Converting nonlocality into contextuality (and back)

http://tph.tuwien.ac.at/~svozil/publ/2023-QIP24-pres.pdf

Karl Svozil

Institute for Theoretical Physics, TU Wien
svozil@tuwien.ac.at

Wednesday, 12 June 2024, Quantum Information and Probability: from Foundations to Engineering (QIP24), Växjö, Sweden

Five types of contextuality: 1–3

- Kochen-Specker all-out contextuality (1967, DOI 10.1512/iumj.1968.17.17004) — complete absence of two-valued states interpretable as classical, binary true-false valu(e)[ation];
- Nonseparability (wrt two-valued states) of vertices — cf KS "demarcation criterion" Theorem 0, Γ_3? — "does anybody care"? I think not!
- "Hardy-Type" ones, such as TIFS and TITS, as exposed already by the KS "bug" (1965, DOI 10.1007/978-3-0348-9259-9_19) two years before their "major paper", which is a TIFS; their Γ_1 is a TITS by an extension of the but TIFS;

Five types of contextuality:: 4,5

- Boole-Bell type violations of classical inequalities stemming from non-independent, non-separable quantum properties – those violate classical predictions relative to the assumption of classical independent existence — cf Froissart (1981, DOI 10.1007/BF02903286) and Pitowsky (1986, DOI 10.1063/1.527066); eg, CHSH (4 disconnected contexts) or intertwining contexts (aka orthonormal bases) Svozil (2001, DOI 10.48550/arXiv.quant-ph/0012066) Specker bug, KLyashko (2008, DOI 10.1103/PhysRevLett.101.020403) pentagon/gram/house;
- GHZ Mermin type parity type proofs within a single context (more on this later).

Are there more?

Are there more? Please let us know!

Challenges to space-time formation for "non-localized" contextuality cntd.

Imo this kind of "transfer of relationality without individual definiteness" by a "transfer of entanglement" between spacially separated under strict Einstein locality conditions, is the gist of the conundrum.

Recall that classical states, as for instance pointed out by Peres in "unperformed experiments have no result", perform relationally by possessing definite local shares, which are revealed by measurements, and, therefore, result in (perfect) relational correllations.

(Even cosine-type correlations are insufficient; but communication of contexts are.)

Challenges to space-time formation for "non-localized" contextuality cntd.

In my opinion, as speculated earlier, in order to reasonably categorize space-time (frames) we need to take quantum mechanics as primary, and develope and operationalize space-time frames entirely by quantum means.

This is different from Kantian conceptualizations of space-time as "intuited a priori".

As a consequence we need to observe what, in quantum terms, may be considered separate, and what not.

I postulate that constituents in entangled states as well as measurement outcomes on such states cannot be considered separate.

Challenges to space-time formation for "non-localized" contextuality cntd.

Therefore, at least in the entangled observables, the constituents are not spatially separated at all: in other words, for such "affected" observables, spatial distances shrink to zero.

This does not necessarily mean that with respect to other observables of these constituents, the separation is zero.

In this view spatial separation is means relative, and thus space-time frames are means relative with respect to the quantum shares involved.

Suggestions for a new protocol of clock synchronization

For entangled shares I therefore suggest to abandon Einstein clock synchronization by exchanges of (light) signals.

I suggest to employ a Bennett-Brassard-Eckert-type protocol utilizing random outcomes of entangled multi-partite states as a time standard. Thereby, local entangled time is successively made precise and generated by the correlated outcomes of entangled states.

As a result, relativity theory is "relativized" further by into a multitude of means relative "patches" of space-time (frames).

Thank you for your attention!