A SHORT DESCRIPTION OF THE PROJECT

The project focuses on finite geometries (over rings) – a newly emerged intriguing link and unifying platform between at first sight so different domains of physics and chemistry as quantum information theory, chemistry of coupling and stringy black holes.

As per the first domain, we aim, on the one hand, at extending our unified finite-ring-geometrical theory of the generalized Pauli group of a single qudit to the case of multiple qudits of an arbitrary rank and, on the other hand, at ascertaining which geometrical and combinatorial aspects of the projective ring lines directly relate to entanglement in a given quantum system and can provide its quantitative measure. In the second domain, we intend to put forward first rudimentary discrete models of chemical bonds that are fully devoid of divergences and degenerations exhibited by continuous models. As a subsequent step, we plan to explore the finest traits of hierarchical properties of chemically coupled systems, with a particular focus on a gradual disappearance of the boundary between individual building blocks, and, hence, of the dichotomy "the object and its surroundings." Concerning the third domain, we would like to inspect which finite geometries underlie the (already known and yet to be unveiled) relations between black-hole entropies and entanglement invariants characterizing multi-qubit/qudit systems. A particular attention will be paid to the role of the Fano plane and its recently discovered non-unimodular "Snowflake" generalizations, generalized polygons of small order (in particular the split Cayley hexagon of order two), and biplanes of small order (especially those of order three and nine).

The main outcome of the project should be: a virtually complete finite-geometrical theory of the commutation algebra of the generalized Pauli groups associated with arbitrary multiple qudits; a fundamental finite-geometrical insight into the intricacies of chemical couplings and hierarchical systems of molecules; and a deep observable-based understanding of the so-called black hole analogy and a wealth of black-hole clues for understanding the quantum entanglement in geometrical terms.