The Concept of Invariant Time-Intervals

The concept of invariant time-intervals is illustrated in the following two Tables. Table 1 gives counts of emissions for successive intervals of time in the decay of a notional radioactive substance with a half life just under 8 seconds. The count during the first second is, say, 10 000 as measured with a stopwatch calibrated in SI units of time-interval on Earth. This number decreases exponentially with time, until after 10 sec it is only 4 066, and the cumulative count is 66 424. The count of 66 424 corresponds to an elapsed time of 10 sec.

Table 1. Possible Differences of Time-interval between Earth and α-Centauri

Consecutive Time-intervals (sec)	Emission Count during Time-interval	Cumulative Count	Elapsed Time on Earth (SI units)	Elapsed Time on α – Centauri (electromagnetically defined 'seconds')
1	10 000	10 000	1 sec	0.9
2	9 048	19 048	2 sec	1.8
3	8187	27 235	3 sec	2.7
4	7408	34 643	4 sec	3.6
5	6703	41 346	5 sec	4.5
6	6065	47 411	6 sec	5.4
7	5488	52 899	7 sec	6.3
8	4966	57 865	8 sec	7.2
9	4493	62 358	9 sec	8.1
10	4066	66 424	10 sec	9.0

The last column shows the possible effect of space and time. The SI unit of time-interval, the second, is in effect defined in electromagnetic terms. However, if an electromagnetically defined time-interval is of different duration at different times and in different places in the Universe, as is suggested by quoted observations, it may be that an electromagnetically measured time-interval on α-Centauri is longer than its equivalent as measured electromagnetically on Earth. A possible cause of this might be the electromagnetic environment.

If for the sake of argument an Earth second is only 0.9 of the duration of an α-Centauri 'second', then on α-Centauri elapsed time will accumulate more slowly than the count, because although the indicated elapsed-time is dilated by the change of location, the decay phenomenon is not affected. A count of 66 424 will therefore occur in only 9 electromagnetically defined 'seconds' on α-Centauri. Moreover, the ratio may itself oscillate over time.

Even if this is a gross exaggeration of any likely effect, it presents a mounting problem over long periods and distances for the computation of times, positions, distances, velocities, accelerations etc, as well as the use of all the other parameters which are defined using seconds on Earth, including radioactive decay 'constants'. In the example the discrepancy is shown by the comparison of the local elapsed time with the emission count. In the absence of such a count i.e. just relying on electromagnetic definitions of time-interval, the difference would remain hidden.

In fact you do not need to go to α-Centauri to detect such an effect. The satellites of the GPS system operate on a different time i.e. seconds are of a different duration from that of the SI unit as defined on Earth, and this has to be corrected for in calculating distances, and hence positions. This is a good reason for continually refreshing times on space craft with times transmitted from the control centre.

There is a more mundane example from railway history. When hours and minutes, and hence seconds, were calculated on a daily basis from noon to noon using the standard defined ratios of 24:60:60, they all varied in duration, because the length of a day calculated in this way, in effect by the Earth's planetary motion, oscillated about a mean value. Mariners corrected for it, but the crunch came with railway timetables, when a lot of ground was covered in a short time.

The solution was to define the second, not as a fraction of a day, but as a fraction of the year. All seconds in the year were then the same length, the average length during a whole year, and the same for multiples of seconds in the form of hours and days. The result is Average or Mean Time i.e. GMT. That was perfectly adequate until it was discovered using atomic clocks that the duration of the year itself oscillated very slightly about a mean, because the orbit of the Earth about the Sun slowly precessed. It is this difference between the length of the second measured in different ways, astronomical and atomic, which has given rise to the need for a unit of time-interval which does not vary with time and space.

Now it is observed that time-intervals defined by atomic clocks themselves vary in time and space. It cannot be detected whether these variations are spatial or periodic until there is a means to compare them with a unit of time which is invariant in time and space.

Table 2. Universal Absolute Time-intervals on Earth and α-Centauri

Consecutive Universal Absolute Time-intervals	Emission Count during Universal Absolute Time-interval	Cumulative Count	Elapsed Time on Earth in Universal Absolute Time-intervals	Elapsed Time on α–Centauri in Universal Absolute Time-intervals
1	10 000	10 000	1	1
2	9 048	19 048	2	2
3	8187	27 235	3	3
4	7408	34 643	4	4
5	6703	41 346	5	5
6	6065	47 411	6	6
7	5488	52 899	7	7
8	4966	57 865	8	8
9	4493	62 358	9	9
10	4066	66 424	10	10

If all times are measured in Universal Absolute Time-intervals, according to the invention, the problems of time dilation cannot occur. Elapsed times and radioactive decay parameters alike are expressed simply in terms of numbers (Table 2). They contain no phenomena which are susceptible to variation as a result of movement through time and space. They are invariant.

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