A Causal-Temporal Model of Discrete Time

research@nodem.info

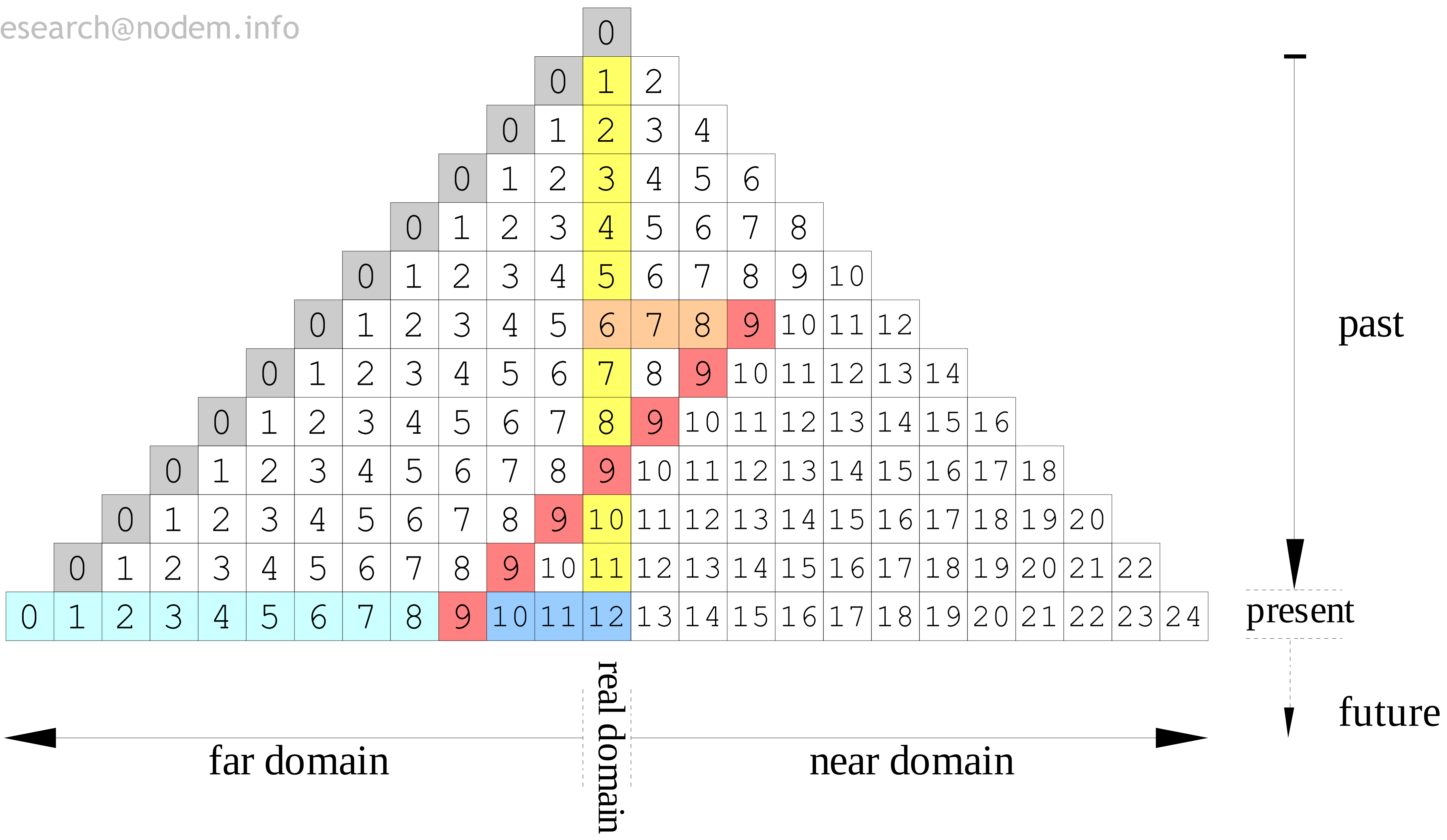


Fig 1 • **Causal-Temporal Discrete Time** • The model extends by one line per step (temporal evolution) and each new line extends by one cell per step (causal evolution). The observer is always located in the present-real domain; after $\boldsymbol{t}$ temporal steps, the causal structure extends $\boldsymbol{t}$ cells into the near and far domains.

Einstien cemented the four dimensional space-time continuum into the foundations of contemporary cosmological models with his highly successful General Theory of Relativity. Sometimes referred to as the *block universe*, this solid view of time affords equal ontological status to every point in time; past, present and future. This obviously deterministic description of time has had great success in classical theories, but by no means does it represent a complete or, in the context of quantum theories, even a useful description of time.

We propose that neither the past or future exist, the only ontological state is the present. However, as observers, our only access to the universe is a purely epistemological one. We can only access information about the past, and only in the form of records that exist in the present; the unrecorded past is irretrievably lost. We also propose that the universe is fully non-deterministic: there is no initial condition and no pre-determined future. Every possible future state of the universe is given an equal weighting, but not given any ontological status.

When we examine the past evolution of the universe we must do so from a specific defined instant in time. Our observation of the past is thus referenced to a universe with a predetermined constant age $t_\circ$; as we look back from here, we essentially examine the causality leading from a state of zero entropy, up to finite time $t_\circ$. We can define causality as an entirely new concept of time, independent from the conventional temporal notion of time. Temporal time breaks down into three states: past, present and future. We will also break down causal time into three domains: near, real and far. Our point of observation will now have both temporal and causal components – *at the present state, in the real domain*.

Since we define an instant in time, we must make time discrete. There will be a minimum division of time, which we shall define as $t_\bullet$. Dividing a measurement of time by $t_\bullet$ results in a dimensionless natural number $\boldsymbol{t}$ (discrete *natural* time).

Information from spatially separated points arrives in the real domain at the present time. This snapshot of data is represented causally in the far domain, where the real domain is located at the oldest point. The distant events exist in the near domain, but ahead of the time at which they generated the data. The real domain is thus located at the youngest point of the near domain, such that the total distant between near and far events is twice the distance from real to far. A connection between a near and far event propagates at a constant rate of one causal cell per temporal step, similar to a *mobile automaton* (Turing machine). The observer's choices in the real domain, select events in the near domain, which propagate into the far domain.

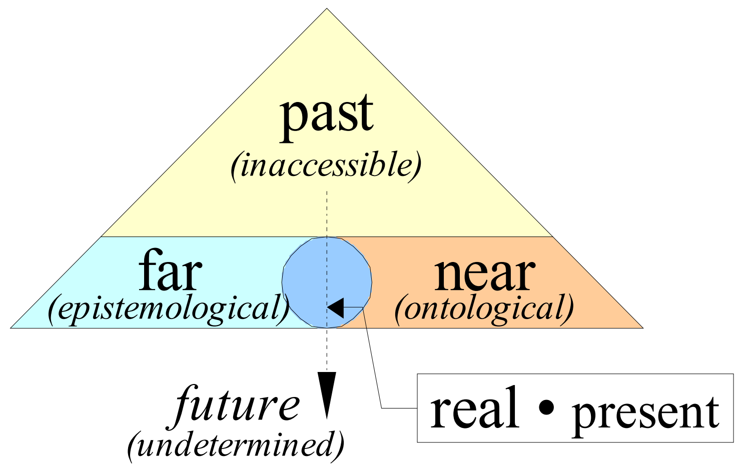


Fig 2 • **Causal Domains** • The observer is always located in the blue circle (real domain, present state). Distant events appear in the far domain (cyan), but actually exist in the near domain (orange).

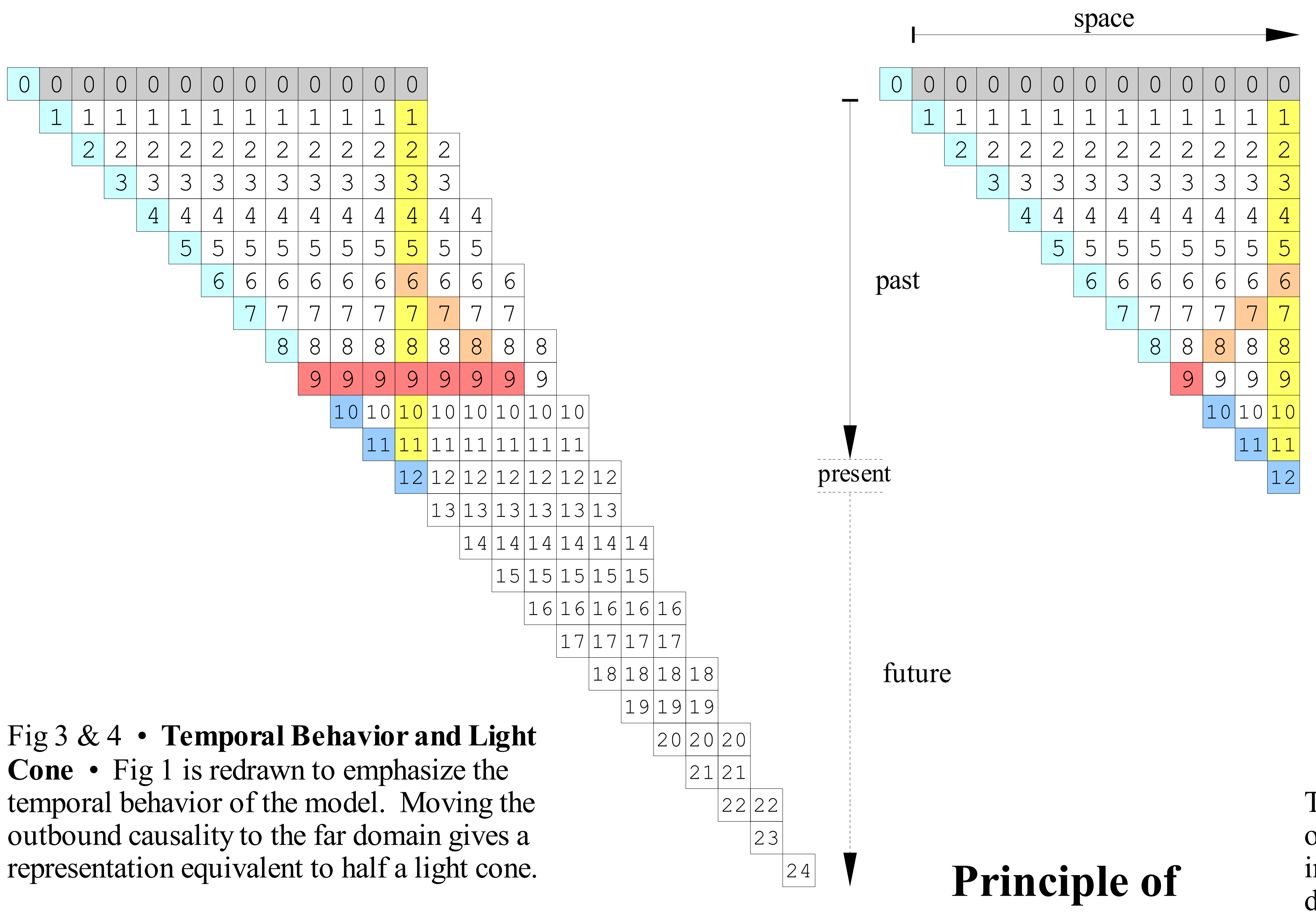
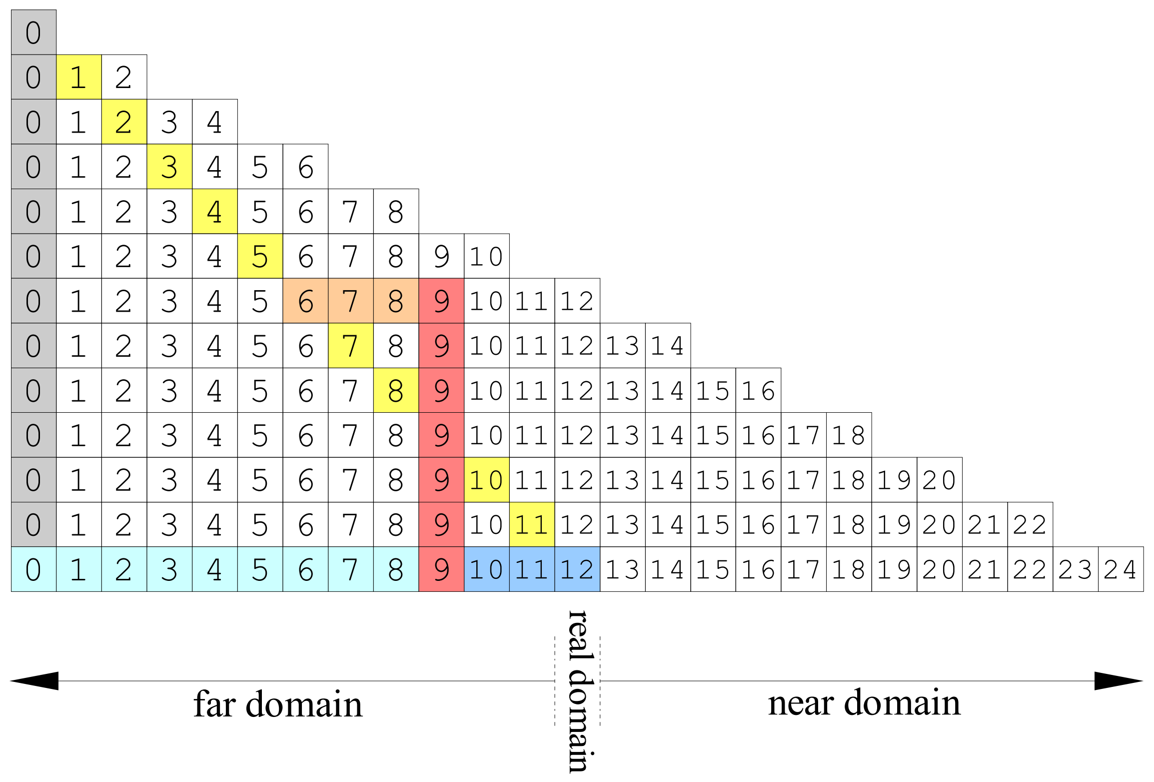


Fig 3 & 4 • **Temporal Behavior and Light Cone** • Fig 1 is redrawn to emphasize the temporal behavior of the model. Moving the outbound causality to the far domain gives a representation equivalent to half a light cone.



Principle of Simultaneity

Since the temporal and causal behavior diagrams in figs 3 & 7 are simply the same model in fig 1 redrawn differently, then both types of simultaneity are exactly equivalent:

No physical observation can be made, or experiment designed, that will prove the universe operates according to the principle of temporal simultaneity at the exclusion of causal simultaneity, or vice-a-versa.

Simultaneity: *n.*

Happening, existing, or done at the same time.

[The American Heritage ® Dictionary of English Language, Fourth Edition Copyright © 2000 by Houghton Mifflin Company.]

We will set up an example where two observers synchronize two clocks and then separate from each other by a distance of 1 A.U. (we assume the same inertial frame and zero gravity, so relativistic effects can be ignored). The first observer is on Earth and reads a time of midday. We now inquire about the second observer located at the Sun. If we observe the distant clock from the Earth, it displays a time of 11:51:41. We fully expect a delay in the transmission of information related to the light travel time, which for a conventional distance of 1 A.U. is 8 minutes 19 seconds (499 seconds).

So what time ***is*** *it on the Sun?*

Temporal Simultaneity

This is the conventional concept of simultaneity and is outlined in detail by the first section of Einstien's Special Theory of Relativity. Temporal simultaneity implies that when one synchronized clock reads midday, then so does the other (regardless of spatial separation). However, we must assume this, since to *know* it would involve the existence of an instantaneous communication channel between two spatially separated points. Since the clock correctly reads what we would expect for an observation from a distance of 1 A.U, then the conventional concept of distance tells us that temporal simultaneity is correct. However, we have defined the *conventional* concept of distance, based on the concept of temporal simultaneity, and not the other way round. This results in an un-warranted bias towards this kind of simultaneity.

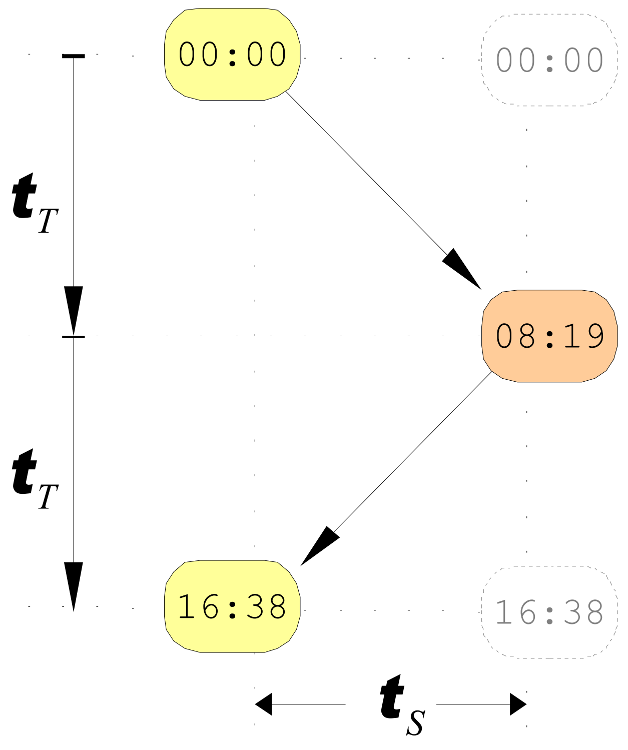


Fig 5 • **Temporal Simultaneity** • A signal leaves the Earth at midday and arrives at the Sun at 12:08:16. The signal returns to the Earth and arrives back at 12:16:38. Both synchronized clocks would always read the same time, as if the universe had an observer independent global present moment.

Instantaneous Causality

The concept of causal simultaneity implies that the outbound transmission of information is instantaneous. Let us assume that an explosive device was installed near the Sun, such that a signal transmitted from the Earth would detonate the device and destroy the Sun. We will also assume that a second party is located next to the device, but is unaware of its explosive potential. To the surprise of everyone involved, the detonation signal is accidentally transmitted from the Earth.

The question is: *Now* that the signal has been sent, can the consequences be avoided?

Even though the outcome is not fully determined, the causality is *completed* as soon as the signal is transmitted. There is no physical mechanism available to inform the second party to disarm the device *before* the signal *arrives*. We still have to wait 16 minutes 38 seconds to find out if the sun really did blow up, but any detonation effectively occurs the same *instant* the signal is transmitted.

Causal Simultaneity

This concept of simultaneity sets the speed of light as the absolute limit for the transmission of information. There is absolutely no meaningful concept of velocity above the speed of light, so in a relative sense, the speed of light is infinite. If we were to travel from the Earth to the Sun at the speed of light, our journey would feel instantaneous even though we arrive 8 minutes 19 seconds *later*. The concept of causal simultaneity treats this journey as *truly* instantaneous; so that when the clock on the Earth reads midday the synchronized clock on the Sun reads 12:08:19. We now have a subtle change in the conventional concept of *locality*: There is no concept of spatial distance for an outbound signal – it effectively travels an infinite distance in zero time. However, the inbound signal does travel at the speed of light, but effectively travels twice the conventional distance. The entire journey for a round trip signal is inbound, so the total journey is twice the conventional one way journey.

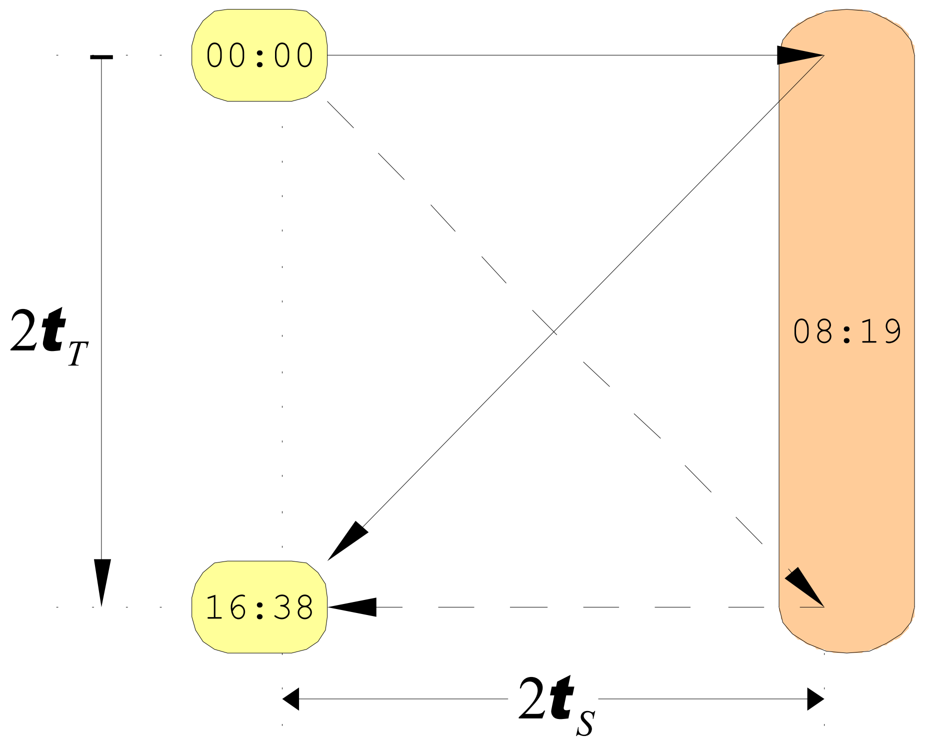


Fig 6 • **Causal Simultaneity** • A signal leaves the Earth at midday and travels instantaneously to the Sun, where a synchronized clock reads 12:08:19. Relative to the Sun at this time, the synchronized Earth clock reads 12:16:38. Only inbound distance in meaningful.

Alastair J. Hewitt • “NKS2004 Poster Presentation” • nodem info. Sys. • 4.23.2004 • http://nodem.info/nks004