

**Igor Khavkine**

ITF, Utrecht

**Time delay observable in classical and quantum geometries**

Authors: I. Khavkine

A class of diffeomorphism invariant, physical observables, so-called astrometric observables, is introduced. A particularly simple example, the time delay, which expresses the difference between two initially synchronized proper time clocks in relative inertial motion, is analyzed in detail. It is found to satisfy some interesting inequalities related to the causal structure of classical Lorentzian spacetimes. Thus it can serve as a probe of causal structure and in particular of violations of causality. A quantum model of this observable as well as the calculation of its variance due to vacuum fluctuations in quantum linearized gravity are sketched. The question of whether the causal inequalities are still satisfied by quantized gravity, which is pertinent to the nature of causality in quantum gravity, is raised, but it is shown that perturbative calculations cannot provide a definite answer. Some potential applications of astrometric observables in quantum gravity are discussed. [arXiv:1111.7127]