DECEMBER 8, 2023

JACA ENGINE
SPACE SCRAPERS (SPACE ELEVATORS)

A JACA ENGINE

Patent Pending, August 1, 2022

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Space Elevators and Broken Laws of Physics

Contrary to popular beliefs, technology is not the reason we do not have yet space elevators. What is holding us back are misunderstood laws of physics. Unlike childhood stories, one cannot wish-and-puff magical space elevators into existence.

Since we cannot fake the laws of physics, why don't we turn the whole concept on it's head? Instead of fake it till you make it, why not use the laws of physics to do it right the first time? Sounds weird, but let's try it.

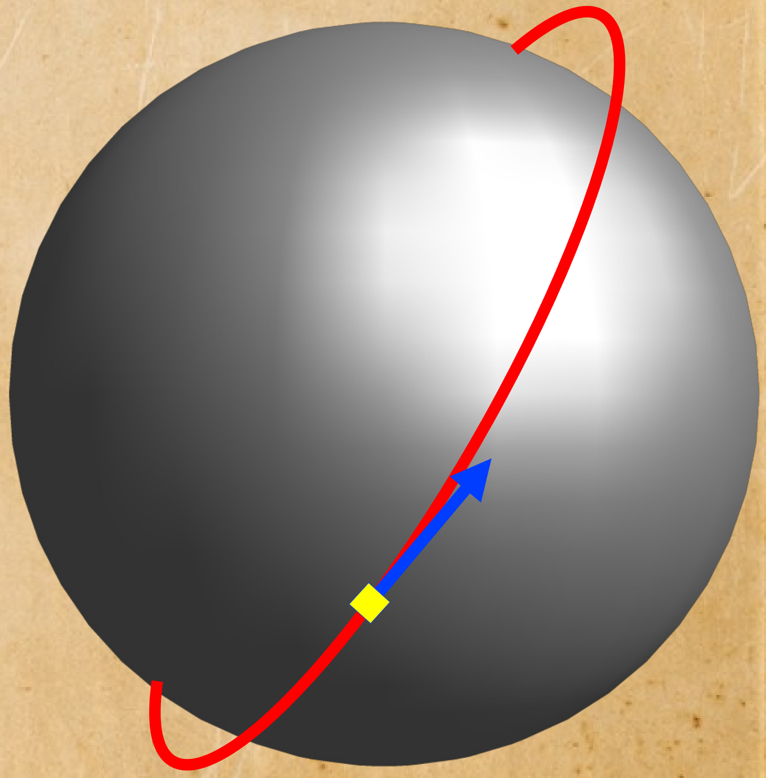
Anti Gravity - Where can we start from?

Imagine you have a satellite (YELLOW box).

The satellite has a stable orbital speed (BLUE ARROW)

The satellite follows a stable orbit in LEO (RED orbit)

The satellite flies around a celestial object (GRAY planet)



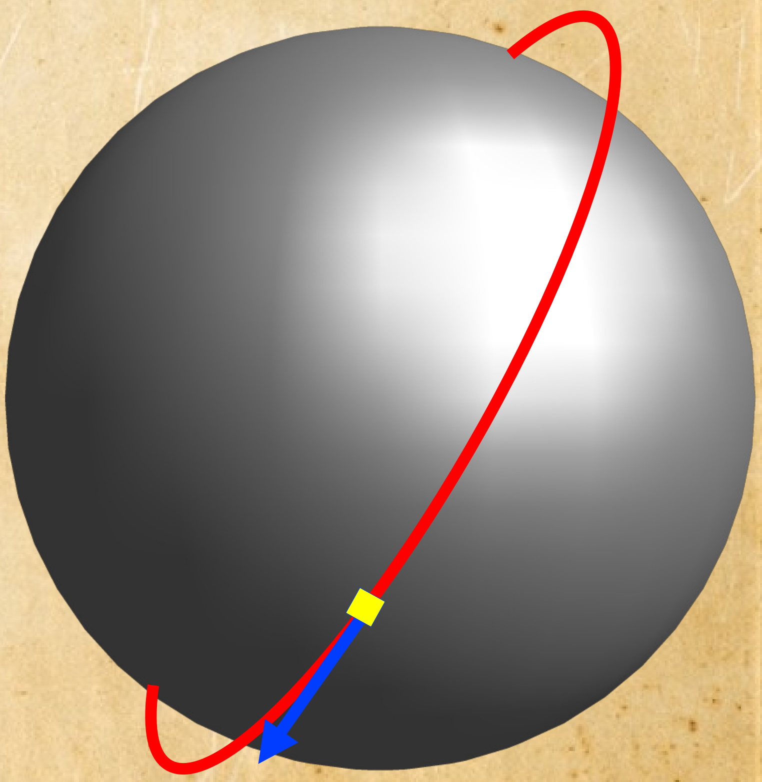
No laws of physics are broken in this slide

Building a Space Elevator: Step 1

Wait a moment, why do we need to duplicate here the previous slide? Look closely: the satellite moves in another direction.

Is there any other change? None that I can see. The satellite flies around a celestial object at the same altitude, the same orbit, only backwards.

A very significant observation: while the satellite has a different direction, it has the same orbit, same speed, same altitude, same centrifugal force, same everything else.



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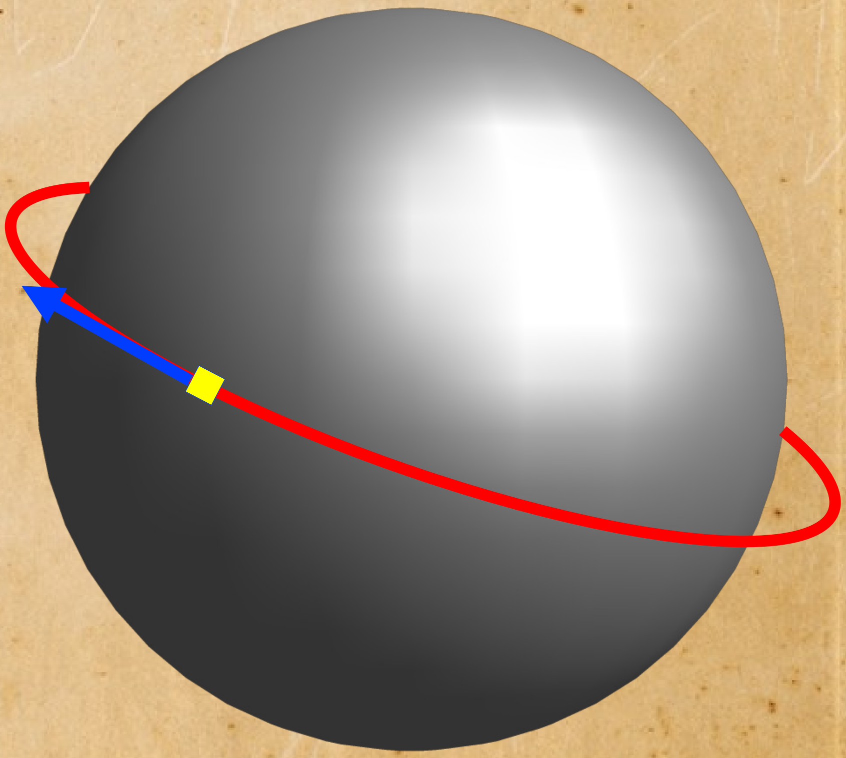
Building a Space Elevator: Step 2

Really? Do we need here to make yet another slide copy?

Yes, this case is fundamental to understand how a JACA engine works, and how we can build a space elevator.

A very significant observation: “**equivalent satellites**” in an “**equivalent orbit**” are any satellites with the same altitude and orbital speed, regardless of their trajectory or direction



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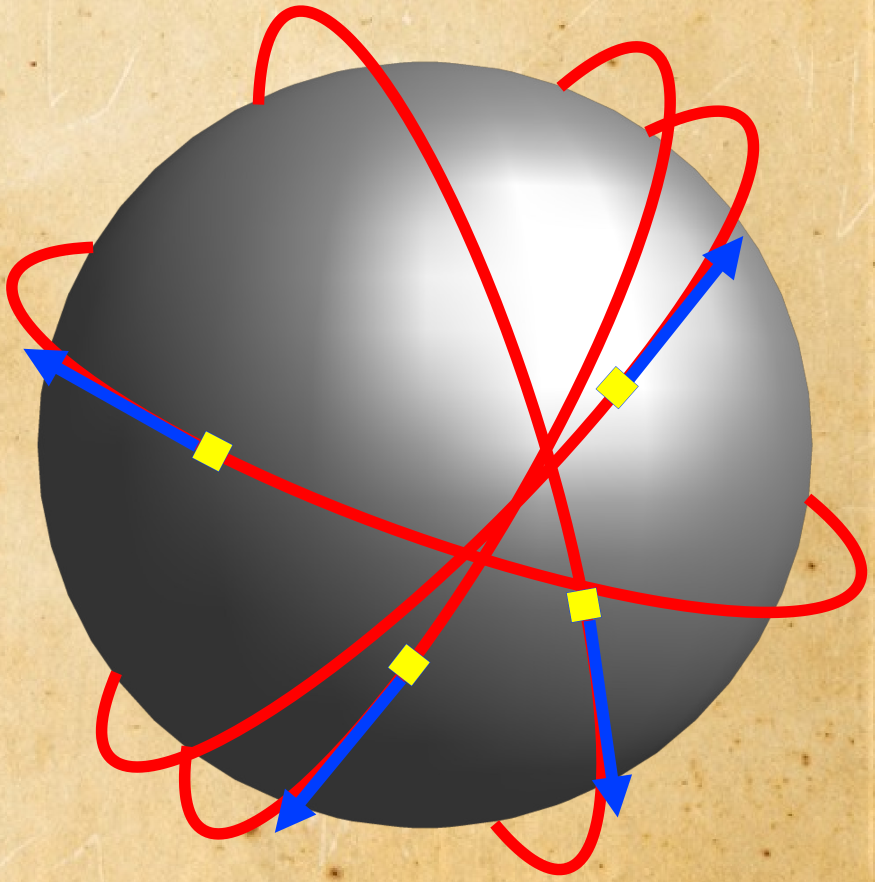
Building a Space Elevator: Step 3

Let's pause here for a moment and summarize what we learned:

A couple very significant observations:

- there is a very large number of possible "equivalent satellites" in an "equivalent orbit"
- theoretically we can switch from one "equivalent satellite" in an "equivalent orbit" to any other one, at any time, without any qualitative changes.



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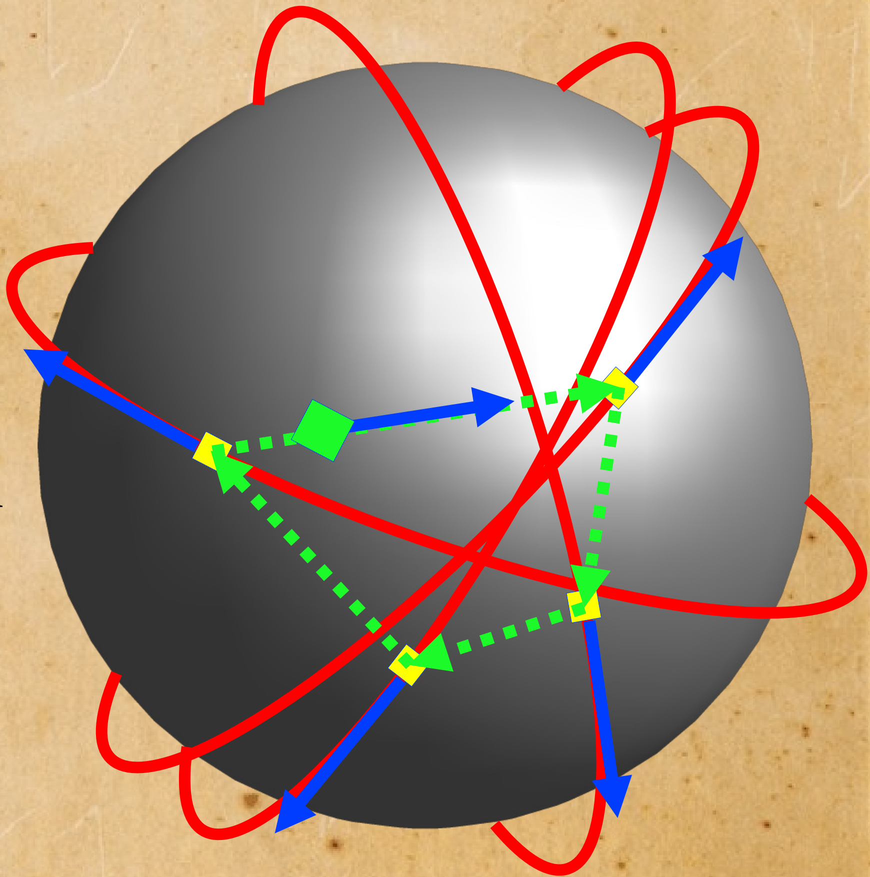
Building a Space Elevator: Step 4

Let’s expand on what we learned:

- none of these “equivalent satellites” in an “equivalent orbit” will fall off the sky, all of them are “mechanically identical”, as long as their average speed is the same.
- Any other “equivalent satellite” (GREEN box) can switch trajectories from different satellites (YELLOW boxes) at any point in time (GREEN trajectory) and again, that GREEN satellite will not fall off the sky.



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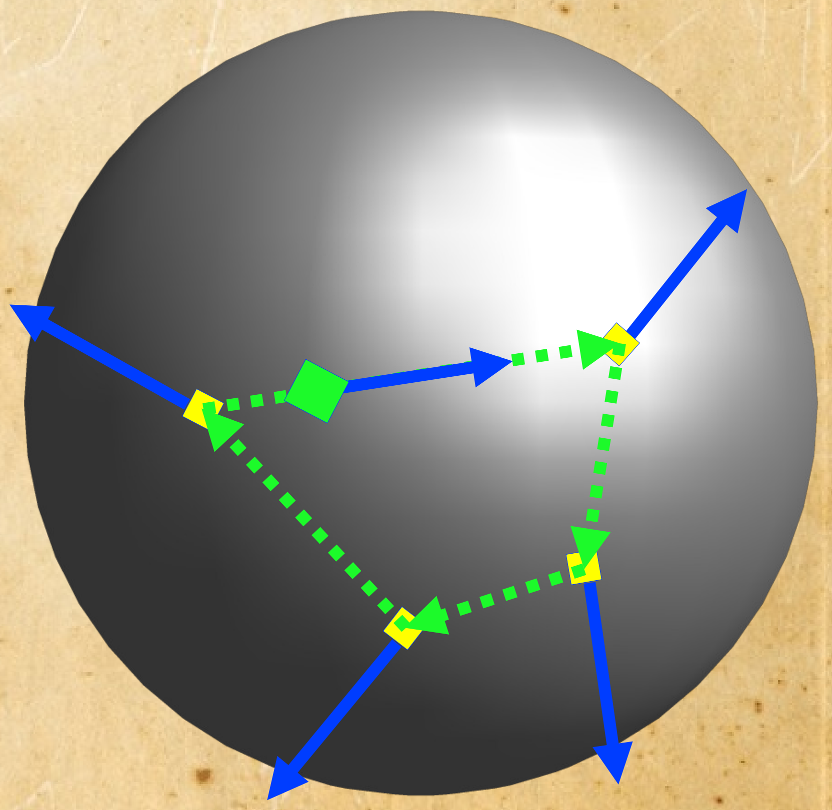
Building a Space Elevator: Step 5

Ah, but you break the laws of physics: you will need propellant and energy to switch on a dime between the trajectories of different “equivalent satellites” in an “equivalent orbit”. That would be true, but also there is no claim of zero energy; there is a claim of “reusable propellant”. How much “reusable propellant” and energy will be needed? Keep reading.



Another very significant observation:

- the trajectory and direction of an “equivalent satellite” in an “equivalent orbit” could be arbitrary, at any moment of time, if the average speed is the same.

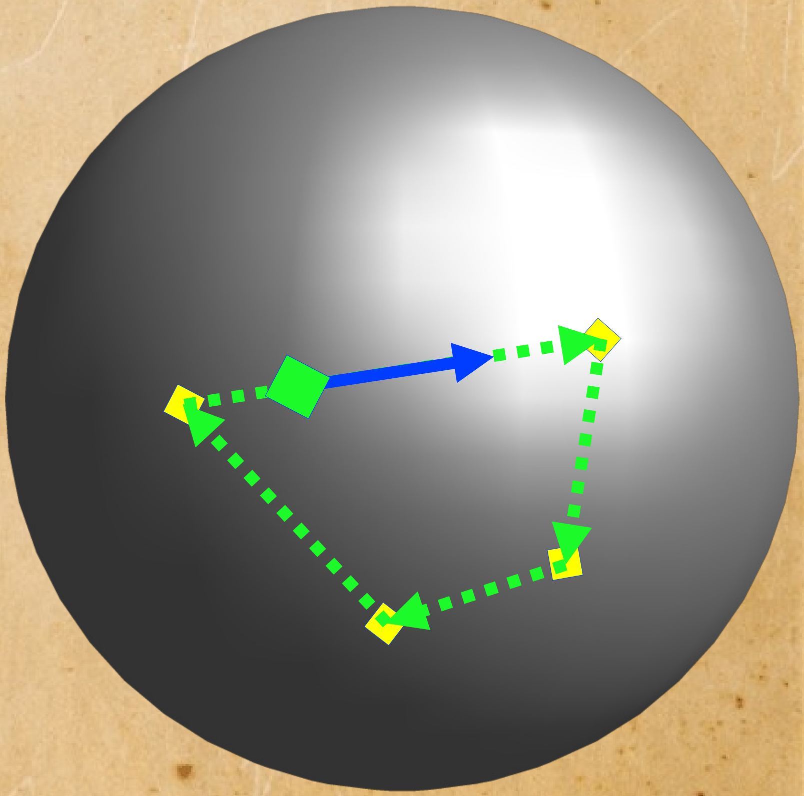
No laws of physics are broken in this slide

Building a Space Elevator: Step 6

Do you remember arbitrary, at any moment of time? What that really means?

A few very significant observations:

- There is no need to complete a full orbit
- Arbitrary long means chunks of trajectory
- Arbitrary direction means **any direction ...**
- **... at any time**
- Again, the satellite will not fall off the sky



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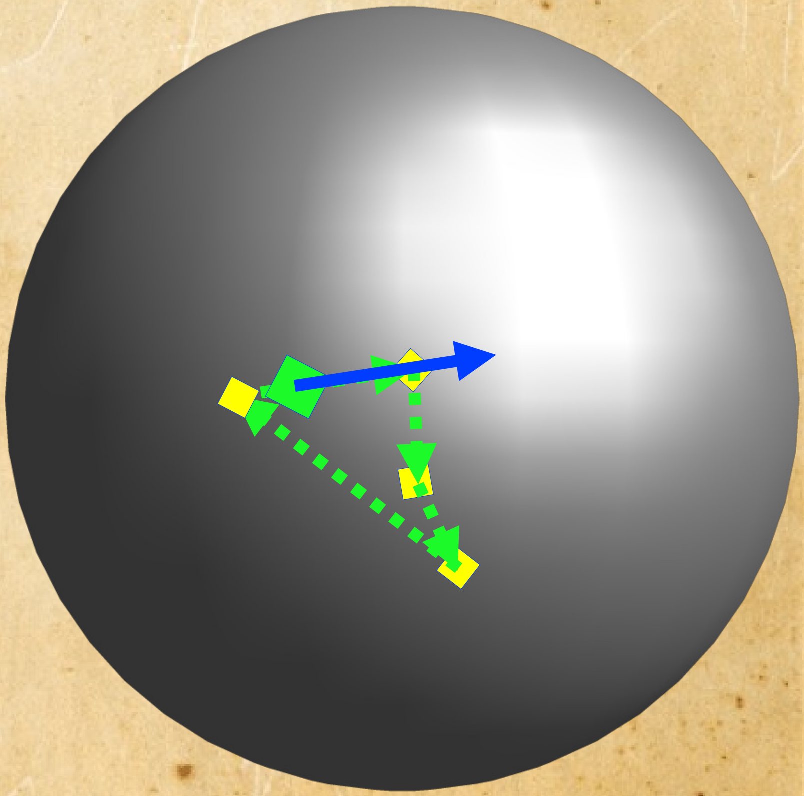
Building a Space Elevator: Step 7

To summarize: as long as an "equivalent satellite" (GREEN box) moves in an "equivalent trajectory" (GREEN dotted path) with a constant speed (BLUE arrow), the satellite will have the same centrifugal force acting on it and it will maintain a stable altitude, like any other standard satellite (YELLOW boxes) in a stable orbit.



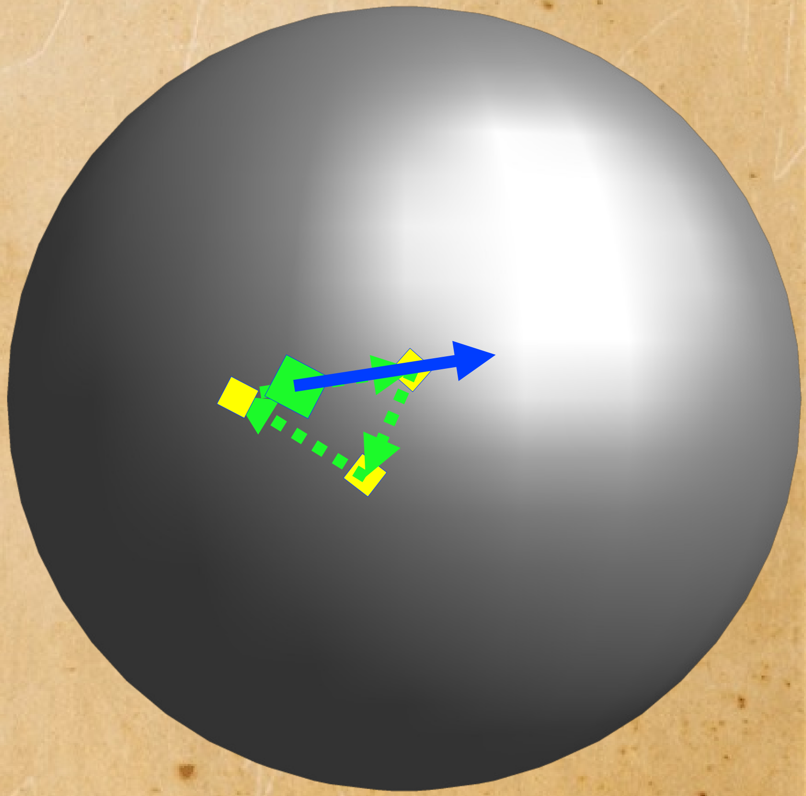
A very significant observation:

- arbitrary length means any length, from very close to zero all the way to infinity

No laws of physics are broken in this slide

Building a Space Elevator: Step 8

Now we know that an “equivalent satellite” could move between random points in an “equivalent orbit” and it will not fall off the sky regardless of the directional changes if and only if it will maintain a stable “orbital” speed that would provide the required upward centrifugal force.



A few very significant observations:

- A “stable speed” means in fact a stable “average orbital speed”.
- A regular satellite flies close to the ideal orbit only because it has minor and periodic flight corrections.
- Flight corrections can be any random changes at any point in time as long as the average speed is constant.

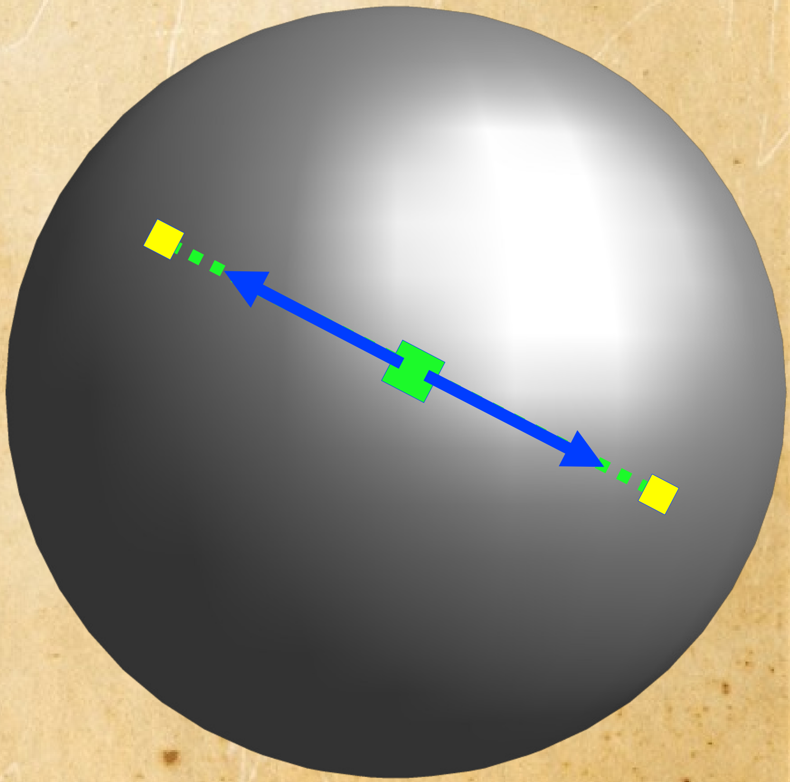
No laws of physics are broken in this slide

Building a Space Elevator: Step 9

Have you spotted the difference from Step 7 to Step 8? It was subtle, but intentional: the “equivalent satellite” from Step 7 moves between 3 points only, not between 4 points like in Step 8.

A few very significant observations:

- You do not need an infinity of points for an “equivalent satellite”.
- An “equivalent satellite” can stay in an “equivalent orbit” moving periodically between at least 2 points, at **any non zero distance** between points.
- The “equivalent satellite” must have the same average speed in order to maintain the altitude.



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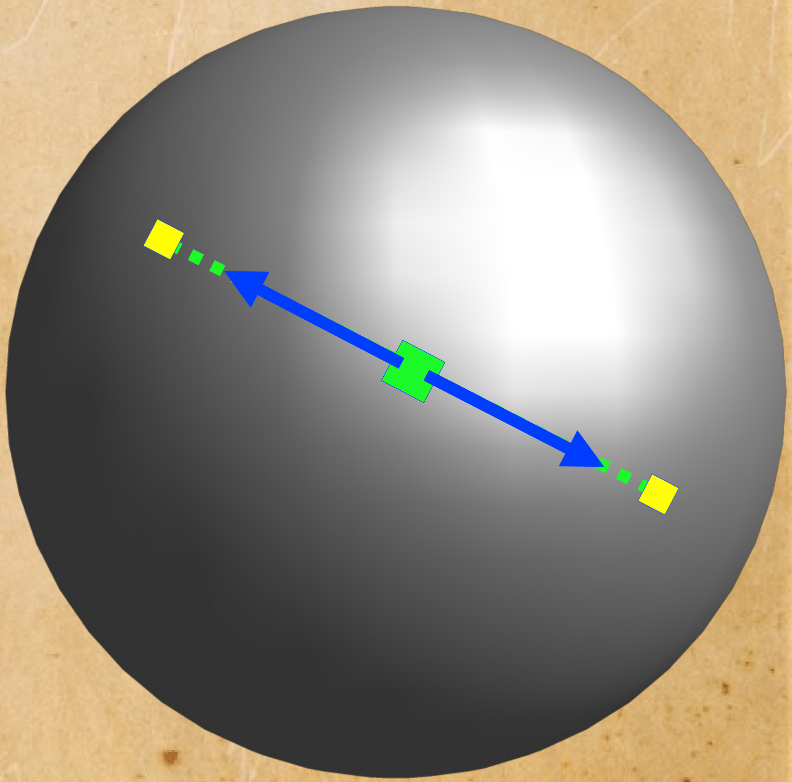
Building a Space Elevator: Step 10

This concludes first part of our presentation: a satellite will maintain a stable altitude around a celestial body, without completing full orbital cycles, by just moving cyclically between at least two different points A and B at any non-zero distance, given that a few conditions are met:

- First, the average “orbital” speed must be high enough to generate sufficient centrifugal force.
- Second, enough energy must be provided to move the satellite in a cyclical path between A and B
- Considering the satellite “dead weight”, an onboard engine could move one or two massive objects between two points in space. The speed of the massive objects must be much higher in order to achieve an equivalent mass and an equivalent orbital speed.
- At least two massive objects (bouncing balls) will be required to cancel out any system vibrations.



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Building a Space Elevator: Step 11

What minimum average speed would be required by a “satellite” moving between two points in close proximity in order to escape and “lift off” from ground level? Let’s see:

Location	Latitude	m/s²	Absolute difference from equator	Percentage difference from equator
Equator	0°	9.7803	0.0000	0%
Sydney	33°52′ S	9.7968	0.0165	0.17%
Aberdeen	57°9′ N	9.8168	0.0365	0.37%
North Pole	90° N	9.8322	0.0519	0.53%

Gravitational Acceleration Change With Latitude (With Centrifugal Force)
https://en.wikipedia.org/wiki/Weight

When the speed is 7908.5 m/s that corresponds to 1 ⁄ √2 times (≈ 0.707 times) the escape velocity. At that speed the satellite perceived weight is 0 N (appears weightless, 100% weight loss). In order to escape gravity, the escape velocity must be at least 11186 m/s at Equator. At the escape velocity, the perceived weight of the satellite appears negative. That looks pretty much like the weight change is double, 200% change as shown in the next slides.

No laws of physics are broken in this slide

Building a Space Elevator: Step 12

A bit of bouncing ball math

We will impose a known lateral speed on a bouncing ball with a known mass and make that ball bounce between two points:

Lateral Tangential Bouncing Ball Speed:	$V_{BBL} := 7888.1237 \frac{m}{s}$	Try **V**BBL $11161.21972327 \frac{m}{s}$
Bouncing Ball Displacement:	$D_{BB} := 10\ cm$	Try **D**BB $10\ cm$
Bouncing Ball Frequency:	$F := \frac{V_{BBL}}{2 \cdot D_{BB}}$	$F = 39.4406185\ kHz$
Earth Mean Radius:	$R_E := 6371000\ m$	
Standard Acceleration Of Free Fall At 45° Latitude:	$g := 9.80665 \frac{m}{s^2}$	
Ball Mass:	$m_B := 0.1\ kg$	Try **m**B from $0.1\ kg$ to 100 ton
Ball Weight (Gravitational Force)	$F_{BW} := m_B \cdot g$	$F_{BW} = 0.980665\ N$
Ecuatorial Tangential Speed:	$V_{eq} := 465.1 \frac{m}{s}$	
Local Latitude:	$LL := 39.758949$	Try **LL** 39.758949
Ball Speed At Local Latitude:	$V_{LL} := \cos\left(\frac{\pi}{180} \cdot LL\right) \cdot V_{eq}$	$V_{LL} = 357.5418804931 \frac{m}{s}$

No laws of physics are broken in this slide

Building a Space Elevator: Step 11

More bouncing ball math

Centrifugal Force On Ball At Local Latitude:	$F_{CB} := \frac{m_B \cdot V_{LL}^{2}}{R_E}$	$F_{CB} = 0.0020065327\ \mathrm{N}$
Ball Weight At Local Latitude (Gravitation - Centrifugal):	$W_B := F_{BW} - F_{CB}$	$W_B = 0.9786584673\ \mathrm{N}$
Bouncing Ball Speed Including Lateral Tangential:	$V_{BB} := \sqrt{V_{LL}^{2} + V_{BBL}^{2}}$	$V_{BB} = 7896.2226224194\ \frac{\mathrm{m}}{\mathrm{s}}$
New Centrifugal Force On The Bouncing Ball:	$F_{CBB} := \frac{m_B \cdot V_{BB}^{2}}{R_E}$	$F_{CBB} = 0.9786584791\ \mathrm{N}$

When **W**BBL is **7888 m/s** that corresponds to 1⁄√2 times (≈ 0.707 times) the escape velocity. At that speed the perceived weight **W**BB of the bouncing ball is 0 N (appears weightless), **100% change** in perceived weight. In order to escape gravity the escape velocity must be at least **11161 m/s** (at equator). At the escape velocity the perceived weight **W**BBL of the bouncing ball appears negative **-W**BBL . That looks pretty much like the weight change is double, from **+W**BBL to **-W**BBL , **200% change!**
https://en.wikipedia.org/wiki/Orbital_period

Bouncing Ball Perceived Weight At LL And VBBL:	$W_{BB} := W_B - F_{CBB}$	$W_{BB} = -0.0000000118\ \mathrm{N}$
Bouncing Ball Perceived Weight Change:	$\Delta W_{BB} := W_B - W_{BB}$	$\Delta W_{BB} = 0.9786584791\ \mathrm{N}$
Bouncing Ball Perceived Weight Change Percentage:	$\Delta W_{BB\%} := \frac{W_B - W_{BB}}{W_B}$	$\Delta W_{BB\%} = 100.0000012015\ \%$

NOTE: the mass of the bouncing ball is always constant, it never changes, at least not significantly at low speed (lower than the speed of light). What will significantly change is the perceived weight of the bouncing ball. So much so that there is a point when the weight of the bouncing ball will reach zero at about 0.707 of the escape velocity, and it will become even negative at higher speed. If the system is already in equilibrium (a satellite in orbit with a bouncing ball on board already has zero perceived weight), then any minute speed increase of the bouncing ball will produce a negative weight on the whole system, hence upward thrust on a satellite.

No laws of physics are broken in this slide

Building a Space Elevator: Step 12

This is great news! At only 70% of escape velocity a bouncing ball will become weightless, true anti gravity. And because the bouncing ball will not stop, that will become automatically a positive feedback: any minute increase in the (lateral) speed of the bouncing ball will force the ball to accelerate upward. Remember? **The moment the ball lifts up a bit (higher altitude), the "average orbital speed" needed to maintain that altitude is lower, but the bouncing ball has no plans of slowing down; hence positive reaction, the bouncing ball will accelerate upward and it will get lost in deep space, starting with only 70% of the escape velocity!**

Actually, the previous statement is not quite true. The celestial body is the one that is "flying away" from the bouncing ball. The mindless bouncing ball is simply falling off the apple cart, not capable anymore to hitch-hike the planet for a free gravity pull ride. Remember? The ball just lost its "perceived weight", got infected with "anti gravity". But, for all practical reasons, the ball is "accelerating away".

No laws of physics are broken in this slide

Building a Space Elevator: Step 13

Talking about the satellite “dead weight” and the engine equivalent “propulsion” mass, keep your eye on the bouncing ball. As shown at Step 12, a satellite or spacecraft (the bouncing ball) would need about 8 km/s “tangential average speed” in order to “defeat gravity” and to appear weightless. That is, the whole contraption would need to bounce between two points in close proximity, at that average speed.

The problem with such numbers is that no customer would be enthusiastic enough to pay for a seat only to be liquefied inside. Is there a better option?

As it happens, yes, there is a way to build an engine capable to cancel the perceived weight of the whole spacecraft and push the spacecraft upward, against gravity. All we need to do is to place the bouncing ball inside a satellite, and make that ball the “propulsion engine” with a much higher bouncing speed; not a real “propulsion”, more like a local anti gravity generator. But, for all practical reasons, the spacecraft will appear like it is accelerating away from the celestial body, even if we know that the celestial body will “run away” without dragging the spacecraft with its gravity.

No laws of physics are broken in this slide

Building a Space Elevator: Step 14

How fast should our bouncing ball bounce? Let's put some numbers on it, looking at the International Space Station as an example:

Average orbital speed of ISS:	$V_{iss} := 7.67 \frac{km}{s}$
Earth's mean radius:	$R_e := 6371\ km$
ISS Perigee Altitude:	$H_{iss} := 415\ km$
ISS orbits per day:	$N_{iss} := 15.49$
ISS mean orbit radius:	$R_{iss} := R_e + H_{iss} = 6786\ km$
ISS mean orbit length:	$L_{iss} := 2 \cdot \pi \cdot R_{iss} = 42637.6955\ km$
ISS mean orbit period:	$T_{iss} := \frac{L_{iss}}{V_{iss}} = 5559.0216\ s$

No laws of physics are broken in this slide

Building a Space Elevator: Step 15

We can calculate how fast will ISS move every second when the forward speed is 7.6km/s and we force the whole ISS to oscillate with an additional average lateral speed of 100 m/s (through small left/right cyclical deviations, no more than 1 cm amplitude for example). In this case we have a right triangle with one leg equal to 7670 m and the other leg 100 m. The hypotenuse of this triangle is:

Lateral ISS speed: $V_L := 100 \ \frac{m}{s}$

New ISS speed: $S_{iss} := \sqrt{V_{iss}^{\ 2} + V_L^{\ 2}} = 7.6707 \ \frac{km}{s}$

ISS speed increase: $\Delta V_{iss} := S_{iss} - V_{iss} = 0.6519 \ \frac{m}{s}$

No laws of physics are broken in this slide

Building a Space Elevator: Step 16

At first glance, looks like we get a very small speed increase. Is it worth the trouble? Let's see. First, we need to figure out how much more ISS will travel on a complete mean orbit period. Assuming this altitude gain is linearly progressing with every complete orbit, we can calculate now how much ISS will move up in a day and in a year:

How much more ISS will travel in one orbital period: $\Delta L_{iss} := \Delta V_{iss} \cdot T_{iss} = 3.6237\ \mathrm{km}$

The new orbit length corresponds to a new orbit height, and we can calculate:

ISS mean orbit radius increase with first complete orbit: $\Delta R_{iss} := \dfrac{\Delta L_{iss}}{2 \cdot \pi} = 576.7328\ \mathrm{m}$

ISS mean orbit radius increase each day: $\Delta R_{iss}(day) := \Delta R_{iss} \cdot N_{iss} = 8.9336\ \mathrm{km}$

ISS mean orbit radius increase each year: $\Delta R_{iss}(year) := \Delta R_{iss}(day) \cdot 365 = 3260.7609\ \mathrm{km}$

No laws of physics are broken in this slide

Building a Space Elevator: Step 17

We did not take into account the true constantly upward increasing acceleration of the whole ISS in this example, and we assumed that at higher altitude the ISS will need the same speed in order to maintain a stable orbit; that is not the case, and the ISS will constantly accelerate away, to the deep space.

Or, as we explained already, the planet Earth will move away and it will leave a “stationary” ISS in the dust, not dragging the lazy space station along for a celestial ride.

Remember? Once you place a bouncing mass inside of an object you infect the object with anti gravity.

No laws of physics are broken in this slide

Building a Space Elevator: Step 18

Let’s see how fast we should bounce the ball inside the ISS in order to lift-off from ground level the whole ISS, assuming that:

- The ISS sits on Earth, on a launch pad
- We will place a bouncing ball inside the ISS
- The weight of the bouncing ball is equal with the weight of the ISS

Why, we should use the golden Newtonian law of conservation of momentum:

$$p = m * v$$

Since the new system has now double mass then the momentum has to be double in order to achieve gravitational equilibrium. But, with only one mass moving (heavy bouncing ball inside stationary ISS), the speed of the bouncing ball must be double!

$$V_{ball} >= 2 * V_{iss} \text{ (about 16 km / s)}$$

No laws of physics are broken in this slide

Building a Space Elevator: Step 19

It is not technically difficult to force a heavy ball (or any other object with mass) to bounce (vibrate between two points in space at non zero distance) with high speed.

A few very significant observations:

If we split the bouncing ball in two parts then we reduce the weight of one ball in half and we will eliminate any vibration by forcing the balls to bounce in mirror.

Only the initial bouncing speed must be maximum in order to locally cancel the gravity pull, and that speed requirement will become lower with any bit of altitude gain.

We can use multiple bouncing balls in order to reduce the weight of a single ball and use much lower power drivers, one driver for each ball.

The numbers shown in the calculations are very much in the real capabilities of today's technology. In fact, even a 200 years old steam engine is capable of pushing this kind of heavy balls around at usable speeds: mechanical or electromechanical forces are extreme, and it is quite difficult to generate more power through some other methods.

No laws of physics are broken in this slide

Building a Space Elevator: Step 20

Now what? We got a bouncing ball and an anti gravity epidemic. What good is that for building a space elevator? Well, we have the building blocks and now it is just a ordinary construction task to build a real space elevator:

- Build a platform say about 20m or 200m radius as the first space elevator level
- Install a JACA engine on this platform (bouncing mass, folded acceleration)
- Connect high voltage lines from the ground level up to this first platform level
- Lift the first platform up, say 10 km upward, using electric energy
- Now build a second platform for the second level, and lift it another 10 km up
- Every 10 km upward we can build a new platform, all the way into space
- This space elevator must have backup power at every level to avoid a catastrophe

No laws of physics are broken in this slide

We have a Space Elevator: Step 21

JACA space elevator: how to build it, and what it is good for?

- With proper backup power on each level it can be a very safe construction
- One attack or failure on one level will be 100% isolated at that level only
- Independently disconnected levels will be able to power-up from other towers
- A whole “city of towers” (elevators) could cooperate for emergency transfer
- Any tower could be used as a fancy space-scraper living quarters
- The emergency backup power at any level should cover a couple levels up/down
- It can provide quick and cheap access to material transport to/from space
- It can become a ground to space docking/shipping port for cheap space travel
- We can install a gigantic solar array at any level to offset the energy from cables

No laws of physics are broken in this slide

Space Elevators: Step 22 - Dyson Shell&Ring

Now our planet has large cities of space elevator towers. All heavy industry was moved into space and no more “pollutants” are released on the planet. Yes, we are designing new energy sources, but how much energy we will need to explore near-by constellations?

Don’t you worry, we have now the technology to build a Dyson sphere. Our JACA engine is the key to the next great chapter in human history. It is the key for the whole humanity to move up one step on the Kardshev Scale, becoming a Type 2 civilization, with good prospects to achieve Type 3 in a not too distant future.

A JACA engine is not only defeating gravity, it is making the gravity just another cog in the engine. It is the ticket to deep space travel and civilization progress.

No laws of physics are broken in this slide

