MP 1: Quantum Mechanics

Time: Monday 16:45–18:05 Location: ZHG001

MP 1.1 Mon 16:45 ZHG001

Advances in quantum dynamics of photons in curved spacetime — •David Edward Bruschi — Institute for Quantum Computing Analytics (PGI-12), Forschungszentrum Jülich, Jülich, Germany

General relativity and quantum mechanics are the two frameworks through which we understand Nature. To date, they have been successful at providing accurate predictions of natural phenomena in their respective domains of validity. Many attempts to find a unified theory of Nature that can describe all of observable phenomena have been tried with varying degrees of success. Regardless, the quest for unification remains open, and therefore continues.

One avenue for investigating the overlap of general relativity and quantum mechanics that is less ambitious but can still provide potentially observable and measurable predictions is that of (low energy) quantum field theory in curved spacetime viewed through the lens of quantum information. In recent years, a great deal of attention has been given to this approach, which has provided novel and intriguing insights into phenomena that can be tested in the laboratory.

We present updates on the investigation into the quantum nature of the gravitational redshift, seeking to understand which are the quantum dynamics that lead to the effective classical observable effect. We present the current state-of-the-art and discuss novel discoveries. We also discuss the place that this avenue of research has in the broader context of relativistic and quantum physics.

MP 1.2 Mon 17:05 ZHG001

Quantum tunneling time via time-of-arrival operators — •Philip Caesar Flores[1], Dean Alvin Pablico[2,3], and Eric Galapon[2] — [1]Max-Born-Institute, Max-Born Straße 2A, 12489 Berlin, Germany — [2]National Institute of Physics, University of the Philippines Diliman, 1101 Quezon City, Philippines — [3]niversity of Northern Philippines, 2700 Vigan City, Ilocos Sur, Philippines

We construct all possible time-of-arrival operators via canonical quantization of the classical time-of-arrival and demonstrate that the tunneling time vanishes for all these operators, regardless of the ordering rule between the position and momentum observables.

MP 1.3 Mon 17:25 ZHG001

The GHZ state and Bohmian positions — •Robert Helling — Ludwig-Maximilians-Universität München

In the Bohmian interpretation, particle positions are realistic that is they have definite values even when not being observed. We realise the GHZ state in terms of position observables at different times and argue that violations of Bell type inequalities pose challenges to this realistic nature of positions. They can be avoided at the price of giving up predictability for outcomes of measurement at multiple times for observables that can be computed with textbook quantum mechanics.

MP 1.4 Mon 17:45 ZHG001

Quantum Analytical Mechanics: What is it and what is it good for? — •Wolfgang Paul — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle

The question whether the Schrödinger equation has to be considered the complete description of (non-relativistic) quantum phenomena or not, has occupied a part of the physics community since the famous controversy between Einstein and Bohr at the 1927 Solvay conference. Based on Nelson's derivation of the Schrödinger equation from the Newtonian dynamics of a time-inversion invariant diffusion process in 1966, by now a complete theory of quantum analytical mechanics has been developed. I will present its structure and discuss applications to the tunneling phenomenon, the dynamic stability of the hydrogen atom in the ground state and the violation of Bell's inequalities in the Einstein-Podolski-Rosen-Bohm thought experiment.

M. Beyer, W. Paul, Foundations of Physics **54**, 20 (2024).