Project Title:
Finite (Ring) Geometries: Where Qudits Meet Black-Holes

Abstract
It has often happened that two completely different areas of theoretical physics shared the same mathematics. This might have been just a pure coincidence, or the manifestation of the fact that the two were, in fact, dual descriptions of the same physical phenomenon. Either way, this frequently led to new insights in both areas. Our project focuses on finite geometries (over rings) – a newly emerged intriguing link between at first sight so different domains of physics as quantum information theory and stringy black holes. As per the former 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. Concerning the latter 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, with a particular focus on the role of the Fano plane and its very recently discovered (arXiv:0803.4436) "Snowflake" generalizations. 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 and a wealth of black-hole clues for understanding quantum entanglement in geometrical terms.