AGPhil 16: Quantum Gravity 4

Time: Thursday 16:45–18:45 Location: PTB SR AvHB

AGPhil 16.1 Thu 16:45 PTB SR AvHB

Decoherence of a composite particle induced by a weak quantized gravitational field — •Thiago H. Moreira and Lucas C. Céleri — Institute of Physics, Federal University of Goiás, Goiânia, Goiás 74.690-900, Brazil

In recent years, several proposals for experimentally investigating quantum gravitational effects far from the Planck scale have recently appeared in literature, like gravitationally induced entanglement, for instance. An important issue of these approaches is the decoherence introduced by the quantum nature not only of the system under consideration but also from the gravitational field itself. Here, by means of the Feynman Vernon influence functional, we study the decoherence of a quantum system induced by the quantized gravitational field (in the linearized gravity) regime and also by its own quantum internal degrees of freedom. Due to the universal nature of the gravitational coupling, both environments are not independent, meaning that, within the Feynman Vernon influence functional technique, the non additivity of the noise effects results in a contribution to the decoherence rate that comes from the interaction between the two environments. This is another decoherence effect that should be taken into account when considering experimental proposals for detecting quantum effects of gravity. The decoherence rate was computed by considering a superposition of the relevant degrees of freedom, from which we estimated the decoherence time.

AGPhil 16.2 Thu 17:15 PTB SR AvHB

Simplicial Graviton from Selfdual Ashtekar Variables — •Wolfgang Wieland — University of Erlangen Nuremberg, Erlangen, Germany

Selfdual gravity is a reformulation of general relativity on the phase space of a SL(2,C) gauge theory. As pointed out by Abhay Ashtekar in the mid 1980ies, this reformulation uncovered a surprising simplicity of gravity. It was a well-known result at the time that the Hamiltonian of the theory is a sum of constraints generating hypersurface deformations. The surprise was that using selfdual variables, the constraints simplify in a very dramatic way. They assume the simplest possible polynomial form. In this talk, I lay out a new non-perturbative lattice approach for selfdual gravity with possible far-reaching consequences for quantum gravity. Three results will be discussed. First of all, I explain how to introduce a local kinematical phase space at the lattice sites. At each lattice site, a set of constraints is found that replace the generators of hypersurface deformations in the continuum. The second and most intriguing result is that the discretized constraints close under the Poisson bracket. The resulting reduced phase space describes the two radiative modes at the discretized level. As consistency check, I apply the construction to gravity in three-dimensions. In this way, the established spin-network representation of three-dimensional gravity is recovered from a local quantisation of space.

AGPhil 16.3 Thu 17:45 PTB SR AvHB

Only Euclidean Relativity Provides a Holistic View of Nature — •Markolf Niemz — Heidelberg University, Germany

Special and general relativity (SR/GR) describe nature "subjectively", that is, from the perspective of just *one observer at a time* (one group of observers, to be exact). Mathematically, SR/GR are correct. I show: (1) Physically, SR/GR have an issue. Despite the covariance of SR/GR, there is always just one active perspective. Because of this constraint, there is no holistic view of nature. The issue shows itself in unsolved mysteries. Still, the Lorentz factor and gravitational time dilation are correct. This is why the concepts of spacetime in SR/GR work well except for cosmology and quantum mechanics. (2) Euclidean relativity (ER) describes nature "objectively", that is, from the perspectives of *all objects at once*. Any (!) object's proper space d_1, d_2, d_3 and proper time τ span natural spacetime, which is 4D Euclidean space (ES) if we interpret $c\tau$ as d_4. All energy moves through ES at the speed c. An observer's reality is created by projecting ES orthogonally to his proper space and to his proper time. In SR, these concepts are considered coordinate space and coordinate time. Neither their reassembly to a non-Euclidean spacetime nor the parameterization in SR/GR provides a holistic view. The scalar τ, in particular, cannot factor in an object's 4D vector "flow of proper time" $\boldsymbol{\tau}$. The SO(4) symmetry of ES is incompatible with waves. This is fine because waves and particles are subjective concepts. We must distinguish between an observer's reality (described by SR/GR) and the master reality ES (described by ER). ER solves 15 mysteries (preprints.org/manuscript/202207.0399).

AGPhil 16.4 Thu 18:15 PTB SR AvHB

Allgemeine Allgemeine Relativitätstheorie — •Thomas Schindelbeck — thomas.schindelbeck@iraeph.de

Grundlage der Allgemeinen Relativitätstheorie ist Differentialgeometrie, der Kraftbegriff wird durch Geodäten im gekrümmten Raum ersetzt. Der entsprechende Formalismus wurde historisch zuerst auf Gravitationseffekte angewandt und wird auch heute fast ausschließlich mit diesen verbunden. Das Konzept selbst setzt keine bestimmte Kraft voraus. T.Kaluza erkannte bereits 1919, dass sich auch die Elektrodynamik mit einem derartigen Formalismus beschreiben lässt. Eine Erweiterung der Metrik auf 5 Dimensionen ergibt, mit entsprechenden Randbedingungen, sowohl die Einsteinschen Feld-, als auch die Maxwellschen Gleichungen. Teilcheneigenschaften liegen in völlig falschen Größenordnungen. Bezieht man Kaluzas Ansatz in 1. Näherung nur auf die Elektrodynamik, erhält man korrekte Größenordnungen. Mit Spin = 1/2 als Randbedingung kann man diese (Masse, magnetische Momente, Ladungsverteilung etc.) auf Basis der Konstanten der Elektrodynamik * ab initio * mit einer Genauigkeit in der Größenordnung von QED-Korrekturen berechnen. Im Vortrag sollen die Konsequenzen eines solchen Vorgehens in Bezug auf die Relation Gravitation/ Elektrodynamik /Quantenmechanik diskutiert werden.