Book of Abstracts

Quasiprobability distributions in quantum mechanics, optics and information

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University of Milan

Jack Davis (INRIA - ENS Paris)

Identifying quantum resources in encoded computations

Universal quantum computation relies on error-correcting codes to protect fragile logical quantum information by robustly encoding it into symmetric states of a quantum physical system. Such encodings make the task of resource identification difficult as what constitutes a resource from the logical and physical points of view can differ significantly. Here we introduce a general framework which allows us to correctly identify quantum resources in encoded computations, based on phase-space techniques. For a given quantum code, our construction provides a Wigner function that accounts for how the symmetries of the code space are contained within the transformations of the physical space, resulting in an object capable of describing the logical content of any physical state, both within and outside the code space. We illustrate our general construction with the Gottesman-Kitaev-Preskill encoding of qudits with odd dimension. The resulting Wigner function, which we call the Zak-Gross Wigner function, is shown to correctly identify quantum resources through its phase-space negativity. For instance, it is positive for encoded stabilizer states and negative for the bosonic vacuum. We further prove several properties, including that its negativity provides a measure of magic for the logical content of a state, and that its marginals are modular measurement distributions associated to conjugate Zak patches.

Stephan De Bievre (Université de Lille)

On the geometry of the Kirkwood-Dirac positive states

In this talk we present recent results on the (perhaps surprisingly) rich geometry of the convex set of quantum states that have a positive Kirkwood-Dirac (KD) distribution. We will, on the one hand, identify conditions under which this set is a minimal and simply described polytope with known vertices. On the other hand, we show that this set of KD positive states may contain extremal states that are not pure. This latter phenomenon also occurs for the Wigner function, where the equivalent identification problem remains only partially understood.

Nuno Dias (University of Lisbon)

Some topological properties of the sets of non-negative Wigner functions

The set of non-negative Wigner functions is a convex set which, in the finite dimensional case, is compact and equal to the convex hull of its extreme points. Thus, in finite dimensions, these particular (extreme) Wigner functions can be used to generate the entire set of non-negative Wigner functions. We show that the extreme Wigner functions can be identified by the properties of their null sets, and discuss the problem of constructing these states explicitly. As a by-product, we also elaborate on the properties of the interior and the boundary of the set of non-negative Wigner functions. Finally, if time permits, we will discuss the difficulties of extending some of these results to the infinite dimensional case.