MP 4: Symposium Quantentheorie und Gravitation

Zeit: Mittwoch 13:30–16:10 Raum: VMP4 Audimax 1

Hauptvortrag MP 4.1 Mi 13:30 VMP4 Audimax 1
Quantum Tests of Gravity — •Markus Aspelmeyer — University of Vienna, Faculty of Physics, Vienna Center for Quantum Science and Technology (VCQ), Vienna, Austria

The early pioneering experiment by Colella, Overhauser and Werner demonstrates the effect of Earth's gravitational potential on quantum interference fringes in a neutron interferometer. It was the first experiment that required the use of both Planck's constant and Newton's constant to describe the observed fringe pattern. Over the following decades, the development of new tools significantly expanded the available quantum experiments that test the effects of weak gravitational fields, including atom interferometers, gravitationally bound states of neutrons or atomic clock tests of the gravitational red shift. The last few years have seen a renewed interest and a significant increase of experiments and experimental proposals to explore the interface between quantum physics and gravity. Quantum optics and cold atom experiments have been pushing the sensitivity of measurements of space and time to unprecedented regimes. Recent proposals even suggest that table-top experiments may allow to falsify low-energy consequences of quantum theories of gravity. On the other hand, the fast progress in macroscopic quantum experiments may soon allow to study quantum superposition states involving clocks or of increasingly massive objects, opening up a completely new regime of experiments in which the source mass character of the quantum system starts to play a role. I will review the current state of the art and discuss some of the challenges and prospects for such quantum tests of (quantum) gravity.

Hauptvortrag MP 4.2 Mi 14:10 VMP4 Audimax 1
A Practitioner's View on Quantum Gravity — •Renate Loll — Radboud University, Nijmegen, The Netherlands

Quantum gravity is a subject difficult to grasp for outsiders. Which lofty ideas of exotic structures at the Planck scale will turn out to be right? Do theorists agree on what "quantum gravity" means and what questions such a theory should answer? How far are we from obtaining answers?

My collaborators and I are trying to show by explicit construction that understanding nonperturbative quantum gravity does not require hitherto unseen symmetries, dimensions, strings, loops or branes, which appear to lead us ever further away from a unique theory. Staying within the framework of quantum field theory, but adapting it to the situation where spacetime itself is dynamical, Quantum Gravity from Causal Dynamical Triangulations (CDT) is a promising candidate theory of this type. It is a gravitational analogue of obtaining nonperturbative QCD as the scaling limit of a lattice theory, and is unique in producing evidence of a good semiclassical limit. Not only may this approach lead us to the correct theory of quantum gravity, it also provides a concrete and extremely useful computational framework to study fundamental questions, as I will try to illustrate. One example is the recent demonstration that a renormalization group analysis can be set up and performed in CDT quantum gravity despite its background-free character.

Hauptvortrag MP 4.3 Mi 14:50 VMP4 Audimax 1
Standard Model Fermions and N=8 Supergravity — •Hermann Nicolai — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Am Mühlenberg 1, Potsdam-Golm

In a scheme originally proposed by Gell-Mann, and subsequently shown to be realized at the $SU(3) \times U(1)$ stationary point of maximal gauged SO(8) supergravity, the 48 spin-1/2 fermions of the theory remaining after the removal of eight Goldstinos can be identified with the 48 quarks and leptons (including right-chiral neutrinos) of the Standard model, provided one identifies the residual SU(3) with the diagonal subgroup of the color group $SU(3)_c$ and a family symmetry $SU(3)_f$. However, there remained a systematic mismatch in the electric charges by a spurion charge of $\pm\, 1/6$. We here identify the "missing" U(1) that rectifies this mismatch, and that takes a surprisingly simple, though unexpected form, and show how it is related to the conjectured R symmetry K(E10) of M Theory.

Hauptvortrag MP 4.4 Mi 15:30 VMP4 Audimax 1
Quantum and gravity: blend or mélange? — •Christian Wüthrich — University of Geneva

Do we need to quantize gravity, as it is tacitly assumed in much of fundamental physics? The standard lore falls short of justifying an affirmative answer. Black hole thermodynamics is widely considered, faint though it may be, our firmest hint at a quantum theory of gravity—despite the failure to date to observe Hawking radiation or any other effect that would require going beyond a classical description of black holes. Hawking radiation hitherto merely enjoys a theoretical derivation in a semi-classical theory combining quantum matter with classical gravity. But how can a semi-classical mélange of physical principles possibly justify that the quantum and gravity are blended into a unified fundamental theory when the latter is generally expected to reject at least some of the principles in the former?