Opponent's Review of the Bachelor's Thesis

Michal Slouka:

Reichenbach's Common Cause Principle

The Reichenbach's Common Cause Principle (RCCP) says, roughly, that if there is a correlation between two events without any direct link then there is a third event that is a common cause of the correlation. Making no steps into troubled waters of philosophical debates (leaving a certain room to the author to comment on...), let us restrict ourselves to the technical side of the thesis. A quantum logic formulation agreed on by several physicists reads as follows :

Definition 0.1 (Common cause in non-classical probability theory) *Let $\mathcal{L}$ be an* ***orthomodular lattice****, let μ be a* probability measure *on $\mathcal{L}$ and let $a, b, c \in \mathcal{L}$ be such that a commutes with c, b commutes with c and $0 < \mu(c) < 1$. Then we say that c is the* common cause *of a and b when the following conditions are satisfied:*

$$\frac{\mu(a \wedge b \wedge c)}{\mu(c)} = \frac{\mu(a \wedge c)}{\mu(c)} \frac{\mu(b \wedge c)}{\mu(c)},$$

$$\frac{\mu(a \wedge b \wedge c^{\perp})}{\mu(c^{\perp})} = \frac{\mu(a \wedge c^{\perp})}{\mu(c^{\perp})} \frac{\mu(b \wedge c^{\perp})}{\mu(c^{\perp})},$$

$$\frac{\mu(a \wedge c)}{\mu(c)} > \frac{\mu(a \wedge c^{\perp})}{\mu(c^{\perp})},$$

$$\frac{\mu(b \wedge c)}{\mu(c)} > \frac{\mu(b \wedge c^{\perp})}{\mu(c^{\perp})}.$$

The author first shows that the above axioms of RCCP are independent. Then he constructs an intuitive non-Boolean example for RCCP to hold. Main results are contained in Chapter 3. He corrects and economizes several results published, often quite carelessly, by known physicists. This is a piece of relatively mature mathematics with a potential for a publication. The results shed new light on the hitherto known main result on this formulation of RCCP.

Theorem 0.2 *Let $\mathcal{L}$ be an orthomodular lattice and a, b, c be elements of $\mathcal{L}$, and, moreover, let a commute with c and b commute with c. Let $\mathrm{cov}(a, b) > 0$. Let μ be faithful and let μ satisfy the Darboux property (resp. let $\mathcal{L}$ be complete and atomless). Then there is a common cause for a, b and c.*

At the end the author finds a counterexample to a conjecture published in *Int Journ Theor Phys*, 2015.

The author contributes to RCCP. He has shown the ability to cope with the complicated calculus of the orthomodular lattices. I find his thesis valuable and therefore I asses it by **A (excellent)**.

Prague, June 4, 2023 Prof. RNDr. Pavel Pták, DrSc.