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

Dennis Lehmkuhl
Institut für Philosophie
Rheinische Friedrich-Wilhelms-Universität Bonn
53113 Bonn
dennis.lehmkuhl@uni-bonn.de

Radin Dardashti
Philosophisches Seminar/IZWT
Bergische Universität Wuppertal
42119 Wuppertal
dardashti@uni-wuppertal

Overview of Invited Talks and Sessions

(Lecture halls JAN/0027 and HSZ/0304)

Invited Talks

AGPhil 5.1	Wed	14:00–14:45	JAN/0027	**Physical probability is relative frequency** — •Simon Saunders
AGPhil 5.2	Wed	14:45–15:30	JAN/0027	**Locality and the Metaphysics of Many Worlds Quantum Mechanics** — •Alyssa Ney
AGPhil 6.1	Wed	16:00–16:45	JAN/0027	**The structure of entangled properties: Distributional holism** — •Paul Näger
AGPhil 8.1	Thu	11:00–11:45	JAN/0027	**Interpreting Quantum Mechanics on an Informational Approach** — •Michael Cuffaro
AGPhil 8.2	Thu	11:45–12:30	JAN/0027	**Does science need intersubjectivity? The problem of confirmation in orthodox interpretations of quantum mechanics** — •Emily Adlam

Sessions

AGPhil 1.1–1.4	Mon	11:00–13:00	JAN/0027	**Quanten und Prozesse**
AGPhil 2.1–2.3	Tue	11:00–12:30	JAN/0027	**Space and Time**
AGPhil 3.1–3.3	Tue	17:30–19:00	JAN/0027	**Philosophy of Physics**
AGPhil 4.1–4.3	Wed	11:00–12:30	JAN/0027	**Quantum Foundations 1**
AGPhil 5.1–5.2	Wed	14:00–15:30	JAN/0027	**Quantum Foundations 2**
AGPhil 6.1–6.3	Wed	16:00–17:45	JAN/0027	**Quantum Foundations 3**
AGPhil 7	Wed	18:00–18:30	JAN/0027	**Members' Assembly**
AGPhil 8.1–8.2	Thu	11:00–12:30	JAN/0027	**Quantum Foundations 4**
AGPhil 9.1–9.4	Thu	14:00–16:00	JAN/0027	**Quantum Foundations 5**
AGPhil 10.1–10.3	Thu	16:15–16:45	JAN/0027	**Quantum Foundations Poster Session**
AGPhil 11.1–11.4	Fri	10:45–12:45	HSZ/0304	**Quantum Mechanics, Philosophy and Information**

Members' Assembly of the Working Group on Philosophy of Physics

Wednesday 18:00–18:30 JAN/0027

- Bericht
- Wahlen
- Planung 2023/24
- Verschiedenes

AGPhil 1: Quanten und Prozesse

Time: Monday 11:00–13:00 Location: JAN/0027

AGPhil 1.1 Mon 11:00 JAN/0027

Vorgriff auf Quanten 2025 — Helmut Hille und •Helmut Hille — Fritz-Haber-Straße 34, 74081 Heilbronn

Da ich auf Grund meines Alters das Jahr 2025 wohl nicht mehr erleben werde, hier mein Vorsxhlag für die Theorie der Quantenphysik.

Durch die Einschätzung der Gravitation als ein von der Quantenmechanik her bekanntes Phänomen der Verschränkung, wird die pragmatische Quantenmechanik zur Theorie der Quantenphysik erweitert, zuständig für Materie und Kosmos. Die Heilbronner Deutung der Quantenphysik sieht dazu einerseits die allgemeine Verschränkung der Materie als Folge des gemeinsamen Ur-Sprungs unseres Kosmos im sog. "Urknall", deutet andererseits den Kosmos als einen von wahrscheinlich vielen im Universum, das selbst ohne Grenzen in Raum und Zeit ist. Unter dem durchgehenden Gesichtspunkt des Energieerhalts als oberstes Kriterium ergibt sich eine rationale Kosmologie, die keiner weiteren Begründung bedarf. Mit dieser Heilbronner Deutung ist die Einheit der Physik wieder hergestellt, und das ohne Hypothesen, nur mit Deutung des schon Bekannten. Man muss vor allem bereit sein, die Fakten als solche zu respektieren: verschränkte Teilchen und Körper verhalten sich nicht wie ungetrennte Einheiten, sondern sind solche! (Sie schauspielern nicht wie wir Menschen.)

AGPhil 1.2 Mon 11:30 JAN/0027

Raumzeitdichte in verschiedenen Dimensionen als gemeinsame Ontologie für ART und QM — •Christian Kosmak — Working Group Dimensional Physics, Würzburg

Es wird das Konzept Dimensionale Physik vorgestellt, welches alle Abbildungen des Standardmodells als eine geometrische Abbildung einer Raumzeitdichte ansieht. Gravitation und Raumzeitdichte sind gegensätzliche geometrische Abbildungen in der 4D-Raumzeit.Postulate aus der Allgemeinen Relativitätstheorie (ART) und der Quantenmechanik (QM) lassen sich auf dieselben drei Kernelemente zurückführen: Raumzeitdichte, Lichtgeschwindigkeit als nieder-dimensionale Grenze und Verbindung der nieder-dimensionalen Untermannigfaltigkeiten über den Raum. Entscheidend ist, dass niederdimensionale geometrische Abbildungen die Eigenschaften der Elementarteilchen erzeugen. In der Berechnung exakte aber in der Logik unverstandene Elemente wie Schwarze Löcher, die Verschränkung oder der Wellenkollaps erhalten in dem Konzept der Dimensionalen Physik eine klare physikalische Interpretation. Die Raumzeit ist nicht nur eine dynamische Bühne, sondern der einzige Akteur. https://dimensionale-physik.de/

AGPhil 1.3 Mon 12:00 JAN/0027

Prozesse statt Zustandsbetrachtungen — •Grit Kalies[1] und Duong D. Do[2] — [1]HTW University of Applied Sciences, Dresden, Germany — [2]The University of Queensland, Brisbane, Australia

Die moderne theoretische Physik beruht auf Zustandsbetrachtungen. Ihre zentrale Größe ist die Kraft F, die geheimnisumwittert geblieben ist [1]. In der Relativitätstheorie existiert keine Prozessgleichung [2]. Die Mechanik kennt nur eine Prozessgleichung $\delta W = Fdx$, die in abgewandelten Formen verwendet wird. Die Energieerhaltung gilt heute als verletzbar, z.B. in sogenannten Quantenfluktuationen des Vakuums oder in der Urknall-Hypothese. Mikro- und makroskopische Prozesse werden als reversibel beschrieben.

In der Natur und Thermodynamik ist der Prozess zentral. Panta rhei. Eine Prozessgleichung beschreibt eine Energieänderung und enthält ein unbeugsames Ursache-Wirkungs-Prinzip [1,2]. Folgt man diesem Prinzip auf fundamentaler mechanischer Ebene, lässt sich die Energieerhaltung als unbegrenzt gültig beschreiben und erklären. Sie gilt dann auch auf Quantenebene zu jedem Zeitpunkt. Quantenprozesse werden als irreversibel beschreibbar, d.h. sie sind nicht auf demselben Wege umkehrbar.

1. M. Jammer: Concepts of Force, Harper Torchbook, New York, 1962. 2. G. Kalies, Z. Phys. Chem. 236 (2022) 481-533. 3. G. Kalies, S. Arnrich, D.D. Do: Coherent process equations in mechanics and thermodynamics, submitted 11/2022.

AGPhil 1.4 Mon 12:30 JAN/0027

Three steps to a realistic foundation of quantum mechanics — •Ed Dellian — Bogenst. 5, 14169 Berlin, Germany.

1. Quantum mechanics currently presupposes the classical concept of energy. It emerges from calculating the faculty *work* of a moving system as a path integral; the time of motion plays no role here. This to ignore entails that in applications of the formalism there occur effects of seemingly timelessness interactions (instantaneous actions at a distance, etc.).

2. The Heisenberg relations presented by Bohr (the 1927 Como lecture) show the operators energy E, momentum p, time t and space s as an equation of products ($\Delta E \times \Delta t = \Delta p \times \Delta s$). Planck*s h works as an intermediate only that must not show up in the equation, which (rearranged) appears as a quaternate proportion: $\Delta E : \Delta p = \Delta s : \Delta t$. The proportionality factor is c [dimensions space over time]. What results is ΔE over $\Delta p = c$, or generally: $E/p = c$, or $E = pc$.

3. Replacing the classical energy concept $E = p^*/2m$ with the well-known $E = pc$, that is, $E/p = c =$ constant, removes mystical and weird implications of quantum mechanics, even gives it the status of a realistic theory of motion which Schrödinger*s equation is not.

AGPhil 2: Space and Time

Time: Tuesday 11:00–12:30 Location: JAN/0027

AGPhil 2.1 Tue 11:00 JAN/0027

Einstein's forgotten interpretation of GR: against geometrization and for the unification of gravity and inertia — •Dennis Lehmkuhl — Lichtenberg Group for History and Philosophy of Physics, University of Bonn

Almost every textbook on general relativity tells us that the main lesson of the theory is that gravity is not a force but that it can be reduced to space-time geometry, that gravity is the curvature of space-time. Unbeknownst to most, Einstein himself actively opposed this interpretation of his theory. He thought that instead general relativity should be seen as a unification of gravity and inertia, analogous to the unification of electricity and magnetism in special relativistic electrodynamics. In this talk I am going to outline how this interpretation of general relativity originated in Einstein's work on a relativistic theory of gravity before he first embarked on a metric theory in 1913, and how his interpretation of the equivalence principle made him hold on to this interpretation even after more and more physicists and philosophers opted for a geometric interpretation of the theory. Finally, I will compare the geometric and the unificationist interpretation and discuss whether either or both of them can be upheld in the modern context.

AGPhil 2.2 Tue 11:30 JAN/0027

A dynamical perspective on the arrow of time — •Kian Salimkhani — University of Cologne

It is standardly believed that the generally time-reversal symmetric fundamental laws of physics themselves cannot explain the apparent asymmetry of time. In particular, it is believed that CP violation is of no help. In this paper, I want to push back against a quick dismissal of CP violation as a potential source for the arrow of time and argue that it should be taken more seriously for conceptualising time in physics. I first recall that CP violation is a key feature of our best physical theory which also has large-scale explanatory import regarding the matter-antimatter asymmetry of the universe. I then investigate how CP violation may help to explain the directionality of time. I argue that accounts a la Maudlin that posit an intrinsic fundamental direction of time are not convincing and instead propose to utilise recent results from work on the dynamical approach to relativity theory.

AGPhil 2.3 Tue 12:00 JAN/0027

Causal Theories of Spacetime — •Baptiste Le Bihan — University of Geneva

In the twentieth century, the causal theory of time was replaced by the causal theory of spacetime. Based on pioneering work by Hawking (1976), Malament (1977) and others, it was argued that special and general relativity were, at core, causal theories and the view that the metric structure of spacetime could be accounted for in terms of a causal topology started to gain momentum (Huggett and Wüthrich, forthcoming, ch2). But the theory was also subject to sustained attack in philosophical circles, especially by Smart (1969), Earman (1972) and Nerlich (1982).

While interest in the causal theory ebbed within philosophy, the core motivations behind the theory never really went away in physics. The work by Malament and Hawking on causal structure in relativity gave birth to an important research programme in physics, culminating in what is now known as causal set theory.

To resolve the tension, we develop a new version of the causal theory of spacetime. Whereas traditional versions of the theory sought to identify spatiotemporal relations with causal relations, the version we develop takes causal relations to be more fundamental than spatiotemporal relations. We argue that this non-identity theory, suitably developed, avoids the challenges facing the traditional identity theory and offers a natural interpretation of causal set theory.

AGPhil 3: Philosophy of Physics

Time: Tuesday 17:30–19:00 Location: JAN/0027

AGPhil 3.1 Tue 17:30 JAN/0027

Realism Going Local: Stabilizing Quarks — •Nurida Lena Boddenberg — University of Bonn, Bonn, Germany

The aim of this talk is to present and defend a local realist position about stable phenomena and the traces leading towards them, called signatures, by acknowledging scientific practice and bottom-up data to phenomena inferences. For this endeavor, I will propose and justify a fourfold distinction into (raw) data, signatures, phenomena, and theories, utilizing a case study concerned with quarks.

I will show that jet events, or the scaling behavior of the structure functions in deep inelastic scattering, are signatures, and that their existence is independent of individual data sets and translatable across different experiments. Further, these signatures are also stabilized by their reliable reproducibility based on the different kinds of data. Nevertheless, they are not explicitly containing the entity, the quark, described in the theory of quantum chromodynamics. However, the (experimental) signatures can be traced back to a common origin, to a phenomenon. Referring to recent work on perspectival realism (Massimi 2022), I proceed to show that the more (experimental) signatures infer to one phenomenon, the more the latter is stabilized. Finally, I shall argue high-level theories or models can latch onto stabilized phenomena and provide further information, but the phenomena themselves can still exist independently.

AGPhil 3.2 Tue 18:00 JAN/0027

Feynman Diagrams providing understanding as Toy Models — •Karla Weingarten — Munich Center for Mathematical Philosophy, LMU Munich

Both in high school and undergraduate university courses, Feynman Diagrams are used to teach students about the mode of operation of elementary particle interactions. This is not for their mathematical rigor or theoretical beauty but for the accessibility and clarity of the pictorial representation. This decoupling of lower-order diagrams from the theoretical framework of perturbation theory is common practice in pedagogical settings, although they do not factually represent the underlying physical mechanisms. This raises the question of whether Feynman Diagrams, taken as literal graphical diagrams, can facilitate some form of understanding, which in most accounts requires the explanatory assumptions and models to be (at least approximately) true. This criterion can be weakened to design a concept of understanding that accommodates so-called toy models, highly idealised and simplified models intended to provide easier access to complex issues. I argue that the use of Feynman Diagrams as pictorial representations can be considered as a case of such a toy model. Although Feynman diagrams cannot (realistically) be considered to present how-actually understanding, I show that as toy models, they can indeed facilitate how-possibly understanding, emphasising their great use in learning particle physics.

AGPhil 3.3 Tue 18:30 JAN/0027

Suzanne Bachelard's Conceptualization of Mathematical Physics — •Ties van Gemert — Tilburg University, Tilburg, Netherlands

Suzanne Bachelard (1919-2007) was a French philosopher and historian of physics and mathematics. Although she was a longtime director of the prestigious l'Institut d'histoire des sciences et des techniques in Paris, she never acquired the same standing as many of her peers and her philosophy has received little to no attention. In this presentation, I will reconstruct her phenomenological epistemology through close-readings of her book The Consciousness of Rationality: A Phenomenological Study of Mathematical Physics (1958). First, I will give a general overview of her conceptualization of mathematical physics. After that, I will elucidate this overview by setting out her account of the history of three critical concepts in mathematical physics: (1) fluid objects, (2) potentiality, and (3) the principle of least action. In conclusion, I will reflect on what Bachelard's philosophy of physics can still teach us today.

AGPhil 4: Quantum Foundations 1

Time: Wednesday 11:00–12:30 Location: JAN/0027

AGPhil 4.1 Wed 11:00 JAN/0027

Supervaluationism, Determinacy, and the Completeness of Quantum Mechanics — •Samuel Fletcher and David Taylor — University of Minnesota, Twin Cities

Putative instances of quantum indeterminacy provide important test cases for theories of metaphysical indeterminacy such as metaphysical supervaluationism (MS). A theory that cannot faithfully model these types of cases is arguably inadequate. While MS has had notable success in modeling run-of-the-mill examples of indeterminacy, such as those which accompany vagueness, it faces a challenge in modeling the peculiar behavior of quantum systems. The challenge goes roughly as follows: (i) MS models indeterminacy via quantification over possible worlds; (ii) those possible worlds require a classically complete assignment of properties to individuals; (iii) there is no consistent, classically complete way of assigning properties to quantum systems; therefore (iv) MS cannot model indeterminacy in quantum systems.

We believe that this challenge has not yet been sufficiently understood and that, as a result, there is considerable confusion regarding its strength and scope. Accordingly, our aims are to: (i) present a version of the challenge that is stronger, more general, and more refined than those currently in the literature; (ii) clarify the role that EEL plays in the challenge, as this is a persistent source of confusion; and (iii) show that the primary disagreement between proponents of the challenge and its critics reduces to a disagreement regarding the (in)completeness of quantum mechanics.

AGPhil 4.2 Wed 11:30 JAN/0027

Classicality and Bell's Theorem — •Márton Gömöri[1] and Carl Hoefer[2] — [1]Eötvös Loránd University, Budapest, Hungary — [2]University of Barcelona, Spain

A widespread view among physicists is that Bell's theorem rests on an implicit assumption of "classicality," in addition to locality. According to this understanding, the violation of Bell's inequalities poses no challenge to locality, but simply reinforces the fact that quantum mechanics is not classical. The paper provides a critical analysis of this view. First we characterize the notion of classicality in probabilistic terms. We argue that classicality thus construed is not a mark of the validity of classical physics, nor of classical probability theory, contrary to what many believe. At the same time, we show that the probabilistic notion of classicality is not an additional premise of Bell's theorem, but a mathematical corollary of locality in conjunction with the standard auxiliary assumptions of Bell. Accordingly, any theory that claims to get around the derivation of Bell's inequalities by giving up classicality, in fact has to give up one of those standard assumptions. As an illustration of this, we look at two recent interpretations of quantum mechanics, Reinhard Werner's operational quantum mechanics and Robert Griffiths' consistent histories approach, that are claimed to be local and non-classical, and identify which of the standard assumptions of Bell's theorem each of them is forced to give up. We claim that while in operational quantum mechanics the Common Cause Principle is violated, the consistent histories approach is conspiratorial.

AGPhil 4.3 Wed 12:00 JAN/0027

On the Bell Notion of Beable: from Bohr to Primitive Ontology — •Federico Laudisa — Department of Humanities and Philosophy, University of Trento, Via Tommaso Gar 14, 38122, Trento (Italy)

There have been in more recent times comprehensive accounts of the Bell scientific developments, but in my talk I would like to focus on a rather specific point. I refer here to the Bell notion of beable, a term first introduced in his 1973 paper entitled *Subject and object*. The aim of my talk is to show that there are at least two different readings of the notion of beable in the development of Bell*s foundational analyses. First, the concept of beable emerges as the consequence of a Bohr-like view of the status of measurement in QM: Bell, across the succession of his papers devoted to the foundations of QM, refers to Bohr in different places and with different senses, often instrumental to supporting claims that in fact appear to be only partially consistent with a Bohrian view of quantum mechanics. Only later the notion of beable acquired the meaning which in retrospect motivated the so-called primitive ontology approach. It will also be shown that in neither of the two readings the use of the notion of beable commits Bell to assume any form of naive *realism*, especially with respect to the so-called *local realism* that, according to a widespread opinion, would be the alleged target of the Bell theorem.

AGPhil 5: Quantum Foundations 2

Time: Wednesday 14:00–15:30 Location: JAN/0027

Invited Talk AGPhil 5.1 Wed 14:00 JAN/0027

Physical probability is relative frequency — •Simon Saunders — Oxford University

Frequentism as a philosophy of probability is a perennial favourite among scientists, but for reasons I shall explain, has long been abandoned by philosophers of probability (physical probability, probability as something in nature). However, this consensus rests on the presupposition that there is only a single world. That assumption is challenged by the Everett interpretation of quantum mechanics, which is independently motivated. Understanding Everett's branches in terms of decoherence theory, there is a ready candidate for an ensemble even in the case of a single experiment: the equi-amplitude branches produced on any given trial. Relative frequencies for ensembles like these agree with the Born rule. As I shall show, for ensembles of this kind, the usual difficulties that render frequentism untenable no longer arise. Arguably, all physical probabilities are quantum probabilities, so the account is quite general.

The argument is strengthened by a recent result due to Tony Short, where given the possibility of swapping branch amplitudes, a probability measure over an ensemble of branches invariant under swapping must agree with the relative frequency rule, for it must treat equi-amplitude branches as equi-probable. It must therefore agree with the Born rule as well. I conclude with a critical evaluation of the invariance condition, and a limited defence. This work extends my https://arxiv.org/abs/2201.06087; The paper by Short is at https://arxiv.org/abs/2106.16145.

Invited Talk AGPhil 5.2 Wed 14:45 JAN/0027

Locality and the Metaphysics of Many Worlds Quantum Mechanics — •Alyssa Ney — UC Davis, Davis, California, USA

Those who defend the Many Worlds Interpretation (MWI) of quantum mechanics often argue it is to be preferred over other solutions to the measurement problem because it provides a local interpretation. However, some have argued that the locality of MWI depends on the way MWI is itself interpreted metaphysically. This paper defends the locality of several metaphysical interpretations of MWI against recent criticisms.

AGPhil 6: Quantum Foundations 3

Time: Wednesday 16:00–17:45 Location: JAN/0027

Invited Talk AGPhil 6.1 Wed 16:00 JAN/0027

The structure of entangled properties: Distributional holism — •Paul Näger — University of Münster, Germany

Which options does a wave function realist (GRW, Everett or other) have to understand entangled quantum states as referring to properties? Since entangled states cannot be reduced to the micro states, the denoted properties must be ontologically irreducible in some sense. There are three major proposals: Either an entangled state refers to an irreducible property of the macro object (as proposed by wave function monists), e.g. "having total spin 0"; or it refers to an irreducible relation between the micro objects (as proposed by some ontic structural realists), e.g. "having opposite spin to"; or, less well-known, it denotes a plural property of the micro objects, e.g. "having total spin 0" understood as a *collective* property of the micro objects. I argue that all three established proposals fail to properly fit with the structure of more general entangled states and develop a new proposal: An entangled state denotes what I call a "distributional property", establishing a specific kind of holism with a characteristic structure.

AGPhil 6.2 Wed 16:45 JAN/0027

The Self-Interaction Problem as the Measurement Problem of Classical Electrodynamics — •Mario Hubert — The American University in Cairo, New Cairo, Egypt

The self-interaction problem is the foundational problem of classical electrodynamics. Although it has been recognized for around 100 years, it has not been satisfactorily solved so far. I argue that the formulation of the problem actually determines how successful solutions may look like. Indeed, I show that the formulation of the self-interaction problem surprisingly parallels the formulation of the quantum mechanical measurement problem. Although Frisch (2005, Ch. 2) presents such a formulation, I criticize his list of assumptions, as well as his proof. The problem, as he sees it, relies on an inconsistency of energy conservation, while I argue that the problem is more severe: the fundamental equations of motion for a charge affected by its own electromagnetic field break down.

Having shown what the self-interaction problem actually is, I then present different strategies for its solution. My focus will be to retain the electromagnetic field with point charges. This strategy has not yet received sufficient attention.

AGPhil 6.3 Wed 17:15 JAN/0027

Quantum Theory Is Not As Strange As We Think (or is classical physics stranger than we think?) — •Fedde Benedictus — Utrecht University, the Netherlands — Amsterdam University College, the Neterlands

Quantum theory is conceptually closer to classical physics than is usually understood. I will discuss two of the characteristics of quantum theory that, at first sight, seem to set it apart from classical physics, but on closer scrutiny are not so different from their classical counterparts * locality and quantization.

To argue my point, I will show that:

1) While gravity in Newton*s theory is notoriously non-local, Einstein wanted nothing to do with this non-locality. However, Einstein's understanding of gravity as a metrical concept cannot fully do without non-locality: any interaction that is strictly local is restricted to a mathematical point (and therefore can never be between objects of finite size).

2) The atoms and molecules in classical physics are quanta of mass. Not only does this show that quantization plays a formative role in classical physics, it leads to the remarkable suggestion that the very idea of quantization (in the form of a fundamental symmetry) is essential for any description in terms of mathematical regularities.

AGPhil 7: Members' Assembly

Time: Wednesday 18:00–18:30 Location: JAN/0027

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

AGPhil 8: Quantum Foundations 4

Time: Thursday 11:00–12:30 Location: JAN/0027

Invited Talk AGPhil 8.1 Thu 11:00 JAN/0027
Interpreting Quantum Mechanics on an Informational Approach — •Michael Cuffaro — Munich Center for Mathematical Philosophy, LMU Munich, Germany

The traditional metaphysical picture of the world takes observation-independent properties as primary and to be the origin of values of dynamical quantities revealed in experiments. It is naturally suggested by classical mechanics, since the classical state fixes the values of all such quantities in advance. Famously this is not true of the quantum state. Although Everett is the most natural interpretation of quantum mechanics given the traditional metaphysical picture, in this talk I defend an informational interpretation. What we preserve from classical mechanics is not the metaphysical picture it suggests, but the empiricist methodology through which one reasons, from the probability distributions over the values revealed in experiments, to a global picture of the world that is anchored in the contextual models one gives of phenomena under the dynamical assumptions characterising each of them. A priori, the question of how to conceive of reality is, on our approach, open; but the answer suggested by the novel kinematical framework of quantum mechanics is that a description of the world that does not include a reference to the possibilities of observation is inadequate for physics. Since observers are represented schematically, our kinematical resolution of the measurement problem reveals the observation-independent structure of the world, but it is a mistake to interpret this structure in substantival terms.

Invited Talk AGPhil 8.2 Thu 11:45 JAN/0027
Does science need intersubjectivity? The problem of confirmation in orthodox interpretations of quantum mechanics — •Emily Adlam — University of Western Ontario

Any successful interpretation of quantum mechanics must explain how our empirical evidence allows us to come to know about quantum mechanics. In this talk I will argue that this vital criterion is not met by the class of orthodox interpretations, which includes QBism, neo-Copenhagen interpretations, and some versions of relational quantum mechanics. I will take a detailed look at the way in which belief-updating might work in the kind of universe postulated by an orthodox interpretation, and argue that observers in such a universe are unable to escape their own perspective in order to learn about the structure of the set of perspectives that is supposed to make up reality according to these interpretations. I will also argue that in some versions of these interpretations it is not even possible to use one's own relative frequencies for empirical confirmation.

AGPhil 9: Quantum Foundations 5

Time: Thursday 14:00–16:00 Location: JAN/0027

AGPhil 9.1 Thu 14:00 JAN/0027
Transcendental dimensions of epistemic networks in the foundations of quantum mechanics — •Alex Seuthe — TU Dortmund University, Dortmund, Germany

The tool of social network analysis has been translated into the history and philosophy of science as epistemic network analysis. According to Renn (cf. The evolution of knowledge, 2020), three dimensions can be assigned to these networks: the social, semiotic, and semantic. The social dimension encompasses social actors and structures, the semiotic dimension encompasses experiments, and representations. The semantic dimension encompasses cognitive structures, concepts, and mental models with two main aspects: 1) They gain meaning through their interpretation of experience and their relationships with one another. 2) They can only be inferred by the reconstructive analysis of social and physical representations. I want to discuss how this novel analysis strategy of epistemic complexes can be related to the philosophy of symbolic forms of Cassirer. This theoretical reflection can help to enrich the sole aggregation of empirical data, as it often can be seen in the social sciences, with theoretical and epistemological meaning. 1) I want to outline how Cassirer's functional concept formation is similar to Renn's understanding of networks of semantic structures. 2) According to Cassirer, the basic forms of thinking manifest themselves in the social and semantic expressions of culture. I will utilise studies about the foundations of quantum mechanics as a case study to develop and illustrate my arguments.

AGPhil 9.2 Thu 14:30 JAN/0027
Heterodox underdetermination: metaphysical options for discernibility and (non-)entanglement — •Maren Bräutigam — University of Cologne

There are largely three views on whether Leibniz‘s Principle of the Identity of Indiscernibles (PII) is violated by similar particles. According to the earliest view, PII is always violated (call this the no discernibility view). According to the more recent weak discernibility view, PII is valid in a weak sense. No and weak discernibility have been referred to as orthodoxy. Steven French has argued that although PII is violated, similar particles can still be regarded as individuals. However, as it is equally possible to regard them as non-individuals, French famously concluded that metaphysics is underdetermined by physics. Call this thesis orthodox underdetermination. Most recently, some authors have turned against orthodoxy by arguing that PII is valid in more than a weak sense. Call this the new discernibility view, also referred to as heterodoxy. As heterodoxy is backed up by physical considerations, metaphysics now seems to be determined by physics: physics indicates that PII is valid. In this talk, I argue that, despite appearances, heterodox metaphysics is just as underdetermined by the physics as orthodox metaphysics; in other words, I argue for heterodox underdetermination. Heterodox underdetermination is problematic because it leaves us with the choice between two crucially different understandings of entanglement, thereby preventing us from getting a clear metaphysical picture of this peculiar phenomenon.

AGPhil 9.3 Thu 15:00 JAN/0027

Perspectival Objectivity in Relational Quantum Mechanics — Noemi Bolzonetti and •Luca Gasparinetti — University of Italian Switzerland, Lugano, Switzerland

What if everything in the world we are living in could be defined only relative to something else? What if different observers might give different accounts of the same sequence of events? According to the relational interpretation of quantum mechanics (RQM) proposed by Carlo Rovelli (e.g., 1996), there is no "absolute", i.e., observer-independent, description of reality. On the contrary, as well as the notion of simultaneity in special relativity, values and states of quantum systems are always defined via a given perspective. Does this mean that RQM cannot be in any way objective? Very roughly speaking, objectivity can be established only when different observers ascribe their descriptions to their different perspectives. But what can be said to further articulate this rough sketch?

Based on recent development on this topic (Emily Adlam and Carlo Rovelli 2022), the aim of this talk is twofold: we (i) take into account Evans's notion of "intersubjective objectivity" (Peter W. Evans 2020) to better understand in which sense it is possible to recover objectivity in relational quantum mechanics and (ii) explore how perspectival objectivity can provide a philosophical foundation for RQM. Along with Evans, we conclude that we should "stop worrying and love observer-dependent reality" also in the context of relational quantum mechanics.

AGPhil 9.4 Thu 15:30 JAN/0027

The Foundations of the Measurement Problem — Diana Taschetto[1] and •Ricardo Correa da Silva[2] — [1]Philosophy Department, University of São Paulo — [2]Department of Mathematics, University of Erlangen-Nuremberg

The measurement problem is the most intensely investigated issue at the foundations of the quantum theory. Since what counts as a solution depends on how the problem is defined, a historical investigation of the development that has conditioned the standard formulation of the problem is most needful as a test of its adequacy. Quantum Mechanics is unique in the history of science in that it resulted from the axiomatized merging of two rival–yet putatively equivalent–theories, namely Matrix Mechanics and Wave Mechanics. In this talk, we shall present a new, detailed mathematical and conceptual analysis of the structures of Matrix and Wave Mechanics. It will follow that the measurement problem is a logical consequence of constructing Quantum Mechanics over a fabricated–and therefore fictitious–equivalence. Matrix and Wave Mechanics are not equivalent quantum theories, but their structures are related, in a way we shall demonstrate. The physical relevance of this relation, stated in exact mathematical terms, is that it gives us new insight into the nature of the measurement problem, enabling us to state it in a different, more general setting than it has been done heretofore, opening new paths in our search for solutions.

AGPhil 10: Quantum Foundations Poster Session

Time: Thursday 16:15–16:45 Location: JAN/0027

AGPhil 10.1 Thu 16:15 JAN/0027

The Limits of the $\hbar$-Limit — •Renzo Kapust — Institute of Philosophy, KU Leuven

It is often thought that the limit of $\hbar \to 0$ is a classical limit, meaning that it retrieves classical mechanics from quantum mechanics. Against this common belief, we argue that the $\hbar$-limit does not fully instantiate the relation between classical and quantum mechanics on its own and mostly serves anecdotal purposes.

Importantly, the conceptual analysis shows that "$\hbar \to 0$" expresses two different limits, which also has practical consequences. Firstly, the "classical idealization" tries to map the set of quantum formulas to the set of classical formulas by changing the constant $\hbar$; pictorially imagining other possible worlds with different $\hbar$-values. Secondly, the "classical approximation" remains in this actual world and tries to map quantum explanations to classical phenomena by letting a variable grow relative to the actual value of $\hbar$.

The problems of the classical approximation include the failure to be a limit in any proper sense and to necessarily neglect important effects of quantum composition. Moreover, it does not fully include other parameters necessary to wholly retrieve classical mechanics. The problems of the classical idealization include implausible convergences, the danger of divergences, the failure to tackle $\hbar$-independent quantum phenomena as well as the failure to apply to all required equations. Consequently, although the investigation of the $\hbar$-limit bears great insight into the quantum-classical relation, neither of its senses fully instantiates it.

AGPhil 10.2 Thu 16:15 JAN/0027

Measuring up to the measurement problem: Decoherence and Bohr's ideas through the lens of the measurement problem and quantum erasers — •Emilia Kjaersdam Telléus — University of Copenhagen

In this thesis, interpretations of the formalism of quantum mechanics are investigated in terms of their address to the classic measurement problem as well as the more modern quantum erasers. The main focus is on the interpretational insight provided by Niels Bohr and the concept of decoherence, but with an overview of other important interpretations as well. The measurement problem is described and strategies for its solution is divided into two main categories: solutions and dissolutions, which are associated with collapse and no-collapse interpretations respectively. Decoherence is found to require an interpretational basis in order to properly address the measurement problem, while Bohr's interpretation has some unresolved points, mainly relating to the understanding of Bohr's notion of context, which is central to his idea of quantum mechanics. By comparing Bohr's ideas and decoherence, I argue that each can be of use to the other; decoherence can formalise some of Bohr's concepts, while Bohr's ideas provides a constructive interpretational basis for decoherence. Lastly, I argue that quantum erasers provides a ground for discussions on interpretational questions, as the insight into the nature of quantum mechanics challenges several aspects of the aforementioned different interpretations, the understanding of the Bohrian context among them.

AGPhil 10.3 Thu 16:15 JAN/0027

Is reality mystical and weird? — •Ed Dellian — Bogenst. 5, 14169 Berlin.

Current quantum mechanics is represented by the Schrödinger equation. This algorithm allows to calculate states of a particle system's kinetic energy. The concept stems from classical mechanics. It is the space integral of the concept of force. Accordingly the Schrödinger equation, as it considers energy states only (indifferently whether time dependent or not), does not consider the time required to generate an energy state, and also not the time that may separate different energy states at different places in space from each other. Therefore all possible energy states in space apparently seem to exist at the same time. As a consequence it may seem that a moving system, or particle, could even arrive at different places in space at the same time, or instantaneously, that is, without consuming time. It was realized already by Galileo and Newton that this result evidently contradicts natural experience, according to which nothing happens but in time. Therefore, the mystical and weird instantaneous effects appearing in quantum mechanics are not the features of a specific microphysical reality but only result from ignorance as to the genesis and mathematical content of the Schrödinger equation.

AGPhil 11: Quantum Mechanics, Philosophy and Information

Time: Friday 10:45–12:45 Location: HSZ/0304

AGPhil 11.1 Fri 10:45 HSZ/0304

Entangled states explained locally — •Eugen Muchowski — Primelstrasse 10, 85591 Vaterstetten

The existence of entangled states (Bell states) forces us to reconsider our conception of physical reality. This is best done using a model. However, after Bell's theorem a local realistic model describing the quantum correlations should not exist. But Bell's theorem has been refuted by a contextual model. So we are able to concretely discuss terms like contextuality, indistinguishability, inseparability and counterfactual definiteness using a local realistic model. We introduce a model in which the indistinguishability of the entangled photons explains the physical states, but in which the photon pairs do not share the value of a statistical parameter. It is astonishing that a model of entangled quantum systems can be derived solely from the initial conditions and the assumption that the behaviour of quantum particles is determined in advance. No coupling of hidden parameters is required.

AGPhil 11.2 Fri 11:15 HSZ/0304

When and why did physicists start bashing philosophy? — •Alexander Unzicker — Pestalozzi-Gymnasium München

While in the first half of the 20th century physics was an integral part of philosophy, after World War II the latter became more and more an unwelcome appendix. The evolution of this role of philosophy is discussed with some key examples. Obviously, the different research traditions in Europe and America also contributed to this shift in significance.

AGPhil 11.3 Fri 11:45 HSZ/0304

Impacts, symmetries and decisions — •Basil Evangelidis — Eschwege, Germany

There is a great amount of research data accumulating by space exploration on the topics of impacts, symmetries, habitable zone, chemical syntheses, atmosphere, climate and geology. The related facts, sayings and relations need to be evaluated by a theory of decision based on strategies of cooperation. A logic of quantum space science and technology is being, therefore, continuously articulated and innovated though focusing on efficiency, computability, polyvalence, feedback control etc.

AGPhil 11.4 Fri 12:15 HSZ/0304

Everything is information: paradox or solution? — •Ewoud Halewijn — TU Delft, Netherlands

If we want to solve fundamental conceptual problems such as the "measurement problem", the "absence of absolute space", the multifaceted "problem of time" and "nonlocality", we should not regard matter, space and time as fundamental. Neither should we wait for reconciliation projects in highly mathematical fields such as loop quantum gravity or string theory. If reconciliation of quantum-mechanics and relativity theory succeeds at all, it might not provide conceptual solutions that we are looking for.

We should take the reconciliation challenge head-on without all the mathematics, and ask ourselves: Why are some scientific findings so hard to swallow? Which strong convictions do they clash with? Why are these convictions held by larger audiences at all?

In this talk I defend that the claim "everything is information" could resolve a number of conceptual problems, while not clashing with the convictions held by larger audiences. Except for maybe one paradox: While information seems to be everything, it doesn't appear to exist at all.