A. K. Das, S. Mukherjee, D. Saha, D. Das, A. S. Majumdar, Operational approach to classifying measurement incompatibility

Referee report

This paper introduces and studies some notions of incompatibility of sets of quantum measurements, capturing the property that the measurements in the set remain incompatible even after undergoing some classical transformations. Namely, these transformations are coarse grainings and some specific convex mixtures combined with permutations of the outcomes. Noise robustness of such properties is considered and some operational witnesses are proposed, both device independent and semi-device independent.

Overall evaluation

The introduced variants of incompatibility properties are quite natural and as far as I know where not studied before in this form. A similar notion appearing in the literature is incompatibility of some subsets of the given set of measurements. The incompatibility w.r. to convex mixtures introduced here is a generalization thereof. So the topic of the paper is timely and of interest.

Unfortunately, in my opinion, there is not much information gained about the introduced notions. Already the choice of the two types of classical operations is not sufficiently explained. As for the coarse grainings, it is clear that the set of measurements with the specified property remains incompatible even if some measurement outcomes are not distinguished, which is a good robustness property to have. But one can think of other choices of post-processings of the measurements. Similarly, one could consider more general convex mixtures of the measurements, not just given by partitions of the measurement set. I think the authors should include more comments about these choices.

For the defined notions, there are some rather trivial observations and partial results in special cases or for specific examples, such as qubit measurements or MUBs, but these are obtained by standard methods and it is not clear what conclusion the reader is to make. For example, concerning the noise robustness, two tables of results obtained by SDP for 3- and 4-dimensional MUBs are presented, but no discussion or interpretation of these values is given. The operational witnesses suggested here are based on well known results for Bell experiments or RACs. Their applicability to the present notions is an interesting (albeit easy) observation made here, but the investigation of their performance is very limited. In any case, I do not think it is justified to write that "...we have developed a method of operationally witness different levels of measurement incompatibility...." as the authors claim in the concluding section.

In conclusion, the authors introduced interesting notions of incompatibility for a set of measurements, but their analysis of these notions is not yet sufficient for publication.