On the proper definition of a clock

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1. What is wrong with using a system moving in uniform motion as a clock?

The first principal objection is that the language itself is circular. One might start with a ribbon on which marks are laid off every 5 miles, and a particle hurtling forward at any sort of combination of acceleration, and conclude, by fiat, that this *is* the standard for "uniform motion"

Then, since, in pre-relativity physics, there is no metric relating time to spatial length, they do not combine to form a geometry, that is to say a continuum subject to a rotation group which is this case is the Poincare-Transformation Group. This being the case, there is no apriori way to lay

off a series of equal durations against a series of equal lengths (Another way of restating what has been said in the previous paragraph).

Finally, a "clock" based on the uniform motion of a system, S, fails to be a clock in it's own reference frame. One should demand, at last, that a "clock" function non-trivially in the frame of the center of gravity of its apparatus. This is not true for a particle or system in uniform motion against some other system.

Superficially it might appear that a system consisting of a single particle moving at some fixed velocity relative to a fixed observer, could be employed as a clock. Markers set along its path at equal intervals could also record the passage of this particle at successive moments of time.

This would seem to contradict a condition for a well-defined clock, that its state variables are all periodic at the same period and that the measurement of time must be of necessity discrete (at the period points) rather than continuous, as is the case with ruler.

This misunderstanding is due to the automatic assumption made by almost everyone that there must be some innate metric connecting space and time (there is one, infact, based on the Principle of Relativity; all considerations evoked here are pre-relativistic)

Uniform linear motion without relativity is a fiction. Historically, the "geometry" of space-time has always been affine rather than metric. Positing a truly uniform motion across all of space implies that one already knows the energy potential at every point on a straight length of infinite length.

In the real universe, any particle moving through space will encounter gravitation and other forces, collisions, dust clouds and so forth. That it should be otherwise would imply that this trajectory or its surrounding space, is causally detached from all other points of space-time, that is to say, that it is not actually a part of space-time.

"Uniform motion" is at best a local approximation. Far more reasonable in defining the requirements for a clock, some device for measuring time, is the following assumption:

(1) If C is a clock, with period π , then all state variables, *including location,* return to their initial values in time π. This is equivalent to:

(2) If C is a clock, then it returns in time π, to the identical configuration relative to its center of gravity.

When C is simple a stationary lump of matter, then the period is 0, which is the same as saying that it cannot provide a measure of motion, (Aristotle's definition of time)

It is also reasonable to require that clock itself be contained within some finite volume. If, then, a clock apparatus be constructed within a laboratory, or is defined as a system in isolation within some finite region of space, then the clock can move within this region or box, but must return to is original configuration in time, π.

We now propose that the notion of the possibility of "uniform motion" be replaced *by the existence of some time-independent potential energy* at every point in space. Then, every time a periodic machine cycles back to its initial position, it will retrace the identical trajectory with all the identical velocities and accelerations of its first orbiting. All that has happened is that the potential energy of space enters at one of the state variables of the initial configuration. In particular, it will always recycle in identical durations in time.

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Given these assumptions, I feel confident in asserting the validity of all the basic temporal paradoxes in my series of papers on time in Ferment Magazine.

http://www.fermentmagazine.org/time.html

To wit:

I. **Let C be a finite collection of clocks in a universe lacking the postulate of relativity. Then it is not possible to construct (by** concatenation or other means) from C a clock that will pulse at a period $k\pi$, where π is the smallest of all the periods, and k is some pre-determined fraction ($k = \frac{1}{2}$ for example) save by accident or trial and error.

II. Likewise, given clocks C_1, C_2 with periods π_1, π_2, one cannot, using this system alone, construct a clock with period $\pi_3 = \pi_1 - \pi_2$.

III. Given clocks C_1, C_2, with periods π_1, π_2 where neither is a subperiod of the other, it is impossible to construct, using C_1 and C_2 alone, a clock that "couples" C_1 and C_2, a clock C_3 whose with period $\pi_3 = \pi_1 + \pi_2$ is the sum of p1 and p2, by attaching the terminal point of C1 with the initial point of C2 (save by accident or trial and error).

IV. Generalizing: Given clocks C1, C2, C3 … Cn, with periods $\pi 1$, π_2,… , $\pi\nu$ such that no period is equal to a linear combination,

$L = a1C1+a2C2+\dots.anCn$, where the a_i are positive or negative integers, or 0, then one cannot construct a clock with period L, without going outside the system.

To understand assertion II, imagine trying to build a clock C_3, whose period is the difference of clocks, C_1 , C_2. One has to "guess" the temporal location inside the cycle of C1 in which to place the initial starting point of C2, and this cant be done without allow for time reversibility, which we have excluded.

To understand assertion III, one has to start clock C1, then "guess" the time it completes its period, so that one can couple clock C2 to it. After that one must again "guess" the period of C2, so that one can complete the total cycle $\pi_3 = \pi_1 + \pi_2$.

IV is simply the repeated application of II and III

V. Unlike the situation with respect to rulers, one cannot use a Euclidean algorithm process to construct a clock with the common period p′ , of two periods p1 and p2. Nor, as is the case

with lengths in 3-space, use a compass to make a geometric construction cutting off a segment kl of a line of length l, where k is a pre-determined rational number.

The ability to use the Euclidean algorithm for spatial lengths l1, l2, to successively cut off "remainders until a common length is found, depends upon the reversibility of motions in space.