MP 6: Quantum Field Theory I

Zeit: Dienstag 14:10–16:05 Raum: SFG 2010

Hauptvortrag MP 6.1 Di 14:10 SFG 2010

Spacelike linearity of the quantum electromagnetic field and topological charges — •Giuseppe Ruzzi — Dipartimento di Matematica, Universita' di Roma "Tor Vergata", Via della ricerca scienitfica 1, 00133 Roma, Italy

A general analysis of the observable structure of the quantum electromagnetic field reveal the presence of a (possibly) new topological charge. This is related to the possibility to give a covariant quantization of the electromagnetic potential, in a Hilbert space, whose the commutator on a pair of mollifying functions localized in a certain topologically non-trivial spacelike separated regions does not vanish, rather it is a central element giving rise to a topological charge.

We shall see that such a quantization is possible if the field is "spacelike linear" on mollifying functions, a weaker, but physically reasonable, form of linearity. We shall give concrete examples also in the presence of electric currents,

Finally, we briefly discuss the status of topological charges in theories with several types of electromagnetic fields, which appear in the short distance (scaling) limit of asymptotically free non-Abelian gauge theories.

The talk is based on two joint works with D. Buchholz, F. Ciolli and E. Vasselli

1) "The universal C*-algebra of the electromagnetic field" LMP (2016), arXiv:1506.06603 2) "The universal C*-algebra of the electromagnetic field II. Topological charges and spacelike linear fields" . arXiv:1610.03302, it will appear on LMP

10 min. break

MP 6.2 Di 15:05 SFG 2010

The D-CTC condition in quantum field theory — •Rainer Verch — Institut für Theoretische Physik, Universität Leipzig

The D-CTC condition has originally been proposed by David Deutsch as a condition on states of a quantum communication network that contains "backward time-steps" in some of its branches. It has been argued that this is an analogue for quantum processes in the presence of closed timelike curves (CTCs). The unusual properties of states of quantum communication networks that fulfill the D-CTC condition have been discussed extensively in recent literature. In this work, the D-CTC condition is investigated in the framework of quantum field theory in the local, operator-algebraic approach due to Haag and Kastler. It is shown that the D-CTC condition cannot be fulfilled in states which are analytic for the energy, or satisfy the Reeh-Schlieder property, for a certain class of processes and initial conditions. On the other hand, if a quantum field theory admits sufficiently many uncorrelated states across acausally related spacetime regions (as implied by the split property), then the D-CTC condition can always be fulfilled approximately to arbitrary precision. As this result pertains to quantum field theory on globally hyperbolic spacetimes where CTCs are absent, one may conclude that interpreting the D-CTC condition as characteristic for quantum processes in the presence of CTCs could be misleading, and should be regarded with caution. This is joint work with J. Tolksdorf, see arXiv:1609.01496.

MP 6.3 Di 15:25 SFG 2010

Feynman Propagators — •Daniel Siemssen — Department of Mathematical Methods in Physics, Faculty of Physics, University of Warsaw

The Klein-Gordon equation has several interesting and relevant propagators (also called Green's functions or two-point functions), e.g., the forward/backward propagators and the Feynman propagator. In this talk I will discuss an approach to construct propagators on curved spacetimes. This approach can also be applied for non-smooth metrics and when external electromagnetic fields are present. I will then show that in some situations the Feynman propagator can be constructed as the limit of the resolvent of the Klein-Gordon operator. This is closely related to the problem of the self-adjointness of the Klein-Gordon operator.

MP 6.4 Di 15:45 SFG 2010

Superconformal Chern-Simons Mater Theory in Lorentzian Curved Manifolds — •Mojtaba Taslimitehrani — Max Planck institute for Mathematics in the Sciences, Leipzig, Germany

We study the N=6 superconformal Chern-Simons field theory (the ABJM theory) conformally coupled to a Lorentzian, curved background spacetime. To support rigid supersymmetry, such backgrounds have to admit twistor spinors. At the classical level, the symmetry of the theory can be described by a conformal symmetry superalgebra. We investigate the question of self-consistency of this theory which is closely related to the realization of the rigid conformal supersymmetry and local gauge symmetry at the quantum level. By carefully analyzing the relevant cohomology class of a suitable BRST differential in curved space-time, we show that there exists a renormalization scheme in which the full classical symmetries are preserved at the quantum level. This leads to an algebraic proof that the beta-function of this theory vanishes to all orders in perturbation theory.