One of the most important unsolved problems in the contemporary theoretical physics is to understand how to quantize gravity – in other words, how to construct the quantum theory of gravity (more briefly called quantum gravity). The methods that have been applied successfully to the quantization of other fundamental interactions – electromagnetic, weak nuclear and strong nuclear – do not work in quantum gravity case. However he quantum effects of gravity are still beyond the reach of contemporary observations, the growing precision of astrophysical measurements suggests that we are now close to successful new observations which can be used in order to orient properly the theoretical studies.
At present researchers developed different approaches to the construction of quantum gravity, based on various assumptions and to some extent covering various aspects of the future complete theory. Among these approaches, we may distinguish the ones in which the quantization of gravity is attempted without a priori modifying the classical description of spacetime. The approach that is more progressive, and which we will follow, is to implement in quantum gravity the essential feature of quantum physics, namely the noncommutativity of observables, and the employment of results obtained in the framework of mathematical methods in non-commutative geometry. Following such ideas, we postulate that in the presence of quantum gravity effects the space-time geometry is inherently noncommutative. From phenomenological point of view, the noncommutativity implies that the points of spacetime are fuzzy, with their coordinates, due to the Heisenberg uncertainty relations, not measurable with an arbitrary accuracy. In present project we study the consequences of such assumptions. The noncommutativity of quantum space-times, quantum phase spaces and the use of their quantum - deformed symmetries as noncommutative counterpart of classical symmetries are our basic hypotheses. The role of theoreticians in such approach is to investigate such new models, but as well to provide the suggestions which are linked with physical implications of quantum noncommutative geometry and quantum symmetries.

The project is composed of three research tasks, each of which is devoted to the extension of our knowledge about the models of noncommutative quantum space-times and quantum phase spaces. We plan to study different algebraic structures used in the construction of such models. These tasks are: spinorial and supersymmetric generalizations of Snyder and Young models, description of new examples of Hopf algebroids which describe the algebraic structure of quantum-deformed phase spaces and finding new deformations of five-dimensional quantum rotations, in particular providing the description of quantum D=4 de-Sitter and anti-de-Sitter spaces.

In the project we propose the theoretical research, based on mathematical models of noncommutative geometry and we will perform calculations done either by hand or with a support of computer software for symbolic computations. The individual research tasks in the project are linked with each other, all of them aimed at contributing to the construction of quantum gravity model based on noncommutative quantum geometry.