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Cinematic or Scientific: Putting Time on Ice

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Abstract

In *Ice Age: Continental Drift*, the character Scrat appears to trigger the breakup of Pangea within 64 s of screen time, compressing a geological process that occurred over approximately 225 million years. This study evaluates the time dilation required for such a compression by comparing Scrat's elapsed time with that at Earth's surface. The analysis demonstrates that both Earth's gravity and the velocity of Scrat are fundamentally incapable of producing the cinematic effect depicted, highlighting the contrast between narrative storytelling and relativistic physics.

Keywords: Film; Physics; Relativity; Time Dilation; Ice Age; Scrat

Introduction

The 'Ice Age' franchise is a childhood favourite for many, using animation to present a simplified view of the Earth's evolutionary history. However, the franchise wildly compresses and exaggerates these important events. This paper focuses on Scrat, the iconic squirrel who appears in every movie and is the apparent force that causes all of these events.

In the fourth movie, *Ice Age: Continental Drift* [1], Scrat appears to have caused the breaking of Pangea by falling to the Earth's core and running around it. In just a matter of 64 s (movie time) the Earth transforms from Pangea to Earth today. In reality, we know that this change took around 225 million years [2].

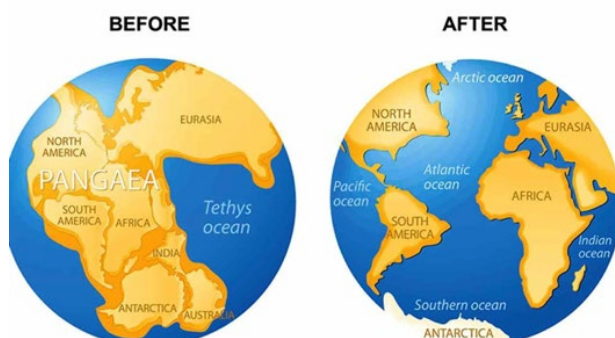


Figure 1 – Pangea vs modern Earth: A change that took 225 million years [3].



Figure 2 – Scrat at the Earth's core in "Ice Age: Continental Drift" [4].

This raises the question: How much time dilation did Scrat experience?

Time Dilation (In Movie)

For simplicity we will assume that Scrat had his own clock during his adventure and the Earth's surface also had its own clock that experienced time at a different rate. For these time scales to be comparable, we must convert 225 million years into seconds [5]:

$$225,000,000 \times 31,536,000 = 7.0956 \times 10^{15} \text{ s}$$

Velocity-Induced Time Dilation

Although the movie implies that Scrat's position near the Earth's core produces the required time dilation, gravitational effects near the Earth's core are

extremely small. For example, it is estimated the Earth's core is approximately 2.5 years younger than the Earth's surface which is assumed to be around 4.5 billion years old [6] due to gravitational time dilation.

An alternative explanation is that Scrat experiences this relativistic time dilation due to his velocity while running around the Earth's core. In special relativity, the time experienced by a moving observer is related to the time measured by a stationary observer through the Lorentz factor [7]:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad (Eq^n 1)$$

where v is the velocity of the moving object (Scrat) and c is the speed of light. The relationship between time for the surface ($t_{surface}$) and Scrat (t_{scrat}) is given by:

$$t_{surface} = \gamma t_{scrat}.$$

Rearranging this equation would give us the opportunity to find the Lorentz factor:

$$\gamma = \frac{t_{surface}}{t_{scrat}} = \frac{7.0956 \times 10^{15}}{64},$$

$$\gamma = 1.109 \times 10^{14}.$$

This represents the time dilation factor required for Scrat to experience only 64 s while 225 million years pass on Earth's surface.

Velocity needed

Using the Lorentz factor, we can determine the velocity that Scrat would need to be travelling in

order for this level of time dilation to take place. By rearranging equation 1 we can find that:

$$v = c \sqrt{1 - \frac{1}{\gamma^2}},$$

$$v = 3 \times 10^8 \sqrt{1 - \frac{1}{(1.109 \times 10^{14})^2}},$$

$$v \approx c(1 - 4 \times 10^{-29}) \text{ ms}^{-1}.$$

This velocity is indistinguishable from the speed of light, with more than twenty decimal places. According to special relativity, objects with mass require infinite energy to reach this speed. Therefore, if Scrat were to be capable of running around the Earth's core, the velocity he would need to obtain would be physically impossible.

Conclusion

This analysis demonstrates that the cinematic compression of over 225 million years in 64 s of movie time would require a time dilation factor of fourteen orders of magnitude. In reality, general relativity predicts that a 'clock' at the Earth's core would differ from one at the surface by a negligible amount [6] for gravitational time dilation to take effect. Further analysis of velocity-based time dilation also highlights an unrealistic representation of relativity. The gap between required and physically possible time dilation is therefore not a matter of approximation, but of fundamental scale.

The contrast highlights the difference between storytelling and physics. While *Ice Age: Continental Drift* [1] offers an entertaining depiction of continental evolution, the relativistic framework governing spacetime remains uncompromising. Scrat may reshape the planet on the screen, but the laws of physics do not bend so easily.

References

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