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Gravitational Aging

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The paper explains that gravitational field affects the speed of the time of a *biological* clock.

1. Assumption

The speed of the time of a biological system is the resultant of the speeds of its atomic-clock times.

2. Time in special relativity

We list below the effect of uniform velocity on the speed of time:

(a) If we observe a clock moving past us with a certain velocity υ, it will *appear* to be losing time, and its rate will be slowed down by a factor $1/\sqrt{(1 - \upsilon^2/c^2)}$, where c is the speed of light.

(b) If we move *with* the clock, we measure *no* time dilatation.

(c) If Observer A is moving relative to Observer B with velocity υ, then B is moving relative to A with velocity $-\upsilon$. Because of υ^2, to each observer, other's clock appears to be losing time. There exists *no* relative aging here.

3. Gravity and the speed of time

The time of an atomic clock runs slower closer to mass (that is, in a gravitational field of higher intensity)[1]. General relativity arrives at similar conclusions. The effects of other fundamental fields (the strong, the weak, and electromagnetic) on time run are not known.

4. Acceleration and the speed of time

Accelerations do not change the speed of time.[2]

5. Gravity and biological time

5.1 We infer from the Assumption and section 3 that a biological system ages more slowly in a gravitational field of higher intensity. For example, a person at the first floor would age more slowly relative to another person on the top floor of a building.

5.2 Twin brothers Resto and Speedo want to determine whether stronger gravity could help them age more slowly. Resto stays at Planet Earth (E); Speedo departs for Planet P, which is comparatively quite massive. See Fig. 1.

Speedo departs E at acceleration a_e from point A to point B, where he leaves E's gravitational field, and achieves sufficient speed υ at which he continues toward P. After 10 years, he enters P's gravitational field at point C, decelerates at a_p to point D, and achieves sufficient speed to orbit P safely. He orbits for 10 years, after which he accelerates at a_p from point D to point C, where he leaves P's gravitational field, and achieves speed υ, with which he continues toward E. He enters E's gravitational field at B, decelerates at a_e to A to landing. (The accelerations and speeds were pre-determined based on the planets' masses, their separation distance, and the rocket's fuel and load.) Resto greets Speedo. Will Resto find Speedo younger or older looking?

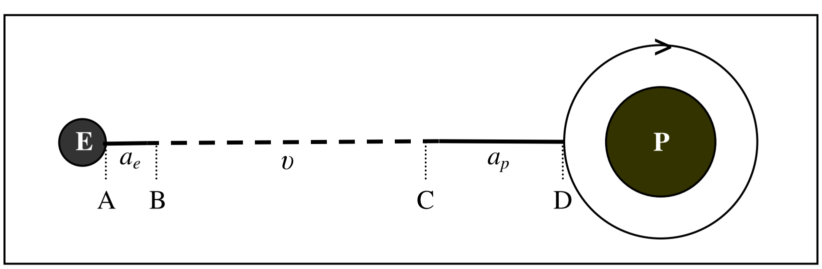

Figure 1. The journey of Speedo from Planet Earth (E) to Planet P.

Based on sections 2, 3, and 4, we discuss the impact on time by changing gravitational fields during the journey from E to P and back. As mentioned previously, accelerations do not affect time run.

(a) A to B: No changes in Speedo's biological clock due to the applied acceleration a_e. However, his biological clock speeds up as Earth's gravity gets weaker from A to B.

(b) B to C: According to 2 (c), the brothers age at the same rate relative to each other. (Regardless, the two gravitational fields are too weak to impact the time run.)

(c) C to D: No changes in Speedo's biological clock due to the applied deceleration a_p. However, his biological clock slows down as P's gravity gets stronger.

(d) Orbiting P: Speedo's biological clock is slower compared to what it was at Earth due to P's stronger gravity. For 10 years he ages at a relatively slower rate.

(e) D to C: No changes in Speedo's biological clock due to the applied acceleration a_p. However, his biological clock speeds up as the P's gravity gets weaker.

(f) C to B: According to 2 (c), the brothers age at the same rate relative to each other. (Regardless, the two gravitational fields are too weak to impact the time run.)

(g) B to A: No changes in Speedo's biological clock due to the applied deceleration a_e. However, his biological clock slows down as Earth's gravity gets stronger. At A, he ages at the same rate as when he departed E.

(h) Any gain (loss) in the run of time during the outward journey from A to D is cancelled by the respective loss (gain) during the return journey from D to A. Ultimately, Speedo's biological clock relatively slows down – but only during the period he orbits in the stronger gravitational field of the more massive planet P. The difference between Planet P's gravity and Planet Earth's gravity actually lowers Speedo's relative age. Yes, Resto will find Speedo relatively younger looking!

(i) As examples: Speedo spending 10 years near Jupiter is younger by about 1.5 seconds to Resto; and Speedo spending 10 years near a black hole is younger by about 10 years to Resto.

6. Remarks

We find that gravitational fields can actually, in absolute terms, affect the speed of time. The effect of other fundamental fields on the speed of time is not known.

References

1. R.P. Singh, A Constructive Model of Gravitation, *General Science Journal*, 2014.

2. R.P. Singh, Pseudogravity, *General Science Journal*, 2014.

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