The macroscopic world around us looks smooth and deterministic. These features are accurately captured in the classical theory of Einstein's relativity. On the other hand, we know that at the atomic scale the objects reveal their peculiar quantum nature and the smooth picture breaks down. However, even in quantum mechanics, the spacetime itself remains classical – i.e. objective and 'absolute'. But what would happen if one would be able to probe the World at very small scales, some 20 orders of magnitude below the nuclear regime?

There exists strong theoretical arguments suggesting that in such an extreme regime the spacetime itself would exhibit quantum properties. On the operational level, it means that one cannot measure objects' localisation in spacetime with an arbitrary precision. Such a viewpoint raises deep fundamental questions about the nature of space, time, causation and information.

There exists a plethora of theoretical models of 'quantum spacetime' leading to different concepts of these fundamental physical notions. Within the proposed project we will concentrate on a particular model of 'quantum spacetime' founded on the advanced mathematics of noncommutative geometry and study its implications on the processing of information. To this end we will draw from several domains of mathematics ranging from functional analysis to differential geometry.

We expect that the quantum nature of spacetime would enable processing devices not available in the classical framework. Within the developed framework we will challenge the foundational results of information processing, in particular related to the superluminal transfer of information and quantum entanglement. We aim at constructing concrete protocols suitable to discern the subtle effects of the spacetime's fine structure.

We believe that the proposed project will further our understanding of the fundamental laws of Nature and the underlying mathematical structures. Moreover, having in mind the recent expeditious progress in turning the abstract theorems of quantum information into actual technologies, one may regard this project as a trail-blazer towards a completely new kind of devices.