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The Chorogeometrical Structure of Special and General Relativity: a Revisitation of Canonical Geometrodynamics

A. The chronogeometrical structure of special relativity.

The 1+3 and 3+1 points of view. Clock synchronization conventions and their gaugee equivalence. Moller admissible 3+1 splittings of Minkowski spacetime and relativistic non-inertial frames. Radar 4-coordinates and their operational definition. Parametrized Minkowski theories for isolated systems (particles, strings, fields, fluids), the rest-frame instant form of dynamics and its Hamiltonian treatment with Dirac constraint theory. Relativistic kinematics for closed and open systems: centers of mass and relative variables, rotational kinematics, relativistic theory of orbits, Moller radius, multipolar expansions. Darwin and Salpeter potentials from classical electrodynamics of particles with Grassmann-valued electric charges for the regularization of self-energies. Quantum mechanics of scalar and spinning particles in non-inertial frames. The Torre-Varadarajan No-Go theorem for the Tomonaga-Schwinger evolution of scalar fields.

B. The chronogeometrical structure of general relativity.

The double role of the metric tensor. ADM canonical metric and tetrad gravity in non-compact Christodoulou-Klainermann spacetimes with suitable boundary conditions. Dynamical clock synchronization conventions and their gauge equivalence (no Wheeler-DeWitt-Kuchar interpretation). The weak ADM energy as Hamiltonian (no frozen time formalism). Gauge fixings, non-inertial frames and Hamilton equations. The rest-frame instant form of tetrad gravity and its deparametrization to the rest-frame instant form of parametrized Minkowski theories. The Shanmugadhasan canonical transformation: the separation of gauge variables (generalized inertial effects) from the Dirac observables (generalized tidal effects). The Hamiltonian expression of Weyl scalars (the Newman-Penrose formalism) and Bergmann observables. The Hamiltonian linearization of tetrad gravity and post-Minkowskian background-independent gravitational waves in a non-harmonic 3-orthogonal gauge. The inclusion of matter. Towards the 2-body problem in general relativity. Einstein's Hole Argument and the objectivity of spacetime point-events.