MP 10: Classical and quantum gravity

Time: Thursday 16:15–17:15 Location: MP-H5

MP 10.1 Thu 16:15 MP-H5

Space - Time - Matter: Finite Projective Geometry as a Quantum World with Elementary Particles — •Klaus Mecke — Institut für Theoretische Physik, Universität Erlangen-Nürnberg

A unified theory for space-time and matter might be based on finite projective geometries instead of differentiable manifolds and fields. In contrast to general relativity the metric is given over a finite Galois field which defines neighbors in the finite set of points. Due to the projective equivalence of all quadratic forms in finite projective geometries this world exhibits necessarily a 4-dimensional, locally Lorentz-covariant space-time with a gauge symmetry G(3)xG(2)xG(1) for points at infinity which represent elementary particle degrees of freedom. Thus, matter appears as a geometric distortion of an inhomogeneous field of quadrics and physical properties of the standard model such as spins and charges seem to follow from its finite geometric structure in a continuum limit. The finiteness inevitably induces a fermionic quantization of all matter fields and a bosonic for gauge fields. The main difference to Einstein's general theory of relativity is the use of finite fields instead of real numbers to parametrize points of events.

K. Mecke, Biquadrics configure finite projective geometry into a quantum spacetime, EPL 120, 10007 (2017).

MP 10.2 Thu 16:35 MP-H5

On consistent gauge-fixing conditions in polymerized gravitational systems — Kristina Giesel[1], Bao-Fei Li[2], Parampreet Singh[2], and •Stefan Andreas Weigl[1] — [1]Institute for Quantum GravityDepartment of Physics, Theoretical Physics III, FAU Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany — [2]Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA 70803, USA

Gauge fixing is a standard method for deriving the physical sector of a gauge theory. In the context of symmetry reduced models of loop quantum gravity a polymerisation has been applied to gauge fixed models to obtain so called effective theories that mimic the underlying quantum theory to some extend. Motivated from the question whether gauge fixing and polymerization commute, in this talk we will discuss the subtleties of implementing dynamical consistent gauge fixings in the effective theory and present a procedure to determine in a given model the effective lapse and shift. Although we can proof for a range of models that gauge fixing and polymerization does indeed commute and discuss consequences, for most models in the literature this is not the case. We further discuss how for a given choice of effective lapse and/or shift one can obtain a corresponding gauge fixing condition and show that in general this requires non-standard polymerisations or gauge fixing conditions with different classical limits. Based on these results we will then conclude with a discussion of some models from the literature.

MP 10.3 Thu 16:55 MP-H5

Local normal forms for Riemannian metrics with infinitesimal symmetries of their pre-geodesics. — •Andreas Vollmer — Corso Duca degli Abruzzi, 24, 10129 Torino TO Italy

Projective vector fields are infinitesimal symmetries that preserve pre-geodesics, i.e. geodesics up to reparametrisation. A classical problem formulated by Sophus Lie is to describe the local metrics that admit such symmetries.

The list of local normal forms in dimension two has only recently been established, by Aminova (1990, 2003), Bryant-Manno-Matveev (2009), Matveev (2012) and Manno-V (2020). In joint work with G. Manno, we have recently derived such a list for dimension three, too (arXiv:2110.06785). The talk will provide an overview of the normal forms and their projective symmetry algebras, and will explain the techniques used to obtain them.