Solving the mystery of dark energy

Tom Fuchs*

Abstract: I show how stars can accelerate away from us in the absence of dark energy.

Thought experiments

Tie a long string to a stone and throw the stone upward. Plot the stone's distance over time as you measure. Is the plot exactly as Galileo predicts? When the stone leaves your hand it's length contracted in your frame, as predicted by special relativity, and so is the string that's moving relative to you. When the stone reaches its apex it's no longer length contracted, and neither is the string. Not only does the stone length uncontract (hereafter "length expand") as it recedes, but also does the string, which represents the space between the stone and you. Since the space between the stone and you length expands in your frame as the stone recedes, the plot of the stone's distance over time isn't exactly as Galileo predicts.

In your frame, when the stone is thrown upward at a speed close to *c*, the length expansion of the space between the stone and you outbalances the stone's deceleration to make the stone accelerate away. See The Relativistic Rocket at "The Equivalence Principle and a Stone Thrown Upwards" for a plot of a stone accelerating away in its thrower's frame in a uniform gravitational field. The acceleration away gives the plot a bell shape rather than parabolic. Since the cause of length expansion of space is deceleration due to gravity, I reason that acceleration away is likewise observable in a non-uniform gravitational field.

Consider the rocket that travels to the Andromeda galaxy at The Relativistic Rocket at "Here are some of the times you will age when journeying to a few well known space marks, arriving at low speed". The rocket is able to traverse 2 million light years in the Earth's frame in just 28 years on the rocket's clock, due to length contraction. In the rocket's frame, at the midpoint of the trip the remaining distance is length contracted to much less than 14 light years, traversable in 14 years at a speed always less than *c*. At the midpoint the rocket begins to brake by accelerating in the direction of the Milky Way, putting it above the rocket. During the rest of the trip the Milky Way-Andromeda

* tomfuchs@gmail.com

system length expands in the rocket's frame. Due to this relative expansion of space, in the rocket's frame a beacon floating at the midpoint accelerates upward, later decelerating to an apex when the rocket arrives at Andromeda at low speed. The beacon recedes 1 million light years in 14 years in the rocket's frame. When during this recession the beacon radios the rocket, in the rocket's frame the radio signal is stretched by the length expanding space.

Cosmology doesn't need multiple ways to explain how light stretches on its way to Earth. So I reject the generally accepted explanation for cosmological redshift, that space itself expands, and say that only length expansion causes that redshift. I say that instead of an absolute expansion where space itself expands, space expands only relatively; i.e. whether space expands depends on the observer. This solves the flatness problem, which is based on the assumption that space itself is expanding. The Relativistic Rocket says "For distances greater than about a thousand million light years, the formulae given here are inadequate because the universe is expanding." When space expands only relatively then those equations for flat spacetime apply to arbitrarily large distances in principle, and spacetime is universally flat by default.

The Relativistic Rocket equations show that a stone can be thrown to a height of *x* light years in much less than *x* years in the thrower's frame in principle. For example, see the plot of the stone that recedes 10 light years in less than 4 years in the thrower's frame. Or consider the beacon that recedes 1 million light years in 14 years in the rocket's frame. This solves the horizon problem. In your frame, two regions of the universe each 10 billion light years away from you in opposite directions can be causally connected when the universe has been relatively expanding for much less than 20 billion years.

Be freely floating, observing a supernova that's accelerating away from you. The star accelerates away because the space between the star and you is relatively expanding as you measure, and that expansion of space is outbalancing the star's deceleration. The length expansion between the star and you in your frame is due to the gravity that decelerates the star. The gravity is caused by the mass within the sphere that's centered on you and extends to the star, so you needn't be feeling an acceleration. If a string dangled from the supernova down to you, the string would be length expanding in your frame because the string would also be decelerating due to gravity.