

Re: Age Correspondences, When Both Travelers Accelerate

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I've finally finished writing (and debugging!) a program that implements the procedure I described in a previous posting for determining age correspondences for two travelers who both accelerate arbitrarily and independently. The implemented procedure is the "direct procedure" that involves finding the point of intersection of the line of simultaneity (LOS) of the "observing" traveler and the worldline of the "object" traveler. I haven't yet implemented the alternative procedure that I briefly described previously (the "Quasi-Minkowski" procedure), and I don't yet know whether it will have any advantages over the "direct" method.

The new program is called "cado2", since it is a generalization of my cado program which requires the object to be unaccelerated. Here are the results from cado2 for a particular example.

Suppose two travelers, T1 and T2, are initially co-located and mutually stationary on the earth when they are each zero years old.

T1 accelerates at 1g in some direction (the "positive" direction) for 2 years, then coasts for 10 years. He then does a series of "yo-yo-like" maneuvers: he accelerates at -1g for 4 years, then accelerates at 1g for 4 years, and then accelerates at -1g for 4 years. (At the end of each of these maneuvers, he is back at the same location (wrt the earth) as when he started the maneuver, except with his velocity reversed). He then coasts for 10 years, and finally accelerates at 1g for 2 years, arriving back on the earth with zero speed (with respect to the earth).

T2 accelerates at -1g (in the direction opposite to T1's initial motion) for 2 years, then coasts for 5 years. She then accelerates at 1g for 2 years (which leaves her at zero speed wrt the earth). She remains motionless

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for 55 years, then accelerates at $1g$ for 2 years, coasts for 5 years, and finally accelerates at $-1g$ for 2 years, arriving back on the earth with zero speed, and at (approximately) the same instant that T1 returns.

According to T1 (who we will consider here to be the "observer"), what is the current age of T2 (considered here to be the "object"), at each instant of T1's life during his voyage? I.e, what is the correspondence between their ages, according to T1? Here are the results from the cado2 program.

At the end of T1's first ($1g$ acceleration) segment, he is 2, and T2 is 0.66 years old. His speed is 0.968 ly/y, heading away from the earth (and from T2). According to the earth, he is 2.9 ly away from earth at this instant in his life.

At the end of his second (coasting) segment, he is 12, and T2 is 1.48 years old. His speed is 0.968 ly/y, heading away from the earth (and from T2). According to the earth, he is 41.49 ly away from earth at this instant in his life. During this segment, T2 has gotten about 0.8 years older, while T1 got 10 years older.

He then goes through his "yo-yo" sequence. At the end of his third ($-1g$ acceleration) segment, he is 16, and T2 is 69.44 years old. He is again (according to the earth) 41.49 ly from the earth, and his speed is -0.968 ly/y (headed toward the earth (and toward T2)). During this segment, T2 has gotten about 68 years older, while T1 only got 4 years older.

At the end of his fourth ($1g$ acceleration) segment, he is 20, and T2 is 3.54 years old. He is again (according to the earth) 41.49 ly from the earth, and his speed is 0.968 ly/y (headed away from the earth (and away from T2)). During this segment, T2 has gotten about 66 years YOUNGER, while T1 got 4 years older.

At the end of his fifth ($-1g$ acceleration) segment, he is 24, and T2 is 71.49 years old. He is again (according to the earth) 41.49 ly from the earth, and his speed is -0.968 ly/y (headed toward the earth (and toward T2)). During this segment, T2 has gotten about 68 years older, while T1 got 4 years older.

He then coasts for 10 years toward the earth. At the end of that (sixth) segment, he is 34, and T2 is 72.27 years

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old. He is 2.9 ly from the earth at that instant (according to the earth). During this segment, T2 has gotten about 0.8 years older, while T1 got 4 years older.

Finally, he accelerates at 1g for 2 years, and arrives back on earth at zero speed, when he is 36, and T2 is 72.86 years old. During this segment, T2 has gotten about 0.59 years older, while T1 got 2 years older. (T2's ageing of 0.59 years doesn't quite match her ageing of 0.66 years during the first segment, because at the instant that T1 reaches the earth, T2 isn't quite back yet...she is (according to the earth frame) still about 0.01 ly away. When she gets back, she is 73.0 years old.)

The cado2 program writes out the pertinent data to disk files, so that I can then plot various quantities against one another (in particular, T2's age vs T1's age, according to T1). Unfortunately, I can't show those plots here. Maybe at some point I'll put them on my web page, but I haven't done that yet. Anyone who would like to see the T2-vs-T1 plot can email me, and I'll send you a jpg.

T2 of course doesn't agree with T1's conclusions about the correspondence between their ages. The cado2 program also gives the correspondence according to T2. The fluctuations during periods of acceleration by T2, in the T1-vs-T2 curve, are not as extreme as the fluctuations during periods of accelerations by T1 in the T2-vs-T1 curve, because T2's accelerations are done when the travelers are closer together.

The above results are qualitatively quite similar to the results obtained from the original cado program (when T1's voyage is the same as above, but T2 doesn't accelerate). T2's accelerations substantially affect the quantitative (numerical) conclusions of T1, but the qualitative nature of the rapid oscillations during the "yo-yo" sequence is essentially the same.

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