OSMU24: Quantum Foundations, Particle Physics, and Unification of Forces

February 16 to December 13, 2024

An online lecture series, held at 4 pm London time, on Fridays [typically, but not necessarily, on alternate Fridays of the month].

Each talk is one hour long, followed by an hour-long discussion session.

Hosts: Tejinder P. Singh and Michael Wright

Organized jointly by:

Archive Trust for Research in Mathematical Sciences and Philosophy, Bristol, UK

and

Inter-University Center for Astronomy and Astrophysics, Pune, India

Program advisors: Latham Boyle, Felix Finster, Niels Gresnigt, Cohl Furey, Jose Isidro, Roger Penrose, Basil Hiley, Ashutosh Kotwal, Anthony Lasenby, Hendrik Ulbricht.

ZOOM LINK FOR ALL TALKS:

https://us06web.zoom.us/j/89956931861?pwd=YkN4bUg0NE1STFlRd0MwY0NUVjcwdz09

Meeting ID: 899 5693 1861
Passcode: 451794

SCHEDULE

DATE	**SPEAKER**	**TITLE**	**REMARKS**
February 16	Roger Penrose	*Why Quantum Wave-function Collapse is a Seemingly Retrocausal Gravitational Effect* [Abstract on p. 4]	Confirmed

March 1	Basil Hiley	*The Algebraic Way: the Legacy of Clifford, Heisenberg and Dirac for Quantum Foundations.* Abstract on p.5	Confirmed
~~March 8~~ POSTPONED TO March 22	Maurice de Gosson	*The symplectic camel, quantum blobs, and the metatron: exploring the interplay between symplectic mechanics and quantum principles* Abstract on p.6	Confirmed
(date to be decided)	Alessio Marrani	TBA	Confirmed
March 29	Xavier Hernandez	*On the consistency of the GAIA Wide Binary Gravitational Anomaly with MOND* [Abstract on p.7]	Confirmed
December 13	Mordehai Milgrom	*A review of MOND*	Confirmed
~~April 26~~ **POSTPONED to June 14**	Bernd Henschenmacher	*Jordan algebras and beyond: on Pascual Jordan's attempt to generalize quantum theory* [Abstract on p.8]	Confirmed **POSTPONED**
May 10	Tim Tait	*Dark matter: theory and observation*	Confirmed
May 24	Leron Borsten	*Gravity as square of Yang-Mills theory*	Confirmed
~~June 7~~ **POSTPONED**	Antonino Marciano	*Gravi-weak unification*	Confirmed
June 14	Bernd Henschenmacher	*Jordan algebras and beyond: on Pascual Jordan's attempt to generalize quantum theory* [Abstract on p.8]	Confirmed
June 21	Siddhant Das	*Quantum arrival-time problem and Bohmian trajectories* [Abstract on p.9]	Confirmed

July 5	Subir Sarkar	*A challenge to the standard cosmological model* [Abstract on p. 10]	Confirmed
July 19	Jochen Szangolies	*The Standard Model Symmetry and Qubit Entanglement* [Abstract on p. 11]	Confirmed
September 6	Kaustubh Agashe	*Composite Higgs*	Confirmed
September 20	Zoltan Fodor	*The muon's (g-2)*	Confirmed
October 4			TBC
October 18	George Sparling	*Spacetime is six dimensional, additional dimensions are timelike*	Confirmed
November 1	Andrew Hamilton	*Geometric algebra and unification*	Confirmed
November 15	David Jackson	*Unification by Generalising Proper Time rather than Appending Dimensions of Space*	Confirmed
November 29	Antonino Marciano	*Gravi-weak unification*	Confirmed
December 13	Mordehai Milgrom	*A review of MOND*	Confirmed

OSMU 2024, Friday, 16th February

Roger Penrose
Oxford

TITLE:

Why Quantum Wave-function Collapse is a Seemingly Retro-causal Gravitational Effect

Abstract:

A conflict between the basic principles of general relativity (equivalence principle) and quantum mechanics (superposition principle) leads to an expectation that a macroscopic quantum superposition will have a lifetime that is roughly limited by a timescale put forward by Lajos Diósi in the late 1900s. Considerations of special relativity lead us to an implication that the wave-function collapse has a curious retro-causal character which, however, does not allow signals to propagate into the past. Importantly, it does not lead to the conclusion of spontaneous heating that appeared to be an implication of Diósi's original proposal and is observed not to pe present, according to recent experiments.

The Algebraic Way: the Legacy of Clifford, Heisenberg and Dirac for Quantum Foundations.

B. J. Hiley. March 1, 2024

Abstract.

Roger Penrose's talk of two weeks ago concluded that the conflict between the basic principles of general relativity (equivalence principle) and quantum mechanics (superposition principle) leads to two realities, one classical and one quantum. That argument is based on the Schrödinger picture. In this talk I set out to show that if one uses the Heisenberg picture, there is only one reality. The argument starts with the Heisenberg groupoid structure which carries both the orthogonal and the symplectic symmetries basic to both the classical and quantum domains. Clifford recognised the role of the groupoid in classical physics where it plays a fundamental part in producing the well known orthogonal Pauli, Dirac and Penrose twistor algebras. The symplectic symmetries were hidden away in a much neglected paper of von Neumann who essentially discovered the Moyal star-product algebra. The von Neumann paper led to the Stone-von Neumann theorem which showed that the various pictures, Schrödinger, Heisenberg, Interaction etc were equivalent up to a unitary transformation. I will show how the Bohm version of the non-relativistic Schrödinger equation emerges from the star-product algebra. The product necessarily introduces a new quality of energy, the 'quantum potential energy' which DeWitt (1952) showed had a geometric origin being associated with a scalar curvature tensor. This structure reveals what could lie behind the appearance of conformal rescaling, hopefully enabling a better understanding of the rest mass problem.

Maurice de Gosson

March 8, 2024

Title: The Symplectic Camel, Quantum Blobs, and The Metatron: Exploring the Interplay of Symplectic Mechanics and Quantum Principles

Abstract: This study explores the subject of symplectic mechanics, delving into the profound implications of Gromov's non-squeezing theorem. Building upon previous research, we introduce the concept of "quantum blobs," the smallest phase space units consistent with the indeterminacy principle of quantum mechanics. Contrary to conventional expectations, quantum blobs are characterized by the Gromov width, which always equates to half of the quantum of action. This unique characterization permits a topological formulation of the principle of quantum indeterminacy, establishing a bijective correspondence with the generalized coherent states of quantum mechanics (minimum uncertainty states). The derivation of Schrödinger's wave equation from first principles, using the metaplectic group, is discussed, along with Fermi's identification of a particle with a set. Time permitting, connections to the Bohm--Hiley holomovement and the geometric notion of symplectic polarity between convex bodies in phase space will be explored.

OSMU2024 March 29

Xavier Hernandez

On the consistency of the GAIA Wide Binary Gravitational Anomaly with MOND.

Over the past couple of years a clear gravitational anomaly has been reported and confirmed by two independent research groups carefully considering relative velocities, v and separations, s, on the plane of the sky, for wide binary star samples from the most recent GAIA catalogue. Over various studies covering a range of sample selection strategies and statistical analysis techniques, a surprising phenomenology has emerged. While the small separation samples for s<2000 au accurately conform to Newtonian expectations, for separations above 3000 au, a clear and systematic departure from Newtonian predictions appears. This high separation regime shows a v proportional to s^(-1/2) scaling, but corresponding to Keplerian orbits under an effective gravitational constant of 1.5G. Given the narrow range of total masses of around 1.6 M_{sun} in the samples considered, the critical separation at which a change in regime appears corresponds to approaching the a0 threshold, where a0 is the characteristic acceleration scale of MOND, as inferred from galactic rotation curve observations. Further, the precise distribution of wide binary relative velocities measured, closely corresponds to MOND expectations for such solar neighbourhood systems under the external field effect predicted by MOND. Now that a low acceleration validity limit for Newtonian gravity has been found, precisely at the acceleration scales over which the presence of dark matter has been proposed, astrophysical inferences for such hypothetical component become suspect.

OSMU2024 April 26

Bernd Henschenmacher

Jordan algebra and beyond: On Pascual Jordan's attempts to generalize quantum theory

Abstract:

I will give a comprehensive summary of Pascual Jordan's ideas and attempts to generalize the mathematical formalism of quantum theory and extend quantum theory. I will start with Jordan's idea from 1925 that space and time need to be quantized, Jordan's and Max Born's suggestion to use a Time Operator in quantum theory in 1930 and briefly describe Jordan's ideas on using Non-Hermitian Operators with a real spectrum as observables from the late 1920ies.

I will then describe the situation in particle physics in the 1930ies and Jordan's introduction of Jordan algebras as an attempt to generalize quantum theory by using non-associative algebras. I will focus on Jordan's ideas related to the octonions from the 1930ies and 1950ies, before describing his ideas to develop a non-linear extension of quantum theory based on Near Rings and Quasi Rings.

After describing Jordan's ideas on nonlinear observables, I will describe his work on Noncommutative or Skew Lattices and their links to Non-Hermitian Linear Operators. Finally, I will describe Jordan's work on Non-Power-Associative Algebras and their putative links to string theory and R-duality.

I will also cover ideas related to Jordan's speculations put forward by Günther Ludwig (Generalized Observables in Banach spaces), Lawerence Biedenharn (Octonionic Quantum Theory) and David Finkelstein (The Space-Time Code).

June 21, 2024

Siddhant Das

Quantum arrival-time problem and Bohmian trajectories

Abstract: Computing the probability density of arrival, detection or flight times of a quantum particle at a detector, which is empirically well-accessible, is one of the last areas where physicists disagree about what QM should predict. Over the years, many disparate proposals have been put forward to address this problem. I will quickly examine some of the key suggestions and make the case that a Bohmian trajectory-based method is the most compelling, broadly applicable, and well-supported by existing experimental data, e.g., momentum and scattering statistics. In certain novel experimental settings, the Bohmian trajectory arrival-time distributions predict unexpected and very well-articulated features demanding experimental inspection, e.g., those suggested in [S. Das and D. Dürr, Sci. Rep. 9: 2242 (2019)]. I will discuss the key findings of this work. Time permitting, I will also comment on any possible drawbacks to the above approach, particularly those relating to the effect of the measuring devices, etc.

OSMU2024 July 5

Subir Sarkar

Title: A challenge to the standard cosmological model

Abstract: In the ΛCDM cosmological model the Universe is assumed to be isotropic and homogeneous, when averaged on large scales. That the cosmic microwave background has a dipole anisotropy is interpreted as due to our peculiar (non-Hubble) motion because of local inhomogeneity. There must then be a corresponding dipole in the sky distribution of sources at high redshift. Using catalogues of radio sources and quasars we find that this expectation is rejected at >5σ, i.e. the distribution of distant matter is *not* isotropic in the 'CMB frame'. This calls into question the standard practice of boosting to this frame for analysing cosmological data, in particular to infer an (isotropic) acceleration of the Hubble expansion rate from Type Ia supernovae, which is interpreted as due to a Cosmological Constant Λ.

July 19

Jochen Szangolies

The Standard Model Symmetry and Qubit Entanglement

Research at the intersection of quantum gravity and quantum information theory has seen significant success in describing the emergence of spacetime and gravity from quantum states whose entanglement entropy approximately obeys an area law. In a different direction, the Kaluza-Klein proposal aims to recover gauge symmetries by means of dimensional reduction of higher-dimensional gravitational theories. Integrating both, gravitational and gauge degrees of freedom in 3+1 dimensions may be obtained upon dimensional reduction of higher-dimensional emergent gravity. To this end, we show that entangled systems of two and three qubits can be associated with 5+1 and 9+1 dimensional spacetimes respectively, which are reduced to 3+1 dimensions upon singling out a preferred complex direction. In the latter case, this reduction is invariant under a residual $SU(3)\times SU(2)\times U(1)/Z6$ symmetry, the Standard Model gauge group. This motivates a picture in which spacetime emerges from the area law-contribution to the entanglement entropy, while gauge and matter degrees of freedom are due to area law-violating terms.