Quantum Physics

The Lie Algebraic Significance of Symmetric Informationally Complete Measurements

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Examples of symmetric informationally complete positive operator valued measures (SIC-POVMs) have been constructed in every dimension less than or equal to 67. However, it remains an open question whether they exist in all finite dimensions. A SIC-POVM is usually thought of as a highly symmetric structure in quantum state space. However, its elements can equally well be regarded as a basis for the Lie algebra gl(d,C). In this paper we examine the resulting structure constants, which are calculated from the traces of the triple products of the SIC-POVM elements and which, it turns out, characterize the SIC-POVM up to unitary equivalence. We show that the structure constants have numerous remarkable properties. In particular we show that the existence of a SIC-POVM in dimension d is equivalent to the existence of a certain structure in the adjoint representation of gl(d,C). We hope that transforming the problem in this way, from a question about quantum state space to a question about Lie algebras, may help to make the existence problem tractable.

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