University of Wuppertal, Germany

The theory-ladenness of observations or data is a much-discussed topic in the philosophy of science. It is common to regard theory-ladenness as something problematic that needs to be overcome in order to be able to confront theories on a more neutral basis. But theories themselves are obviously not developed in a vacuum. So one might also ask whether there is a kind of theory-ladenness involved in theory development itself, and whether this might pose a threat to the reliability of theory development. In this paper I discuss different kinds of theory-ladenness in theory development in fundamental physics and the conditions under which they may or may not be problematic.

AGPhil 3: Foundations of Quantum Mechanics: The Measurement Problem and the Many Worlds Interpretation

Time: Tuesday 11:00–12:45 Location: HS XVII

Invited Talk AGPhil 3.1 Tue 11:00 HS XVII

Is there a mechanism that produces many parallel worlds? — •Meinard Kuhlmann — Philosophy Department, University of Mainz

My question is whether the emergence of many parallel worlds in the (contemporary) Everettian solution to the quantum measurement problem can be understood in a mechanistic fashion. I will conclude with a clear "Yes!". One crucial element in my argument will be quantum decoherence, a process that partly explains why our world appears so very classical, and which rescues the original many-worlds interpretation of quantum mechanics from one fatal objection. However, while my positive answer may first sound like untarnished good news for the mechanistically inclined lover of parallel worlds, it comes with a grain of salt: It is a proper physical mechanism that produces parallel worlds, but due to the nature of this mechanism, these worlds are not quite what one may hope for.

AGPhil 3.2 Tue 11:45 HS XVII

An interpretation-independent formulation of the measurement problem — •Antoine Soulas — University of Vienna, Austria — IQOQI Vienna, Austria

In this presentation, we do not try to solve the measurement problem of quantum mechanics (QM), but rather to properly formulate it. One of the reasons why it still lacks a precise, agreed definition is that the problem may take very different forms depending on the interpretation of QM embraced. We propose to identify the common root of the puzzle in an interpretation-independent way (i.e. as a property of the probabilities only) and derive its ontological consequences. The key point is that the violation of the total probability formula in QM does not allow to construct an objective ontology, independent from epistemology. This enables us to:

(i) shed light on the ubiquitous presence of the total probability formula in the quantum foundations literature (definition of hidden variables, historical and modern formulation of Bell's theorem, absoluteness of observed events in the local friendliness theorem, macrorealism à la Leggett-Garg, ontological models à la Spekkens...);

(ii) study how the problem manifests itself in five famous interpretations of QM (Copenhaguen, collapse-models, Bohmian mechanics, many-worlds and relational QM) : how they propose to solve it and which new difficulties arise. This provides a fresh look on the different interpretations, and allows to better compare them.

AGPhil 3.3 Tue 12:15 HS XVII

A New Perspective on Quantization and the Measurement Problem — •Simon Friederich and Mritunjay Tyagi — University of Groningen, University College Groningen

Quantization is traditionally viewed as a method for transitioning from classical to quantum theory, mapping phase space functions to self-adjoint operators on Hilbert space. While not usually linked to the measurement problem, this work examines whether refining our understanding of quantization could help vindicate single-world realism about quantum theory. We propose reconceptualizing quantization as a mapping within quantum theory, connecting phase space functions*dynamical variables with sharp values*to their corresponding self-adjoint operators. This perspective circumvents the Kochen-Specker theorem by acknowledging that promising quantization schemes generally do not preserve algebraic relations, making KA non-contextuality an implausible assumption. The criterion for quantization is that the quantum expectation value of an operator corresponds to a weighted integral of its associated phase space function with a suitable probability distribution. Applying this approach to Weyl, Wick, and Anti-Wick quantization schemes reveals that Anti-Wick quantization uniquely satisfies this interpretation. The Husimi function naturally serves as the probability distribution for Anti-Wick quantization. Further research, beyond the ontological models framework, is needed to explore the empirical and theoretical implications. This approach opens new possibilities for quantum foundations and the search for theories beyond the Standard Model.

AGPhil 4: Integrated History and Philosophy of Quantum Mechanics

Time: Tuesday 14:00–15:45 Location: HS XVII

Invited Talk AGPhil 4.1 Tue 14:00 HS XVII

History and Philosophy of Physics in Physics Education — •Oliver Passon — Bergische Universität Wuppertal

This talk deals with the relation between HPP and physics education. The largest overlap between these fields is the discourse on the so-called Nature of Science (NoS), i.e. the inclusion of meta-knowledge about the natural sciences in physics education. I discuss current trends and desirable developments.

AGPhil 4.2 Tue 14:45 HS XVII

Reflections on a Revolution — •Noah Stemeroff — University of Bristol, Bristol, UK

The development of quantum mechanics marks a turning point in the philosophical interpretation of physical theory. The early architects of quantum mechanics are claimed to have banished the last vestiges of philosophical intuition from the foundations of physics. Through the discovery of the fundamentally irrational, and indeterministic, nature of the quantum world, these physicists are credited with reorienting physical inquiry toward a more direct reliance on empirical facts, which no longer required (or were even amenable to) any intuitive picture.

However, this story is far from the actual facts. By the end of the 1920s, the founders of modern quantum mechanics had settled on a basic interpretation of quantum theory. Yet, central problems remained unresolved. In the search for new physics, the early architects of quantum mechanics did not, as one would expect, renounce forms of speculative philosophy. This talk will trace the history of the philosophical interpretation of the quantum revolution by its founders: Niels Bohr, Werner Heisenberg, and Wolfgang Pauli. In particular, it will focus on Pauli and Heisenberg's decades-long attempt to come to terms with the meaning of the quantum revolution and its implications for the future of scientific inquiry. Much of this history has been lost in the traditional narratives surrounding the interpretation of quantum mechanics, but it can shed important light not only on the early history of theory, but also on the nature of philosophical discourse within the practice of science itself.

AGPhil 4.3 Tue 15:15 HS XVII

Einstein's Sanity Check: The Forgotten Paper on the Quantum Theory of Ideal Gases — •Kabir Singh Bakshi — Department of History and Philosophy of Science, University of Pittsburgh

Einstein's three papers on the quantum theory of ideal gases, his second "statistical trilogy", stand as important finger-posts for the history and philosophy of physics. First, on the more personal side, they mark a transition point in Einstein's oeuvre. The second statistical trilogy has been variously characterized as Einstein's "last decisive positive contribution to physical statistics" (Born 1969, "In Memory of Einstein") and "the end of [Einstein's] substantive contributions to the development of quantum theory" (Howard 1990, "Nicht Sein Kann was Nicht Sein Darf ..."). And second, on the more intellectual side, the second statistical trilogy, with its early development of quantum statistics, has been viewed as a harbinger of quantum mechanics, thus serving as a transition point from the old quantum theory to the new quantum mechanics (Monaldi 2019, "The Statistical Style of Reasoning").

In this paper I critically engage with the third paper in the trilogy. By going in detail through the first two and the third paper, I show the difference in aim, content, and methodology of the papers. I also argue, contra the consensus in historiographical analysis, against the claim that the third paper is best understood exclusively as Einstein's response to Ehrenfest's criticism. Instead, I claim that a fuller picture highlights the third paper as Einstein's attempt to perform a sanity-check on his new - and unintuitive - quantum theory of gases.

AGPhil 5: Foundations of Quantum Mechanics I

Time: Wednesday 14:00–16:30 Location: HS XVII

AGPhil 5.1 Wed 14:00 HS XVII

In Place of Quantization: A Universal Group-Theoretic Approach to Quantum Mechanics — •Gerald Goldin — Rutgers University, New Brunswick NJ, USA

This talk summarizes and expands on very recent results with David Sharp at Los Alamos, where we obtain a universal kinematical group for quantum mechanics directly from fundamental physical assumptions, without quantization in the usual sense. One then obtains distinct quantum systems with different configuration spaces, standard and exotic particle exchange statistics, and other properties, directly by classifying the inequivalent unitary representations of a single infinite-dimensional group. The method applies to arbitrary physical spaces, and does not seem limited to any particular space-time symmetry structure.

Here I explore whether such a unifying group-theoretic description can extend to dynamical as well as kinematical observables, and what that means. I also discuss some further ramifications and philosophical perspectives. Nature does not quantize classical dynamics; the latter merely approximates quantum phenomena in macroscopic domains. Quantization methods are essentially addressing an *inverse problem* regarding measurement, which is now more clearly characterized.

Reference: G. A. Goldin and D. H. Sharp, arXiv:20404.18274 [quant-ph]

AGPhil 5.2 Wed 14:30 HS XVII

How can we detect localized particles? — •Alexander Niederklapfer — London School of Economics and Political Science, United Kingdom

The consensus in philosophy of physics is that quantum field theories are, on the fundamental level, not about particles. However, almost all contact of the theories with empirical observations happens in terms of particle experiments. Thus, it is an important task to recover the particle phenomenology from the theory, and one of the main aspects of this is localizability: there are several no-go theorems that show that there cannot be localized states in quantum field theories, and there are as many attempts to reconcile this with the appearance of being able to detect localized particles in experiment.

I compare approaches by Wallace, Halvorson and Clifton, Haag, and Buchholz in terms of their ontological commitments about the non-localizability of physical systems. While some of them employ mathematically similar methods to recover a particle notion, I propose that the differences of the approaches can be attributed to the different stances on the representational relations of the theory not only with the physical systems themselves, but, more importantly, the representation and role of the actual particle measurement devices and methods. This, in turn, shows that some of the reasons to reject a particle ontology for QFTs rest on assumptions about measurement that are still controversially discussed in the literature.

AGPhil 5.3 Wed 15:00 HS XVII

Revisiting the Copenhagen Interpretation of QM — •Christopher Tyler — Vision Sciences, City St-George's, University of London

The core synthesis of QM is the Copenhagen Interpretation, whose basic form restricts interpretation solely to the measurement of energetic transition events and the mathematical theory that predicts their frequencies of occurrence, implying that no implicit or hidden variables should be postulated to mediate the theoretical analysis. Yet, the consensus view is that the underlying entities involved local particles with defined trajectories in quantum superposition of probability distributions of multiple possible states resolved by the observation of transition events, in violation of the Copenhagen proscription of such underlying variables.

An alternative view that is rarely considered is that that the mathematical theory, epitomized by the Schroedinger equation, directly describes the deterministic evolution of the overall energy state of the system, implying that *material points are nothing but wave-systems* (Schroedinger, 1926), consistent with the soft energy patterns of the recent Compact Muon Collider results, and that the detection events are not instantaneous state transitions but time-resolved nonlinear interactions of the energy wave with the atomic structure of the absorption matrix. Recognition of the nonlinearity of the detection events can resolve many paradoxical aspects of QM in favor of a deterministic interpretation of the quantum realm.

AGPhil 5.4 Wed 15:30 HS XVII

Re(l)ality: The View From Nowhere vs. The View From Everywhere — •Nicola Bamonti — nicola.bamonti@sns.it

Using the fiber bundle framework, this work investigates the conceptual and mathematical foundations of reference frames in General Relativity by contrasting two paradigms. 'The View from Nowhere' interprets frame representations as perspectives on an invariant equivalence class, while 'the View from Everywhere' posits each frame representation as constituting reality itself. This conception of reality is termed 'Relality'. The paper critically examines the philosophical and practical implications of these views, with a focus on reconciling theory with experimental practice. Central to the discussion is the challenge of providing a perspicuous characterisation of ontology. The View from Nowhere aligns with the so-called 'sophisticated approach on symmetries' and it complicates the empirical grounding of theoretical constructs. In contrast, the View from Everywhere offers a relational ontology that avoids the abstraction of equivalence classes. The paper may establish multiple points of contact with discussions on the ontology of Relational Quantum Mechanics. In particular frameworks like the View from Everywhere and the Relality definition can offer valuable insights in that context

AGPhil 5.5 Wed 16:00 HS XVII

Quantum Relativism Tame and Feral — •Timotheus Riedel — Université de Genève, Département de Philosophie, Rue De-Candolle 2, 1205 Genève, Switzerland

A new trend towards relativism has taken hold in quantum foundations, as evidenced by lively debates about perspectivist approaches like Relational Quantum Mechanics, QBism, and pragmatism. However, these debates often suffer from a lack of clarity regarding the conceptual commitments of relativist interpretations. Two key questions are: (i), whether they allow for cross-perspective communication, and (ii) whether they postulate absolute facts about which facts obtain relative to which observer.

I suggest that relativist interpretations can usefully be categorised as either 'tame' or 'feral' along these two dimensions. Specifically, a relativist interpretation counts as tame if and only if it enables cross-perspective communication and maintains second-order absoluteness. Moreover, I argue that standard arguments against absolute facts in the quantum domain - based on Wigner's Friend or Extended Wigner's Friend scenarios - only support feral interpretations. This is because the commitments of tame relativists render them vulnerable to 'revenge arguments': structural replicas of the original arguments against absolute facts that, however, target absolute facts about relative facts instead. This suggests that quantum relativism is only tenable if we can make sense of its particularly radical manifestations.

AGPhil 6: History and Philosophy of Physics

Time: Wednesday 17:00–18:15 Location: HS XVII

AGPhil 6.1 Wed 17:00 HS XVII

Louis de Broglie and the Five Dimensions; or, How Unified Field Theory Was Employed in the Quest for Realism in Quantum Mechanics — •Bernadette Lessel[1] and Alessio Rocci[2] — [1]Philosophisches Institut, Universität Bonn — [2]Vrije Universiteit Brussel

Louis de Broglie is most prominently known for his doctoral thesis from 1924 in which he introduced the notion of material waves. He is also known for belonging to the camp opposing the Copenhagen point of view on quantum mechanics, denying state space formalism and advocating a realist interpretation of the wave function until he gave it up in the year 1928. This talk explores de Broglie's use of ideas from classical field theories, particularly general relativity and unified field theory, in his quest for a causal interpretation of quantum mechanics. In this regard, two distinct phases of de Broglie's work are identified: 1. The academic year 1926/27 - collaborating with young Léon Rosenfeld, de Broglie experimented with a five-dimensional formalism, similar to Kaluza and Klein's approach, to counter Schrödinger's notion of configuration space. 2. A later development starting in 1952 - utilizing the property of gravitational field singularities following geodesics, de Broglie incorporated concepts from general relativity into his 1927 theory of double solution. In this phase, de Broglie is assisted by French relativist Vigier. Central to their reasoning was the duality of particle and wave which they viewed as analogous to the particle-field duality in classical field theory.

AGPhil 6.2 Wed 17:15 HS XVII

Simulating spin measurement as unitary time evolution — •Thomas Dittrich, Oscar Rodríguez, and Carlos Viviescas — Departamento de Física, Universidad Nacional de Colombia, Bogotá D.C., Colombia

Quantum measurement is studied as a unitary time evolution of the measurement object, coupled to an environment representing the meter and the apparatus. Modelling the environment as a heat bath comprising a large but finite number of boson modes, it can be fully included in the time evolution of the total system. As a prototype of quantum measurement, we perform numerical simulations of projective measurements of the polarization of spin-1/2 particles. Their spin is prepared in an unpolarized pure state, the environment as a product of coherent states with a thermal distribution of centroids. Initially, the spin gets entangled with the heat bath and loses coherence, reproducing the collapse of the wave packet. For most of the initial states of the environment, we see a definite outcome of the measurement as the spin returning asymptotically to a pure state, either spin up or spin down with equal probability. Unitarity allows us to run the simulations backwards, undoing the measurement and recovering the initial state of the apparatus that led to the specific final spin state, relating it to the respective initial conditions of the heat bath, i.e., the observed randomness to quantum and thermal noise of the macroscopic environment. Extending our approach to a complete EPR setup with two arms remains as a challenge for future work.

AGPhil 6.3 Wed 17:30 HS XVII

History and Metaphysics of Shape Dynamics — •Paula Reichert — Mathematisches Institut, LMU München, Theresienstr. 39, 80333 München

This talk will discuss the history and metaphysics of shape dynamics. Shape dynamics is a relationalist theory of gravity in the spirit of Leibniz and Mach. It has been introduced by Barbour and Bertotti in the 1980s. In shape dynamics, space and time are relational. This makes it a rival theory both to Newtonian gravity and to Einstein's general relativity. In this talk, I will distinguish three ontologies of space and time: 1) Newtonian absolute space and absolute time, 2) Leibnizian relational space and relational time, and 3) Einsteinian relativistic spacetime. I will show how the standard route from Newtonian absolute space and time has led via Galiliean spacetime and Minkowski spacetime to curved spacetime. Relationalists, however, followed a different path. They developed a theory of 3d conformal space + 1d relational time instead of 4d relativistic spacetime. Still, shape dynamics and general relativity agree on the relevant set of solutions. One reason for this to work is that time, in shape dynamics, is essentially given by the expansion rate of the universe (the dilational momentum or York time) and enters the time-dependent Hamiltonian, taking up the role of (relative) scale. After having outlined the different historical routes and the metaphysical and physical differences between shape dynamics and general relativity, I will shortly compare future prospects of the two theories.

AGPhil 6.4 Wed 17:45 HS XVII

Bohr's hidden variables — •Moritz Epple — Center for Science and Thought, University of Bonn, Konrad-Zuse-Platz 1-3, 53227 Bonn

In 1927, Einstein and Bohr discussed the foundations of quantum mechanics. While Bohr held the view that the quantum formalism was complete and best understood in terms of complementary quantum phenomena, Einstein was skeptical und unleashed an unparalleled, decade-long effort of ingenuity aimed at showing that quantum mechanics offered only an incomplete description of physical reality. According to the standard narrative, Bohr not only persevered, but also won the intellectual competition between the two friends. However, looking back at these thrilling discussions from the distance of almost a century, new perspective can emerge. In this talk, I will present a non-deterministic hidden variable interpretation of quantum mechanics, which can be seen as a mathematically precise (re)formulation of Bohr's interpretation. I will thus argue that (contrary to Bohr's own claims) Bohr's interpretation of quantum mechanics actually goes beyond the standard (von Neumann-Dirac) quantum formalism und thus agrees with Einstein's criticism at least in so far as it affirms the incompleteness of the standard formalism. I will also discuss the relation of our proposal to quantum nonlocality and Bell's theorem.

AGPhil 6.5 Wed 18:00 HS XVII

On the prospects of a grounding-based account of entanglement swapping — •Jørn Kløvfjell Mjelva — Department of Philosophy, Classics, History of Art and Ideas, University of Oslo, Norway

Quantum mechanics predicts that measurements on entangled systems will display correlations that defy a causal explanation in terms of a common cause, apparently indicating "spooky action-at-a-distance". Ismael and Schaffer (2020) have proposed that the modal connections between entangled systems may instead be explained by the correlated events being the results of a common ground. Rather than attributing the connection to action-at-a-distance, the common ground explanation attributes it to an ontological dependence of the parts on the entangled whole they compose. But what if the state of the whole itself depends on distant events? In particular, what if the state of a composite system could be either entangled or non-entangled depending on operations performed on a distant system? These questions become pertinent as we consider the case of entanglement swapping; a process in which entanglement is "transferred" from on pair of particles to another, without any direct interactions facilitating the transfer. In this paper, I discuss the issues entanglement swapping raises for the common ground-strategy, and present a way they may be resolved.

AGPhil 7: Members' Assembly

Time: Wednesday 18:30–19:00 Location: HS XVII

All members of the Working Group on Philosophy of Physics are invited to participate.

AGPhil 8: Foundations of Quantum Mechanics: Bohm and Hidden Variables

Time: Thursday 11:00–13:00 Location: HS XVII

AGPhil 8.1 Thu 11:00 HS XVII

Questioning the Dogma: A Different Perspective on Spin in Bohmian Mechanics — •Andrea Oldofredi — Centre of Philosophy, University of Lisbon

Bohmian Mechanics is a quantum theory of particles moving in three-dimensional space along deterministic trajectories. According to most contemporary Bohmians, the only fundamental property instantiated by particles is position. From it some derivative quantities can be defined, e.g. velocity and momentum. However, quantum observables are generally not considered attributes of the corpuscles. Specifically, it has been argued that spin does not refer to any physical property of the particles.

Moreover, many Bohmians claim that one must be realist only towards those entities playing a fundamental explanatory role: since spin measurements are reducible to position measurements, they conclude that spin cannot be real.

Contrary to this received view, I provide arguments for the reality of spin in BM based on case studies from Bohmian quantum chemistry, where spin-dependent particle trajectories are employed. In particular, I argue that by assuming the existence of spin one obtains significant advantages over canonical BM for the explanation of the chemical bond.

If employing spin-dependent laws in BM entails relevant explanatory benefits, and if one must be committed to the reality of those explanatory essential theoretical entities, then there are reasons to argue for the reality of spin also in BM.

AGPhil 8.2 Thu 11:30 HS XVII

Which quantum foundations for the minimalist ontology framework? — •Emilia Margoni — Philosophy Department, University of Geneva, Switzerland

Michael Esfeld's minimalist ontology is committed to two axioms relating to (1) distance relations that identify simple objects (permanent matter points) while (2) the distances between them change. This article scrutinizes such a conceptual strategy to determine whether it can successfully be applied to all levels of physical reality, as Esfeld contends. To do so, it explores one of his paradigmatic sources, that is, Bohmian mechanics. Two arguments are proposed. First, while Bohm's original formulation of Bohmian mechanics and the interpretation advocated by Dürr, Goldstein & Zanghì are typically taken as mathematically equivalent, I argue that Esfeld's minimalist ontology does not cover the former's ontological richness. To secure its achievement, the minimalist ontology framework needs to i) break the equivalence between the two versions via a commitment to the nomological interpretation of the wavefunction ii) yet attribute some kind of physical efficacy to the wavefunction as a guiding parameter for the evolution of particles living in three-dimensional space. Both requirements will be critically addressed. Second, the article shows that Esfeld's metaphysical program is not only forced to rely on a theoretically suspicious formulation of quantum mechanics, but that more fundamental, under-development approaches in theoretical physics are way less reconcilable with its axioms, thus questioning its alleged universality.

AGPhil 8.3 Thu 12:00 HS XVII

Superluminal Causation in Quantum Mechanics — •Mario Hubert[1] and Frederick Eberhardt[2] — [1]LMU Munich — [2]Caltech

We want to make precise how superluminal causation can work in quantum mechanics. First, we argue, pace Egg and Esfeld (2014), that instantaneous causation can be interpreted to have a causal direction. Second, we show by assuming a counterfactual theory of causation that these instantaneous causal directions are instantiated in the de Broglie-Bohm theory for space-like separated entangled particles. Third, we argue that these instantaneous causal relations are fine-tuned in the sense of causal modeling (that is, violating faithfulness) but not in the sense of physics (relying on special initial conditions).

References: Egg, M. and Esfeld, M. (2014). Non-local common cause explanations for EPR. European Journal for Philosophy of Science, 4(2):181-196.

AGPhil 8.4 Thu 12:30 HS XVII

Modal interpretations, hidden-variables and simple realism — •Yanis Pianko — Panthéon-Sorbonne University, Paris, France — IHPST, Paris, France

I present and review the modal approach to quantum foundations in a comprehensive way, and provide a novel way to classify its interpretations. This classification can be extended to non-modal interpretations, and reveals that modal interpretations were part of a bigger framework, sometimes called "simple realism" in the literature. This novel insight, as well as the introduction of a distinction between the kinematics and dynamics of an interpretation, allows for a sharper characterization of hidden-variables theories. I then give an account of why, while the modal approach was an influential research program in philosophy of physics during the 1990's, one barely hears about it today. After presenting and classifying the various difficulties modal interpretations encountered, I identify two epistemic factors in their downfall: the mathematical abstractness of the approach, along with the lack of physical intuition; and the ad hoc flavor manifested in the structure and historical development of the overall approach. I argue that, although there were good reasons to criticize the modal approach in some regards (particularly their dynamics), some fruitful insights in contemporary quantum foundations could still be gained by a larger exposure of this approach.

AGPhil 9: History and Philosophy of General Relativity

Time: Thursday 14:00–15:45 Location: HS XVII

Invited Talk AGPhil 9.1 Thu 14:00 HS XVII

Waves in a turbulent sea: controversies over gravitational waves — •Henrique Gomes — University of Oxford, Oxford, UK.

Einstein first claimed gravitational waves would be produced in certain situations within general relativity in 1916. And yet, different parts of that claim were controversial, right up to the discovery of the Hulse-Taylor binary pulsar. In this talk I want to distinguish and give more details about three separate controversies: (1) Are there solutions of the Einstein equations that admit gravitational waves? (2) Can they be produced in systems that are freely-falling? (3) Do gravitational waves carry energy?

Each of these controversies has an interesting history and, even if there are a few holdouts, an interesting resolution.

AGPhil 9.2 Thu 14:45 HS XVII

Interpreting the Schwarzschild Metric — •Dennis Lehmkuhl — Lichtenberg Group for History and Philosophy of Physics, University of Bonn

It is sometimes said that the Schwarzschild solution to the Einstein field equations was discovered in 1916 but that it took until the 1950s or 1960s before it was understood that the Schwarzschild metric represents a black hole. Such statements are puzzling, for the Schwarzschild metric was successfully used and applied from its very inception. In this talk, I will trace the history of different applications, interpretations and, intimately linked, coordinatizations of the Schwarzschild metric. The focus will be on a.) Einstein's use of an approximation to the Schwarzschild metric in the prediction of Mercury's perihelion in 1915 and his subsequent correspondence with Schwarzschild and others on the corresponding exact solution; b.) discussions of what we would today call the event horizon of the Schwarzschild metric during the 1920s; and c.) the development of a conceptual distinction between singularities and horizons in the late 1950s and early 1960s and the resulting new perspective on the Schwarzschild metric.

AGPhil 9.3 Thu 15:15 HS XVII

Spacetime Theories Beyond Curvature: Two Incompatible Approaches to Torsion Gravity — •Kartik Tiwari — University of Bonn, Bonn, Germany

Although the standard picture of gravity utilizes a connection between mass-energy distribution and curvature of spacetime, this connection is not unique. Using additional differential geometric concepts (torsion and non-metricity), a relativist can construct various modifications and reformulations of general relativity. Each alternate theory of spacetime is bundled with a blend of attractive and repulsive scientific (or aesthetic) features. In my talk, I discuss two mutually-incompatible frameworks for endowing spacetime with additional geometry. During the first half of the talk, I describe the nature of this incompatibility by comparing the technical foundations of the geometric-trinity paradigm with gauge gravity approaches. In the latter half of the talk, I use Ehlers' work on Frame Theory to re-evaluate the strength of evidence that existing results on the Newton-Cartan limit of Teleparallel Gravity provide.

AGPhil 10: Foundations of Quantum Mechanics II

Time: Thursday 17:00–19:00 Location: HS XVII

AGPhil 10.1 Thu 17:00 HS XVII

Unveiling Biases in Physics: the Case of Higher-Order Equations and the Quest for a Theory of Quantum Gravity — Luca Gasparinetti[1] and •Aaron Collavini[2] — [1]University of Milan, Milan, Italy — [2]University of Italian Switzerland, Lugano, Switzerland

Drawing on the work of Anjum and Rocca (2024), this talk examines philosophical biases in theoretical physics, focusing on the Lagrangian formalism's dominance in formulating, among others, theories of quantum gravity. In particular, Lagrangian theories of order higher than the second in the time derivatives are unstable according to Ostrogradsky's no-go theorem (Swanson 2022). This implies that, in physical practice, higher-order theories are often rejected a priori. However, Collavini and Ansoldi (under review) critique the application and the consistency of the Lagrangian framework to higher-order formulations, and invite to reconsider and extend the conceptual framework on which the standard treatment of second-order theories is based. Their arguments exemplify the weakness of the foundational premises hidden in physical theories, and invite to uncover new pathways for reconciling general relativity and quantum mechanics. Drawing on their analysis, we argue that the unquestioned reliance on the Lagrangian formalism is shaped by specific philosophical biases and value judgments. Collavini and Ansoldi*s work thus serves as a key example of how confronting implicit assumptions can drive progress towards a better understanding of the physical world. This would finally demonstrate how revealing and interrogating hidden philosophical biases can foster a productive interplay between philosophy and science.

AGPhil 10.2 Thu 17:30 HS XVII

The Quantum Landscape: a Status Report — •Marc Holman — Utrecht University

Regardless of one's sentiments about the strength of various arguments to modify (aspects of) the mathematical structure of quantum theory, it must be acknowledged that this structure could simply turn out empirically inadequate at some point. Yet, in sharp contrast to the situation with our *other* highly successful fundamental theory in physics, viz. general relativity - for which the same basic verdict of course applies *and* for which countless alternative theories have been developed over the years - alternatives to quantum theory have been very little explored and at any rate seem out of vogue. After briefly reviewing underlying reasons for this situation (which can be traced, at least in part, to different views on general relativity as a physical theory), I discuss some recent proposals, motivated by quantum field theory and cosmology, to modify the standard quantum formalism, and conclude with a rough sketch of the landscape of alternatives to quantum theory - i.e., the "quantum landscape".

AGPhil 10.3 Thu 18:00 HS XVII

Natural Spacetime: Describing Nature in Natural Concepts — •Markolf Niemz — Heidelberg University, Germany

Today's physics describes nature in "empirical concepts" (based on observation), such as coordinate space/time, wave/particle, force/field. There are coordinate-free formulations of special and general relativity (SR/GR), but there is no absolute time in SR/GR and thus no "holistic view" (universal for all objects and at the *same* instant in time). **I show:** Euclidean relativity (ER) provides a holistic view by describing nature in "natural concepts" (immanent in all objects). "Pure distance" (proper space/time) replaces coordinate space/time. Pure energy replaces wave/particle. Process is a promising concept to replace force/field. Any object's proper space d_1, d_2, d_3 and its proper time τ span a natural, Euclidean spacetime (ES) d_1, d_2, d_3, d_4, where $d_4 = c\tau$. For each object, there is a relative 4D vector "flow of proper time" $\boldsymbol{\tau}$. The new invariant is absolute, cosmic time θ. All energy moves through ES at the speed c. An observer's view is created by orthogonally projecting ES to his proper space and to his proper time. *Information is lost in projections giving rise to mysteries.* ER explains the 10% deviation in the published values of H_0, and it declares dark energy and nonlocality obsolete. **I conclude:** (1) Information hidden in the 4D vector $\boldsymbol{\tau}$ solves 15 mysteries. (2) An acceleration rotates $\boldsymbol{\tau}$ and curves an object's worldline in flat ES. (3) ER complements SR/GR. We must apply ER if there are significantly different 4D vectors $\boldsymbol{\tau}$ and $\boldsymbol{\tau}'$, as in high-redshift supernovae or entanglement. We must apply SR/GR if we use empirical concepts (www.preprints.org/manuscript/202207.0399).

AGPhil 10.4 Thu 18:30 HS XVII

More on a Presupposition of Bell's Theorem — •Carsten Held — Nonnenrain 2, 99096 Erfurt, Germany

In earlier work, the Bell-CHSH inequality was shown to rest on a nontrivial presupposition, i.e., that the values of elementary spin quantities are scalars, not, e.g., vectors. The theorem's argument succeeds for scalars and fails for vectors. However, the reference to vector values can be motivated from the physics of spin. Hence, it seems that the Bell-CHSH inequality fails as a proof of non-locality. But how powerful is this argument really? We discuss two objections: (A) If we introduce four unit vector values, we learn that they cannot be mapped consistently onto QM observables. (B) Given the four vector values, the contradiction vanishes but we can map them 1:1 to scalar values and for them the contradiction reappears. If we analyze these objections, we find that neither is convincing.

AGPhil 11: Philosophy of Particle Physics and Quantum Field Theory

Time: Friday 11:00–13:00 Location: HS XVII

AGPhil 11.1 Fri 11:00 HS XVII

From Data to Theory: Raw vs. Pre-Packaged Entities — •Nurida Boddenberg — University of Bonn, Bonn, Germany

In the philosophy of science, entities, whether objects, processes, events, or relations, are often interpreted literally as they appear in our theories. Even within a practice-oriented view of science, experimental findings are frequently assigned to specific entities, typically accompanied by a predefined framework of what those entities are assumed to represent.

In my talk, I will examine what can be inferred from experimental data. I introduce the term "raw entity" to describe entities whose properties are inferred directly from experimental data through causal reasoning, meeting criteria such as non-redundancy and empirical adequacy. In contrast, "pre-packaged entity" refers to entities tied to additional hypotheses or embedded within a theoretical framework, offering a ready-made interpretation but potentially incorporating non-empirical elements, such as theoretical assumptions unsupported by the experimental evidence.

To illustrate this distinction and explore whether meaningful "raw entities" exist, I will analyze three cases: the Cowan-Reines neutrino experiment (1956), often described as a direct detection of neutrinos; the Deep Inelastic Scattering (DIS) experiments of the 1960s, where partons, later identified as quarks and gluons, were the entities in question; and modern gravitational wave detections by the LIGO-Virgo collaboration.

AGPhil 11.2 Fri 11:30 HS XVII

Inconsistencies in Quantum Field Theories: Replacement vs. Refinement? — •Francisco Calderón — University of Michigan, Ann Arbor

The history of QFT is one of inconsistencies and attempts at overcoming them. Specifically, Blum*s history of QED (ms.) shows that it is one of inconsistencies in the UV. While it was known that QED also had divergences in the IR, IR problems are considered less pathological. Four decades after QED, it was discovered that soon-to-be QCD is asymptotically free. Although QCD also bore the worst of QED*s inconsistencies, the Landau pole, asymptotic freedom put worries about the consistency of QFT to rest. The only difference between QED*s and QCD*s Landau poles was that the former lies in the UV and the latter in the IR. Is there a historical explanation for this double standard? A common reaction to QED*s inconsistencies was to reject QFT altogether*call this attitude Replacement. A common reaction to QCD was that cleverer ways of looking at or extending RG techniques would prevent a catastrophe in the IR*call this attitude Refinement. One goal of my paper is to chart the history of asymptotic freedom, which is undertheorized from the point of view of QFTs (as opposed to a history of the discovery of quarks). Another goal is to compare my historical reconstruction of QCD with Blum*s of QED and draw some philosophical morals about the differences between Replacement and Refinement.

AGPhil 11.3 Fri 12:00 HS XVII

Deep Learning and Model Independence — •Martin King — MCMP, LMU Munich

Despite probing physics at unprecedented energies at the Large Hadron Collider, the Standard Model remains empirically adequate, though incomplete. The lack of evidence in favor of any new physics models means that the search for new physics beyond the Standard Model (BSM) is wide open, with no direction clearly more promising than any other. This marks a turn towards what are called 'model-independent' methods—strategies that reduce the influence of modelling assumptions by performing minimally-biased precision measurements, using effective field theories, or using Deep Learning methods (DL). In this paper, I present the novel and promising uses of DL as a primary tool in high energy physics research, highlighting the use of autoencoder networks and unsupervised learning methods. I advocate for the importance and usefulness of a philosophically substantial concept of model independence and propose a definition that recognizes that independence of models is not absolute, but comes in degrees.

AGPhil 11.4 Fri 12:30 HS XVII

Thermal qualification of the silicon detector modules for the Phase-2 upgrade of the CMS Outer Tracker — •Niyathikrishna Meenamthuruthil Radhakrishnan, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Stefan Maier, Lea Stockmaier, Tobias Barvich, and Bernd Berger — Karlsruhe Institute of Technology, Karlsruhe, Germnay

The LHC is about to enter its high-luminosity era in 2029. In order to prepare the particle detectors to deal with the high particle rate and radiation damage, the detector components must be upgraded. One upgrade project is the replacement of the tracking system of the CMS detector. The new Outer Tracker will consist of two types of silicon sensor modules: 5592 PS modules which are made of one pixel sensor and one strip sensor and 7608 2S modules with two strip sensors.

Production and testing of these modules are carried out at 10 sites and one of the centers producing the 2S modules is KIT. In the tracker, these modules will be operated with a coolant temperature of around -35. It must be verified that the modules can function flawlessly at this temperature prior to installation in the detector. In order to do that, modules are placed inside a thermally insulated box with active cooling, called burn-in station, to perform temperature cycles and expose the modules to thermal stress for up to 48 hours. The electrical functionality of the modules is monitored during this period.

The talk will give a summary of the current status of the burn-in station at KIT and present the thermal qualification of the station as well as results with the first production modules.

AGPhil 12: Foundations of Classical and Quantum Mechanics

Time: Friday 14:00–16:00 Location: HS XVII

AGPhil 12.1 Fri 14:00 HS XVII

On the applicability of Kolmogorov's theory of probability to the description of quantum phenomena — •Maik Reddiger — Anhalt University of Applied Sciences, Köthen (Anhalt), Germany

Through his axiomatization of quantum mechanics (QM), von Neumann laid the foundations of a "quantum probability theory." In the literature this is commonly regarded as a non-commutative generalization of the "classical probability theory" established by Kolmogorov. Outside of quantum physics, however, Kolmogorov's axioms enjoy universal applicability. One may therefore ask whether quantum physics indeed requires such a generalization of our conception of probability or if von Neumann's axiomatization of QM was contingent on the absence of a general theory of probability in the 1920s.

Taking the latter view, I motivate an approach to the foundations of non-relativistic quantum theory that is based on Kolmogorov's axioms. It relies on the Born rule for particle position probability and employs Madelung's reformulation of the Schrödinger equation for the introduction of physically natural random variables. While an acceptable mathematical theory of Madelung's equations remains to be developed, one may nonetheless formulate a mathematically rigorous "hybrid theory", which is empirically almost equivalent to the quantum-mechanical Schrödinger theory. A major advantage of this approach is its conceptual coherence, in particular with regards to the question of measurement.

This talk is based on `arXiv:2405.05710 [quant-ph]` and Reddiger, *Found. Phys.* **47**, 1317 (2017).

AGPhil 12.2 Fri 14:30 HS XVII

Absolute time and absolute space — •Grit Kalies[1] and Duong D. Do[2] — [1]HTW University of Applied Sciences, Dresden, Germany — [2]The University of Queensland, Brisbane, Australia

The kinematic concept of velocity led to the geometric mechanics of Newton, Lagrange and Hamilton [1] and to further geometric theories such as special and general relativity, according to which time and space are relative. A different picture emerges when velocity is described as a dynamic (energetic) state variable of a material object (system, body, elementary particle, etc.) and the dynamic role of velocity in a collision is taken into account: 'Velocity is a physical level, like temperature, potential function,...' [2]. The velocity as an intensive state variable of an object leads back to absolute time, absolute simultaneity and absolute space and to the insight that nature is more than geometry. [1] G. Kalies, D. D. Do, AIP Adv. 14, 115225, 1-16 (2024); [2] E. Mach, The science of mechanics (The Open court publishing co, Chicago, 1907), p. 325.

AGPhil 12.3 Fri 15:00 HS XVII

Rethinking Consciousness Through Quantum Perspectives: A Challenge to Individualism and Objectivity — •Konstantinos Voukydis — Department of History and Philosophy of Science, National and Kapodistrian University of Athens, Athens, Greece

In the Philosophy of Consciousness, a central issue revolves around how mental states represent objects of the world, particularly concerning whether mental content is individuated by factors that are external or internal to the subject.

From a conceptual and meta-theoretical standpoint, the physical-logical framework introduced by quantum mechanics disrupts the ontological and semantic interpretative schemes of classical logic, redifining the traditional notions of individuality, separability, contextuality, and reality. By foregrounding the observer's role and the inherent interconnectedness of elements in quantum systems, the quantum paradigm provides a novel lens for re-evaluating relationships between wholes and parts, objectivity and subjectivity, and the very nature of phenomenal consciousness.

This interdisciplinary approach seeks to bridge two foundational problems in its epistemic extent: the quantum measurement problem in physics and the hard problem of consciousness in philosophy. By doing so, we propose a framework for understanding phenomenal consciousness not as an autonomous, objective property but as emerging from a dynamic network of interactions involving the internal subjectiveness and the external objectiveness.

AGPhil 12.4 Fri 15:30 HS XVII

Dialektische Aufhebung des Widerspruchs zwischen klassischer Physik und Quantenmechanik — •Roland Schmidt — Schwalbenweg 21, 34225 Baunatal

In der Newtonschen Theorie ist Wirklichkeit der determinierte Ablauf eines universellen Geschehens. In der relativistischen Nachbesserung geht der universelle Charakter des Wirklichen verloren. Demnach lassen sich ausschließlich subjektiv erlebte Wirklichkeiten gegeneinander abgleichen. Wenig überraschend wird diese Subjektivierung durch die klassische Elektrodynamik erzwungen, der bei der metaphysischen Betrachtung subjektiver Wahrnehmung eine ganz entscheidende Rolle zukommt. Das letztgültige Vordringen elektromagnetischer Potenzialität in die zerebralen Zusammenhänge eines Subjekts erfordert aber auch Ansätze quantenphysikalischer Art. Die Aufspaltung der physikalischen Theorie in einen klassischen und quantenmechanischen Zweig kann durch eine weitere Subjektivierung der elektromagnetischen Theorie behoben werden. Dabei ist die Unterscheidung zwischen zerebral anhängigem und zerebral entkoppeltem Elektromagnetismus von entscheidender Bedeutung. Es wird sich herausstellen, dass klassische Kategorien wie Raum, Gegenwart und das Dasein gegenständlicher Bedeutsamkeiten von einem grundlegenden Symmetriebruch herrühren, der sich aus der zerebralen Existenz erlebender Subjekte ergibt. Empirischer Ausdruck ist beispielsweise die kosmologische Rotverschiebung, die nunmehr aus dem Umstand folgt, dass die elektromagnetische Trägheit grundlegender Teilchen gegen den kosmologischen Ereignishorizont hin allmählich verschwindet.