Local Quantum Physics 52 and Mathematical Physics in the Heart of Germany VII

Report of Contributions

Contribution ID: **2** Type: **not specified**

Chris Fewster: Local Quantum Physics: Ancient and Modern

Thursday, May 7, 2026 2:20 PM (1h 15m)

I will give an outline of local quantum physics/algebraic quantum field theory, starting from basic operational ideas and leading to some modern perspectives concerning measurement in QFT. If time allows I will also discuss some situations in which the local paradigm must be loosened to include “semi-local” observables.

Contribution ID: **3** Type: **not specified**

Christiane Klein: Coupled Proca theories - Green-hyperbolicity and application to quantum polarization measurement

Thursday, May 7, 2026 3:40 PM (30 minutes)

The Proca equation describes a massive relativistic spin-1 particle, such as the Z-boson appearing in the Standard Model of particle physics. In this talk, we consider various extensions of the Proca equations on curved spacetimes, such as the equation of a charged Proca fields coupled to a background electromagnetic field or the one of a Proca field linearly coupled to a scalar field. We introduce an auxiliary field method to analyse the Green-hyperbolicity of these equations. With this method, we can show that all the variations of the Proca equation we consider are Green hyperbolic. As an application, we quantize the Proca field coupled to a Klein-Gordon scalar field. We use this theory to develop a measurement scheme sensitive to the Proca field polarization within the meausrement framework of Fewster and Verch, using the scalar field as the probe. For suitable states of the Proca field, we find that the leading-order response agrees with Malus' law. This confirms that this scheme models a ploarization-sensitive detector. This talk is based on joint work ArXiv:2511.11348 with Chris Fewster.

Contribution ID: **4** Type: **not specified**

Matteo Bruno: Spin Structures and Cosmology in Loop Quantum Gravity

Thursday, May 7, 2026 4:45 PM (30 minutes)

In this talk, we analyze the role of the spin structure in the Ashtekar–Barbero–Immirzi formulation of General Relativity. While not often taken into account in the full theory, it becomes crucial in cosmology. In particular, by employing a suitable notion of homogeneous connection, in the spirit of Wang's theorem, we classify the homogeneous Ashtekar variables by computing the corresponding moduli space. We demonstrate that the resulting classification is consistent with Loop Quantum Cosmology only when the spin structure is properly taken into account. Finally, we outline a quantization preserving local gauge symmetry in the spirit of Loop Quantum Gravity, where quantum states arise as cylindrical functions with enhanced symmetry properties.

Contribution ID: **5** Type: **not specified**

Gilles Jordan Pedieu Tcheuha: Non-Existence of Stationary Equilibrium Configurations of Three Aligned Rotating Black Holes

Thursday, May 7, 2026 5:20 PM (30 minutes)

Following the foundational studies of Hennig and Neugebauer on the balance of binary black holes, this work addresses the long-standing question of whether a third body can stabilize a stationary configuration. By constructing the explicit Triple-Kerr-NUT solution and employing a generalized regularity criterion based on sub-extremality inequalities, we provide a rigorous proof for the non-existence of equilibrium. Our results confirm that spin-spin repulsion remains insufficient to counter non-linear gravitational attraction in the three-body case, suggesting a universal constraint within the theory.

Contribution ID: **6** Type: **not specified**

Jesús Fernando Barbero González: The Husain-Kuchar model as the Carrollian limit of the Holst action

Thursday, May 7, 2026 5:55 PM (1 hour)

The Husain-Kuchar model is a useful auxilliary theory in the context of Loop Quantum Gravity. Its Hamiltonian formulation shares the same phase space as the Ashtekar formulation for General Relativity. In this talk I will show how this model can be understood as the Carrollian limit of the Holst action. This explains in a neat way some of its dynamical features and suggests other related models that may be useful to understand General Relativity.

Contribution ID: **7** Type: **not specified**

Volker Bach: Renormalization Group based on the Smooth Feshbach-Schur Map

Friday, May 8, 2026 9:00 AM (1 hour)

About three decades ago, a renormalization transformation based on the Feshbach–Schur Map was developed and applied to spectral problems in nonrelativistic QED. Among other things, the existence of ground states and resonances of these systems, and their computation to arbitrary accuracy by a convergent renormalization scheme was established. Starting from these results, further developments of the method and their applications, such as a smooth version of the orginal RG transformation, a continuous version of the RG transformation, and applications to singular models are reviewed in the talk. Furthermore, recent results in this context obtained in collaboration with M. Ballesteros, J. Geisler, and S. Karimi are presented.

Contribution ID: **8** Type: **not specified**

Jobst Ziebell: Functional renormalisation flows without regularisation

Friday, May 8, 2026 10:35 AM (30 minutes)

I present a very general framework in which Wetterich's equation can be applied to a vast class of probability measures on locally convex spaces. I will focus on the ϕ_2^4 model as a particular example.

Contribution ID: **9** Type: **not specified**

Denis Perice: Ground state of the Bose-Hubbard model with large coordination number

Friday, May 8, 2026 11:10 AM (30 minutes)

We consider the ground state energy of the Bose-Hubbard model on a graph with large and homogeneous coordination number. In the limit of infinite coordination number, we prove convergence of the ground state energy to the minimizer of a mean-field energy functional. This functional is obtained by averaging the hopping term over the large number of connected sites, while the interaction energy is not averaged. Hence, the resulting mean-field description is in the strong coupling regime, and is expected to provide a qualitatively correct picture of the phase diagram of the Bose-Hubbard model for large enough coordination number. For our proof, we develop a new version of a de Finetti type theorem, which we call a polaron-type quantum de Finetti theorem, and which we expect to be a more broadly useful extension of existing quantum de Finetti results. Our theorem covers the case where the Hilbert space is a tensor product of some Hilbert space with a Bosonic Fock space. This theorem is applied to the convergence of the ground state energy of the Bose-Hubbard model after reducing it to a polaron-type model.

Contribution ID: **10** Type: **not specified**

Fabian Nolte: Time-Dependent van Hove-Miyatake Model

Friday, May 8, 2026 11:45 AM (30 minutes)

The model's simplicity and exact solvability enable a detailed analysis of its dynamics. Its semiclassical nature provides heuristic insight into obstacles to convergence toward scattering states, with insights that extend to more complex models. The use of cutoffs and regularization procedures, originating in Nelson's model, leads to scattering amplitudes whose cutoff dependence becomes explicit. Our results expose challenges that approaches aiming to represent scattering states while avoiding cutoff procedures face.

Contribution ID: **11** Type: **not specified**

Maik Reddiger: A solution of the time of arrival problem via mathematical probability theory

Friday, May 8, 2026 1:50 PM (30 minutes)

Time of arrival refers to the time a particle takes after emission to impinge upon a suitably idealized detector surface. Within quantum theory, no generally accepted solution exists to date for the corresponding probability distribution of arrival times. Here I derive a general solution for a single body without spin impacting on a perfectly absorbing detector in the absence of any other forces or obstacles. In dynamical terms, the presence of the detector requires a modification of the Schrödinger equation. This guarantees that the probability flux through the detector surface is always positive, so that the arrival time distribution can be derived via an approach originally suggested by Daumer, Dürr, Goldstein, and Zanghì. The key innovation of this work is the explicit reliance on mathematical probability theory rather than more conventional quantum-mechanical concepts of probability. If time permits, I will also provide a simple, analytical example for a spherical detector. This talk is based on R., Philos. Mag. (2026). DOI: 10.1080/14786435.2026.2627725

Contribution ID: **12** Type: **not specified**

Fridolin Melong: q-Deformed Topological Recursion: Quantum Curves and Non-perturbative Analysis

Friday, May 8, 2026 2:25 PM (30 minutes)

This work investigates the q-deformation of (r, s)-Airy structures and their realization via symmetric q-difference operators, providing a bridge between quantum spectral curves and integrable systems. We construct an all-order q-WKB solution for the matrix systems associated with the q-quantized curve $E_q(x, y) = 0$. We demonstrate that the resulting non-perturbative connected q-amplitudes satisfy a set of shifted q-loop equations, which can be interpreted as the Ward identities of a q-deformed $\mathcal{W}(\mathfrak{gl}_r)$ algebra. Our main result provides a rigorous classification of admissible (r, s) pairs and q-Casimir configurations that satisfy the q-topological type property. This ensures that the semi-classical expansion is uniquely governed by the q-topological recursion, offering new insights into the q-quantization of mirror curves and their underlying algebraic structures.

Contribution ID: **13** Type: **not specified**

Carmine De Rosa: Achronal localization and representations of the causal logic

Friday, May 8, 2026 3:00 PM (30 minutes)

Achronal localization has recently been proposed as a natural framework for relativistic quantum localization. In this talk, I will present a general covariant construction of achronal localizations from conserved currents via their flux through achronal surfaces. I will discuss the case of the massive scalar boson, showing how probability currents with causal kernel and the stress-energy tensor both give rise to covariant representations of the causal logic. This provides a covariant realization of causal localization for an elementary relativistic quantum system. The construction relies on a suitable divergence theorem for open sets with almost Lipschitz boundary, which will also be briefly described.

Contribution ID: **14** Type: **not specified**

Christiaan Jozef Farielda van de Ven: Coupling of the continuum and semiclassical limit. Part I: convergence of eigenvalues

Friday, May 8, 2026 4:05 PM (30 minutes)

In this talk we analyze the semiclassical d-dimensional Schrödinger operator in the continuum $-1/2\Delta + \lambda_N^2 V$ discretized on a mesh with spacing proportional to $1/N$. The semi-classical parameter λ_N is chosen as $\lambda_N = N^{1-\gamma}$, with $\gamma \in (-1, 1)$, which ensures that N governs both the semiclassical and continuum limit simultaneously. We prove that all eigenvalues of the discrete operator converge to those of the continuum, as $\lambda_N \to \infty$. Beyond this semi-classical domain, in the case of the harmonic oscillator, we further discuss the spectral asymptotics for $\gamma \in \mathbb{R} \setminus (-1, 1)$, thereby fully characterizing the eigenvalue behavior across all possible values of $\gamma \in \mathbb{R}$. Joint work with L. Pettinari and M. Keller.

Contribution ID: **15** Type: **not specified**

Lorenzo Pettinari: Damping of phonons in Bose gas at low temperature

Friday, May 8, 2026 4:40 PM (30 minutes)

Condensed Bose gases can be effectively described in terms of quasi-particles, commonly referred to as \textit{phonons}. Their dynamics are captured by a \textit{c-number condensate Hamiltonian} consisting of a quadratic term supplemented by third- and fourth-order perturbative corrections. These additional interaction terms render the phonons unstable, giving rise to two distinct decay processes known as \textit{Beliaev} and \textit{Landau} damping. From a mathematical perspective, such decay mechanisms should manifest as a \textit{broadening} of the Bogoliubov dispersion relation in the thermodynamic limit. To validate this picture, I will present two different approaches to deriving the phonon decay rates. The first is inspired by the W^*-algebraic framework of Jak\v{s}i\'{c}–Pillet, employing Standard Representations and perturbative expansions of a suitably chosen vector state. The second method is based on the analysis of two-body correlation functions. Both approaches yield the same imaginary correction to the Bogoliubov dispersion relation, which in turn determines the expected broadening. Furthermore, our approaches offer a new perspective on the decay of phonons in terms of the \textit{left} and \textit{right} components of these quasi-particles. The talk is based on joint work with Jan Derezi\'{n}ski and may be viewed as a modern elaboration of the classical contributions of Beliaev, Hohenberg–Martin, and others.

Contribution ID: **16** Type: **not specified**

Marcel Griesemer: On Rayleigh scattering in the massless Nelson model

Friday, May 8, 2026 5:15 PM (1 hour)

Asymptotic completeness of Rayleigh scattering in models of atoms and molecules of non-relativistic QED is expected, but to prove it, we still lack sufficient control over the number of emitted soft photons. So far, this obstacle has only been overcome for the spin-boson model. In a general class of models, asymptotic completeness holds provided the expectation value of the photon number N remains bounded uniformly in time. This was shown a few years ago by Faupin and Sigal. We review and simplify their work, and, more importantly, we replace the bound on N by a weaker assumption on the distribution of N that is both necessary and sufficient for asymptotic completeness. - This is joint work with Valentin Kußmaul.

Contribution ID: **18** Type: **not specified**

Francesco Fidaleo: Twisted C*-tensor product

Saturday, May 9, 2026 8:30 AM (1 hour)

We describe the (infinite) C*-tensor product as the generalization of the usual tensor product and the Fermi one (that is what based on the Fermi bicharacter). After constructing the infinite chain tensor product, we show that the investigation of the set of the symmetric states (that is those invariant under the action of the finitary symmetric group), can be fruitfully carried out in only three cases. The first two are the usual tensor product and the Fermi one, generalizing the well-known De Finetti's Theorem provided, in non commutative case, by E. Stormer and FF, respectively. We have only one more (completely new) situation arising for the Klein 4-group and the associated Klein bicharacter. It is interesting to note that, while the first two examples (usual, i.e. Bose, and Fermi) have many natural applications to Quantum Physics and Probability, it is not know any reasonable application of this Klein twisted tensor product to natural models, up to now.

Contribution ID: **19** Type: **not specified**

Christoph Minz: A scheme to bound relative modular Hamiltonians in QFT

Saturday, May 9, 2026 9:35 AM (30 minutes)

Relative modular Hamiltonians are operators in quantum field theory to compute relative entropy, relating to a key concept in quantum information theory. Since explicit expression for these operators are known to be very difficult to find, we describe a scheme to estimate relative modular Hamiltonians between two states, both related to a reference state (like the vacuum) for which the modular Hamiltonian might be known or at least better understood. So we can formulate upper and lower bounds of relative modular Hamiltonians by choosing pairs of states for larger and smaller regions, respectively. In this talk, I will summarize the scheme, emphasize that those states and regions available to our scheme do not signal superluminally (in the sense of Sorkin's paradox), and show how to evaluate the quality of the estimates with some explicit computations. This is joined work with Ko Sanders and Adriano Chialastri.

Contribution ID: **20** Type: **not specified**

Igor Kanatchikov: Precanonical quantization of Yang-Mills theory and the problem of mass gap

Saturday, May 9, 2026 10:10 AM (30 minutes)

We discuss precanonical quantization of pure YM field theory, its relation to the canonical quantization in the functional Schr\"odinger representation, the expression of the Schroedinger wave functional as a Volterra product integral of precanonical wave functions, the emergence of a mass gap from the spectrum of the De Donder-Weyl Hamiltonian operator derived from precanonical quantization, and, briefly, relevance of this result in the context of quantum gravity and dark matter/dark energy problems. Based on I. Kanatchikov, Rep. Math. Phys. 82 (2018) 373, IJGMMP 14 (2017) 1750123; Symmetry 11 (2019) 1413; EPL 150 (2025) 59002, and a work in progress.

Contribution ID: **21** Type: **not specified**

Alessandro Pietro Contini: Timelike boundaries and the Hadamard condition

Saturday, May 9, 2026 11:15 AM (30 minutes)

In this talk we review the setting of globally hyperbolic manifolds with timelike boundaries and discuss the Klein-Gordon field on them. We will then discuss work in progress with Alexander Strohmaier concerning the extension of the Hadamard condition for states to include, among others, fields satisfying the Dirichlet boundary condition.

Contribution ID: **22** Type: **not specified**

Markus B. Fröb: News on relative entropy

Saturday, May 9, 2026 11:50 AM (30 minutes)

I present recent work on a new integral representation for the relative entropy (or Kullback-Leibler divergence) for general tracial von Neumann algebras, generalizing results for matrix algebras. This representation allows easy proofs of its properties such as joint convexity and an extended version of the data processing inequality, namely monotonicity under positive unit-preserving maps. Moreover, it can be used to define Csiszár's f-divergences for von Neumann algebras, which depend on an arbitrary convex function f, and which give the relative entropy in the special case f(x) = x ln x. Joint work with Ricardo Correa da Silva, Gandalf Lechner, and Leonardo Sangaletti.

Contribution ID: **23** Type: **not specified**

Daniela Cadamuro: The massive modular Hamiltonian in the case of fermions

Saturday, May 9, 2026 12:25 PM (1 hour)

The Tomita-Takesaki modular operator for local algebras plays an important role in quantum field theory, and more recently in the study of relative entropy. However, the explicit expression of this operator, except for the case of wedges, is difficult to describe mathematically. We have obtained numerical results for the form of the modular Hamiltonian for free massive Majorana fermions in 1+1 dimensional Minkowski space in the cases of a single and two double cones, which shows how it differs from the wedge case, in particular regarding the dependence of the modular Hamiltonian on the mass of the field.