The lapse of time in time loops and cyclic temporal logic

Denis I. Saveliev

Gödel's pioneer work stating possibility of closed timelike curves posed various questions, some of which concern acceptability of such common concepts as the lapse of time. Gödel himself wrote [1]:

> ...in whatever way one may assume time to be lapsing, there will always exist possible observers to whose experienced lapse of time no objective lapse corresponds... But if the experience of the lapse of time can exist without an objective lapse of time, no reason can be given why an objective lapse of time should be assumed at all.

and also

> ...if someone asserts that this absolute time is lapsing, he accepts as a consequence that whether or not an objective lapse of time exists (i.e, whether or not a time in the ordinary sense of the word exists) depends on the particular way in which matter and its motion are arranged in the world. This is not a straightforward contradiction; nevertheless, a philosophical view leading to such consequences can hardly be considered as satisfactory.

We argue that this conclusion is based on an implicit understanding time as ordered, and that the concept of lapsing time can be repaired by understanding time as endowed by a certain ternary relation, which turns out to be a cyclic order on time loops. A similar view may be applied to the concept of causality where a binary relation between a cause and its consequence should be replaced a ternary relation. Specifically, we propose a modal logic of cyclic time involving a binary modality and establish soundness and completeness results.

References

[1] K. Gödel, *Collected Works*, vol. II, III, Feferman et al. (eds.), Oxford University Press, 1995.