

Causality violating lightlike trips in Gödel's universe

Brien C. Nolan

*Centre for Astrophysics and Relativity, School of Mathematical Sciences,
Dublin City University, Glasnevin, Dublin 9, Ireland.*

We revisit the issue of causality violations in Gödel's universe, restricting to geodesic motions. It is well-known that while there are closed timelike curves in this spacetime, there are no closed causal geodesics. We show further that no observer can send a signal directly to their own past. However, we show that this type of causality violation can be achieved by a system of relays: we prove that from any event P in Gödel's universe, there is a future-directed *lightlike trip* - a sequence of future-directed null geodesic segments, laid end to end - which has P as its past and future endpoints. We show that this lightlike trip must contain a minimum of eight geodesic segments. We prove a related general result, that events of a time orientable spacetime are connected by a causal curve if and only if they are connected by a lightlike trip. This provides a means of violating causality in Gödel's universe without the need for unfeasibly large accelerations. Finally, we consider the motion of a gyroscope on Gödel's closed timelike curves and argue that this motion is intrinsically contradictory.