GR 18: Quantenfeldtheorie in gekrümmten Raumzeiten

Zeit: Freitag 11:45–12:30 Raum: HS 6

GR 18.1 Fr 11:45 HS 6

Quantization of submanifold embeddings — Dorothea Bahns[1], Katarzyna Rejzner[2], and •Jochen Zahn[1] — [1]Courant Research Centre "Higher Order Structures", Universität Göttingen — [2]II. Institut für Theoretische Physik, Universität Hamburg

We describe a perturbative quantization of the embedding of d-dimensional submanifolds into n-dimensional Minkowski space, based on suitable generalizations of the Nambu-Goto action. We use tools from perturbative algebraic quantum field theory, quantum field theory on curved spacetimes, and the Batalin-Vilkovisky formalism. The resulting theory is perturbatively non-renormalizable, but well-defined as an effective theory, i.e., there are no anomalies, for any dimension d, n. In particular there is no critical dimension for the case of string theory ($d = 2$).

GR 18.2 Fr 12:00 HS 6

On dynamical mass generation in Euclidean de Sitter space — •Paul Moch[1,2] and Martin Beneke[1,2] — [1]Physik Department T31, Technische Universität München — [2]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University

We consider the perturbative treatment of a minimally coupled, massless, self-interacting scalar field in Euclidean de Sitter space. Generalizing the work of Rajaraman, we obtain the dynamical mass $m^2 \propto \sqrt{\lambda}H^2$ of the scalar for non-vanishing Lagrangian masses and the first perturbative quantum correction in the massless case. We introduce the rules of a systematic perturbative expansion, which treats the zero-mode non-perturbatively, and goes in powers of $\sqrt{\lambda}$. The infrared divergences of the massless free field theory are self-regulated by the zero-mode dynamics. Thus, in Euclidean de Sitter space the interacting and massless scalar field is just as well-defined as the massive field. We then show that the dynamical mass can be recovered from the diagrammatic expansion of the self-energy and a consistent solution of the Schwinger-Dyson equation. This requires the summation of a divergent series of loop diagrams of arbitrarily high order. We note that the value of the long-wavelength mode two-point function in Euclidean de Sitter space agrees at leading order with the stochastic treatment in Lorentzian de Sitter space, in any number of dimensions.

GR 18.3 Fr 12:15 HS 6

Quantum simulation of curved spaces in optical lattices containing topological defects — •Nikodem Szpak — Fakultät für Physik, Universität Duisburg-Essen

We discuss the possibility of quantum simulation of relativistic fields living in curved spaces realized in optical lattices loaded with ultracold atoms. In some regime their dynamics can be described by the Hubbard model which can be mapped onto a discrete version of a relativistic quantum field theory. Manipulation of the laser beams can lead to the emergence of curvature and torsion in an artificial Riemann-Cartan geometry. We give examples of several lattice geometries and discuss the properties of the emerging curved spaces with their field theoretic effects, like scattering on curvature centers and birefringence on torsion lines. Since the interaction of quantum fields with curvature or torsion is very difficult to observe in real experiments the proposed table-top analog model can be very instructive.