Greg's Space Calculations

Relativistic Rocket

A rocket departs Earth for another star. We divide the trip into three phases:

- During the boost phase, it accelerates at a fixed rate. This phase is *powered* because the rocket is firing.
- During the cruise phase, it coasts at a fixed velocity. This phase is *unpowered*.
- During the deceleration phase, it decelerates at the same rate as it had originally accelerated. That is, deceleration phase is a mirror of the boost phase. This phase is also powered.

The rocket thus arrives at the target star with zero velocity relative to the start point--ignoring issues like gravity, resistance of the interstellar medium, relative motions of the stars, etc.
This page computes a number of interesting properties of such a trip, given just a few bits of information. Fill in what you know and it computes the rest.

Powered Phase Questions.

What is the acceleration?

Answer any one of the next five questions.

How far does it travel under power?
How far does it travel during boost alone?
What velocity does it reach?
How long does it accelerate? (ship time)
How long does it accelerate (earth time)?

Cruise Phase Questions.
Answer any one of the following six questions. "Total" in this section includes boost, cruise, and deceleration, so "total distance" is the entire distance from Earth to the star.

What is the total distance travelled?
How long is the whole trip? (ship time)
How long is the whole trip? (earth time)
How far does it travel during cruise?
How long does it cruise? (ship time)
How long does it cruise? (earth time)

Other Statistics
At max velocity, time slows down and lengths contract by a factor, tau, while and mass increases by its reciprocal, gamma.

Gamma	1.0001
Tau	0.9999

How much "time slip" is there between the crew and the people on Earth?
Earth minus Ship Time 0.0000

How much reaction mass is needed, assuming we use anti-matter fuel and our exhaust is coherent gamma rays.

Mass per kilogram to cruise velocity	0.0107
Energy per kilogram to cruise velocity	0.2308
Mass per kilogram to destination	0.0216
Energy per kilogram to destination	0.4642

Suppose there were no such thing as relativity. What would the times look like? (For cruise

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Greg Hullender

After decades of experience in computer programming and foreign-language study, I'm spending my retirement exploring the problem of reading in a foreign language. For more details about my career, read my web page (actually my LinkedIn profile) via the link on the left of my "complete profile page."

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segments, this keeps the distances constant.)

Newtonian Boost Time	0.0104
Newtonian Cruise Velocity	0.0107
Newtonian Cruise Time	0.0000
Newtonian Total Time	0.0207

Other relativity numbers. You should read the Relativistic Rocket (below) for explanations.

Rapidity	0.0107
Horizon	0.9687

Link for sharing these calculations:
http://gregsspacecalculations.blogspot.com/p/blog-page.html?a=9.80665&b=326775.37417565426&c=0

All calculations taken from the Relativistic Rocket (Don Koks and Phillip Gibbs, 2006)

13 comments:

Vickram Ratnam April 27, 2015 at 10:48 PM

Hi

How would you compute length contraction and energy increase (relativistic) for a constant acceleration rocket?

Reply

Vickram Ratnam April 27, 2015 at 10:52 PM

PS: my email address is testrope@yahoo.com

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tonyon November 14, 2015 at 11:39 AM

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