Why We Can’t Go to Mars…

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Why We Can't Go to Mars...

...YET!

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Why We Can't Go to Mars...

...EVER!

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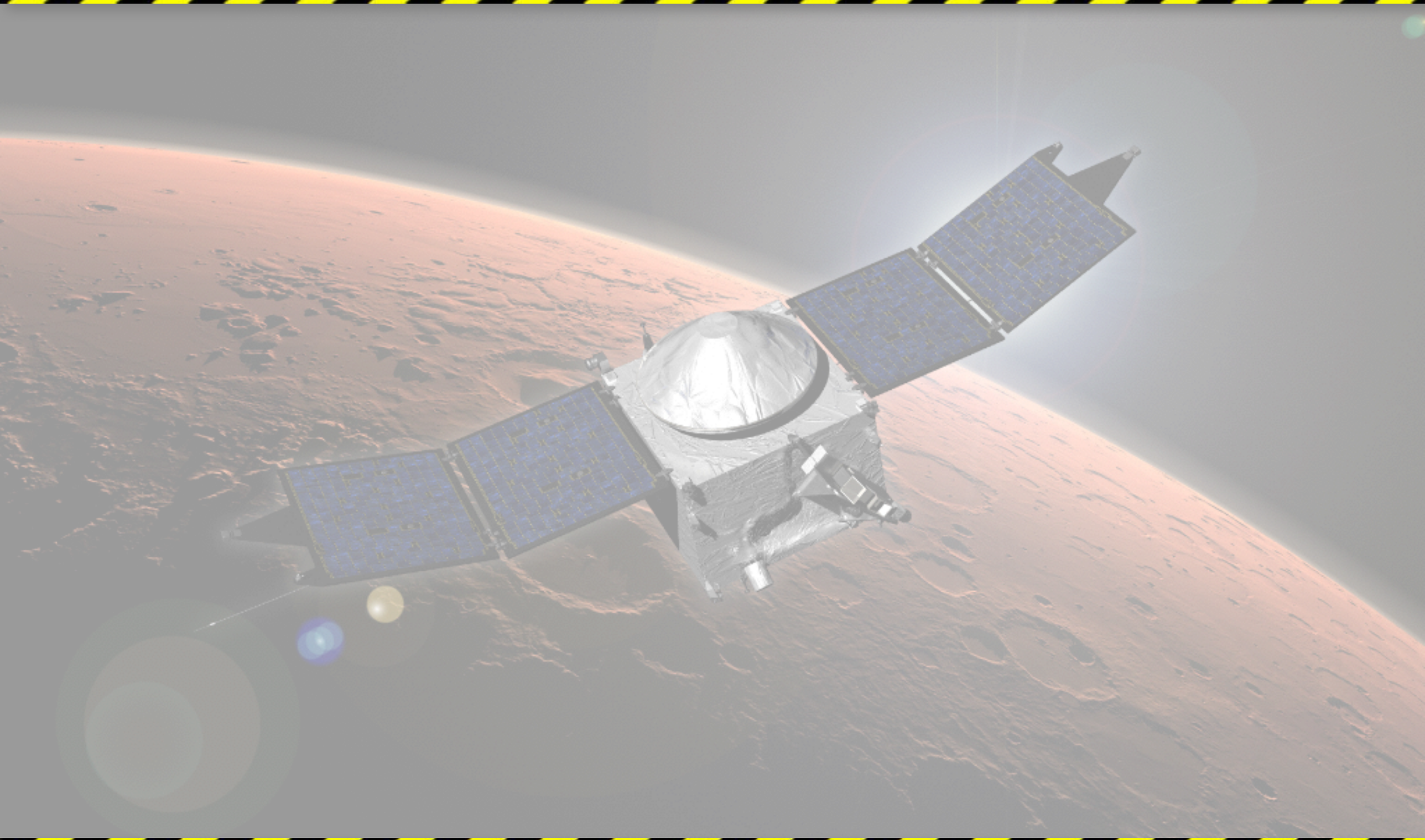
Why the Heck Not?

Why the Heck Not?

Why the Heck Not?

- Martian Defense Grid
- Money
  - Congress
  - SLS
- Mission Duration
  - Meteor damage
- Human Physiology
  - Muscular atrophy
  - Bone loss
- Vision changes
- Low blood pressure
- Immunodeficiency
- Radiation
- Practice of medicine
- Psychological Stresses
- Life support / Recycling
- In Situ Resource Utilization
- Aerobraking & Landing

Martian Defense Grid



Martian Defense Grid

Successes: 19

First flyby, 1964: Mariner 4

Martian Defense Grid

Successes: 19

Martian Defense: 28

First mission failure: OKB-1, 1960

How Much Would It Cost?

Courtesy of www.creativecartoons.org

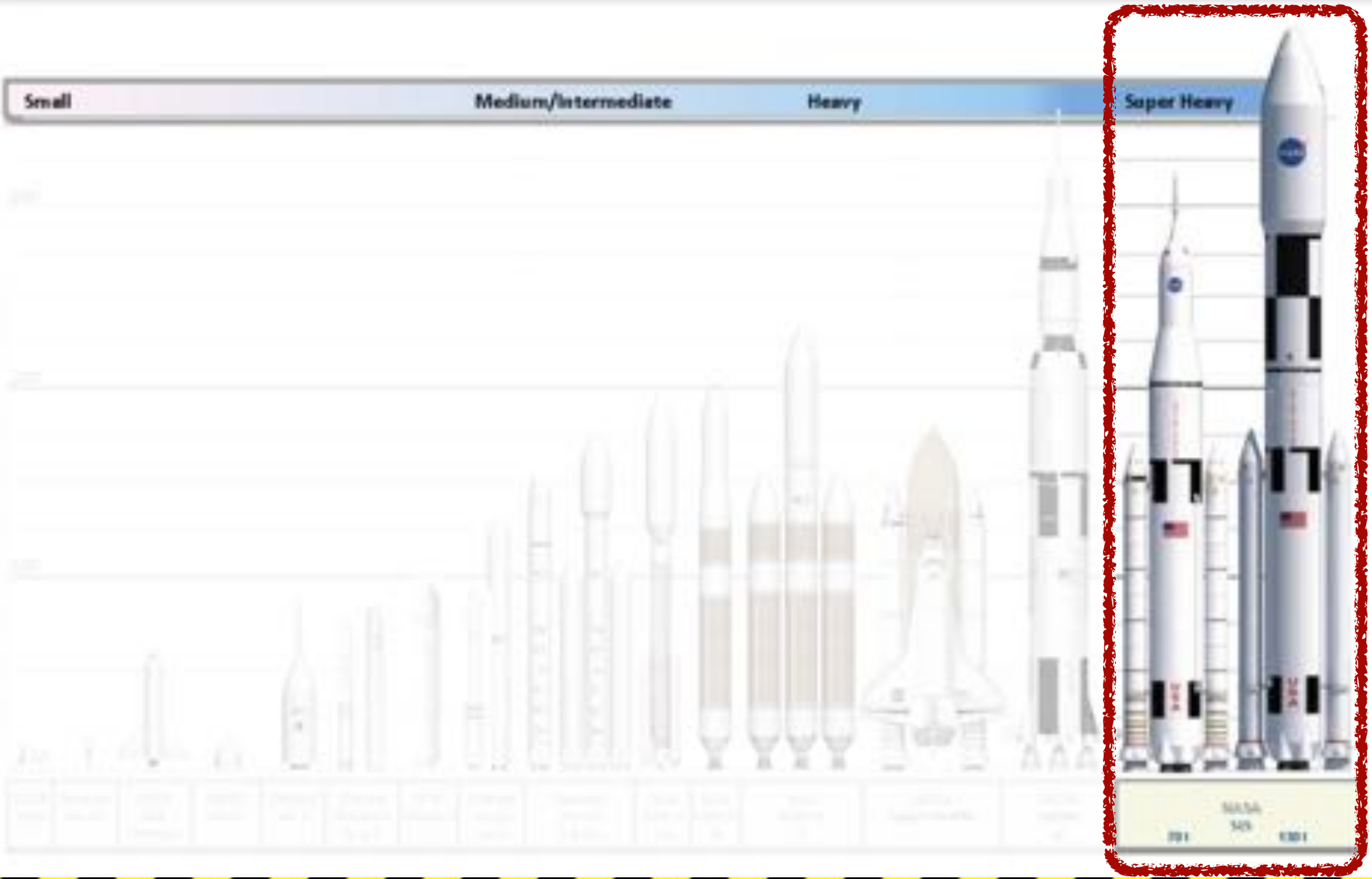
“One Trillion Dollars!”

Probably $100 Billion via NASA

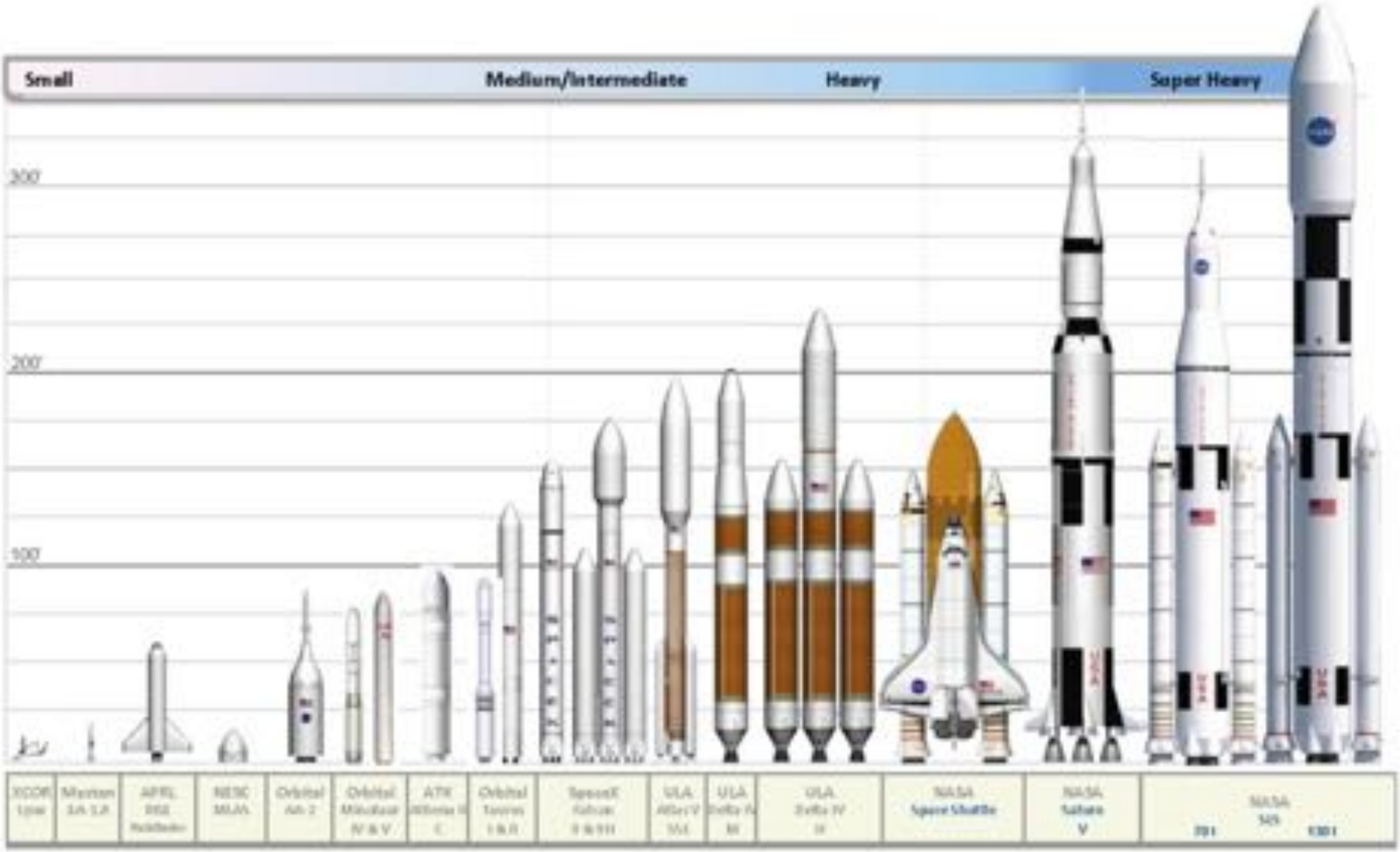
Cost of NASA Mars mission would be comparable to the lifetime cost of building ISS.

National Rocket Design Bureau

SLS: Senate Launch System



SLS: Senate Launch System



SLS: Space Launch System

Between $2-5 billion per launch.

Multiple launches required per Mars mission.

Gonna Be A Long, Long Time…

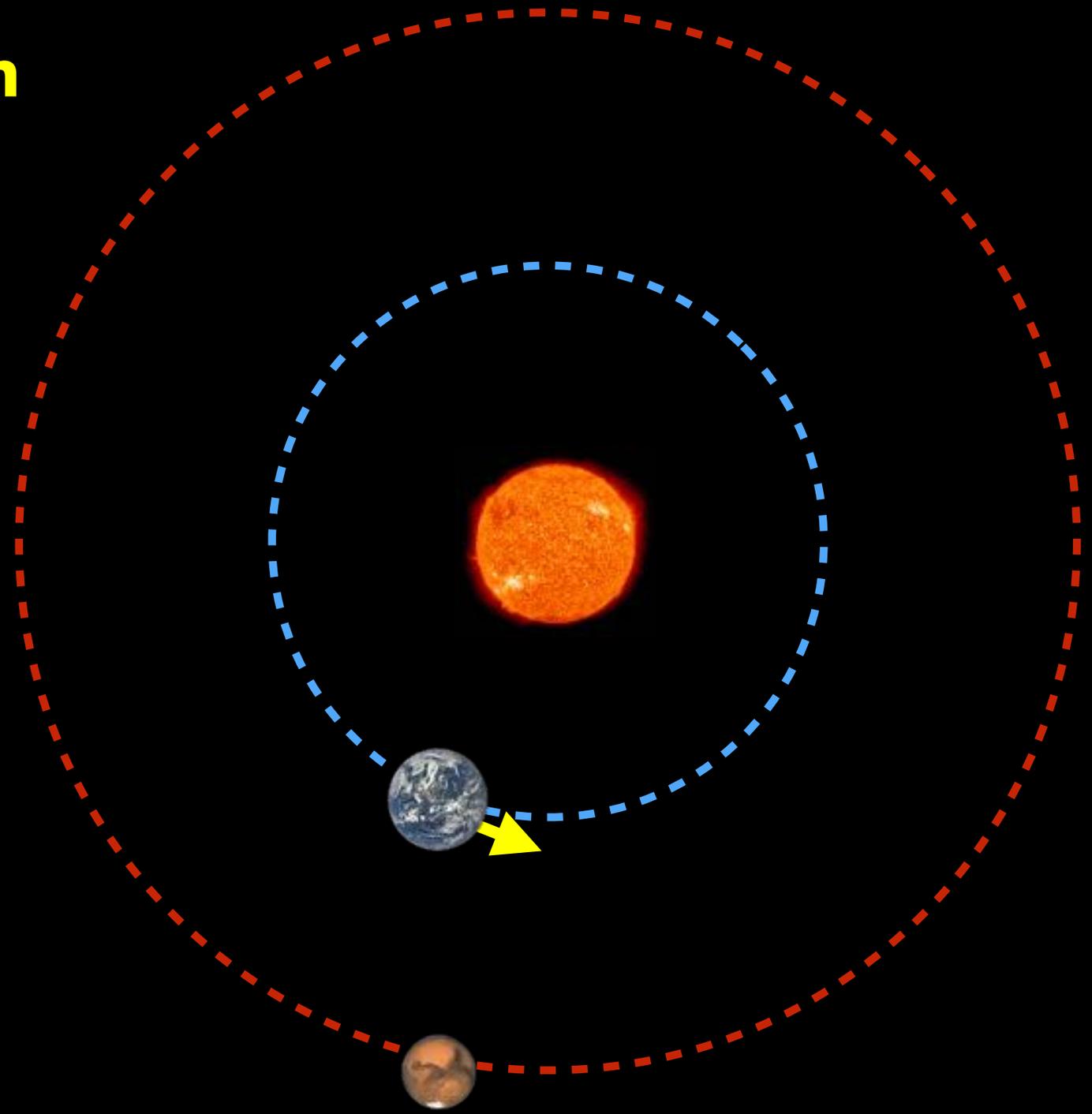
On average, Mars is

500x

as far away as the Moon.

Your 2.5 Year Mission…

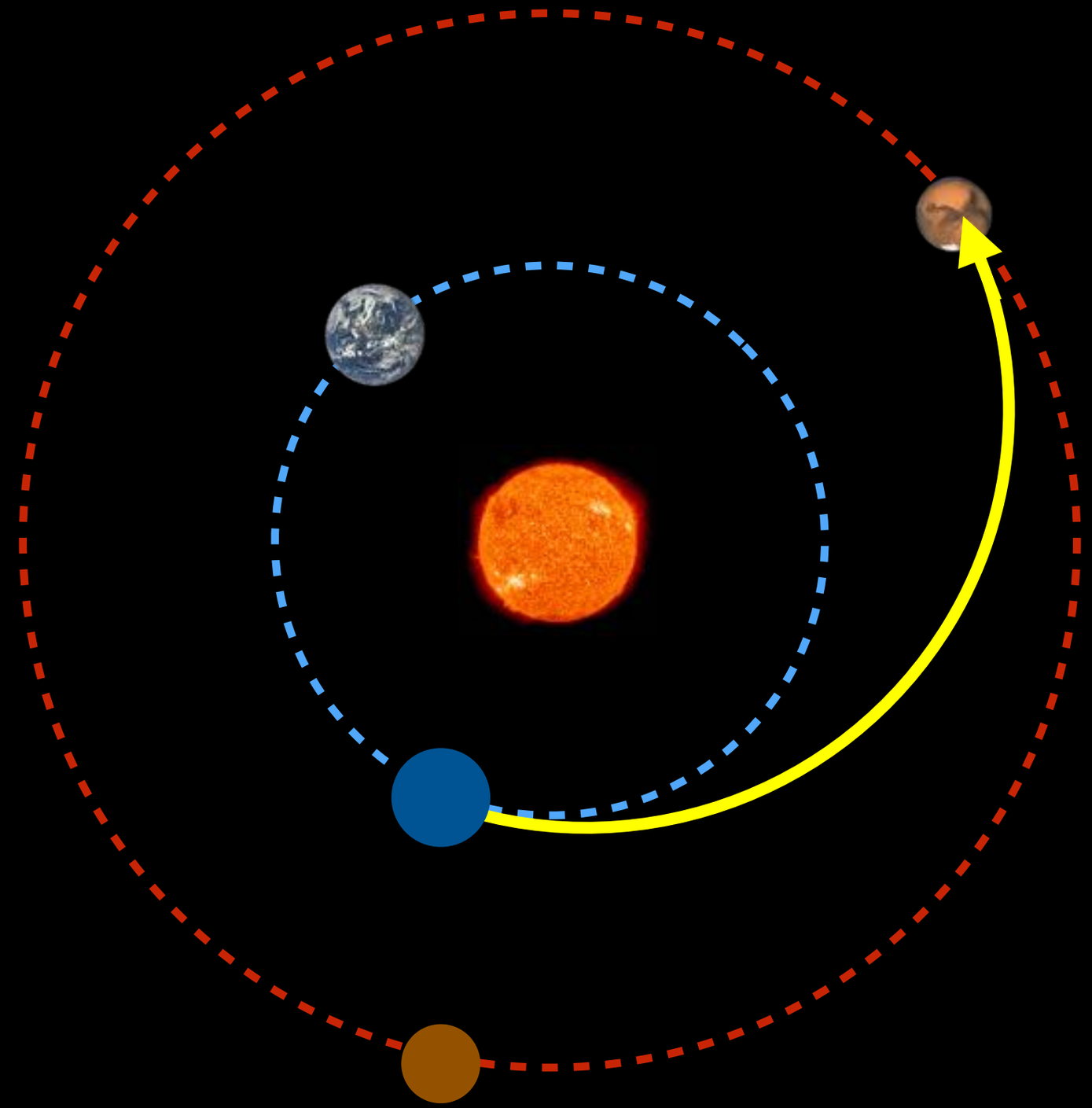
Leave Earth near Mars closest approach



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

Your 2.5 Year Mission…

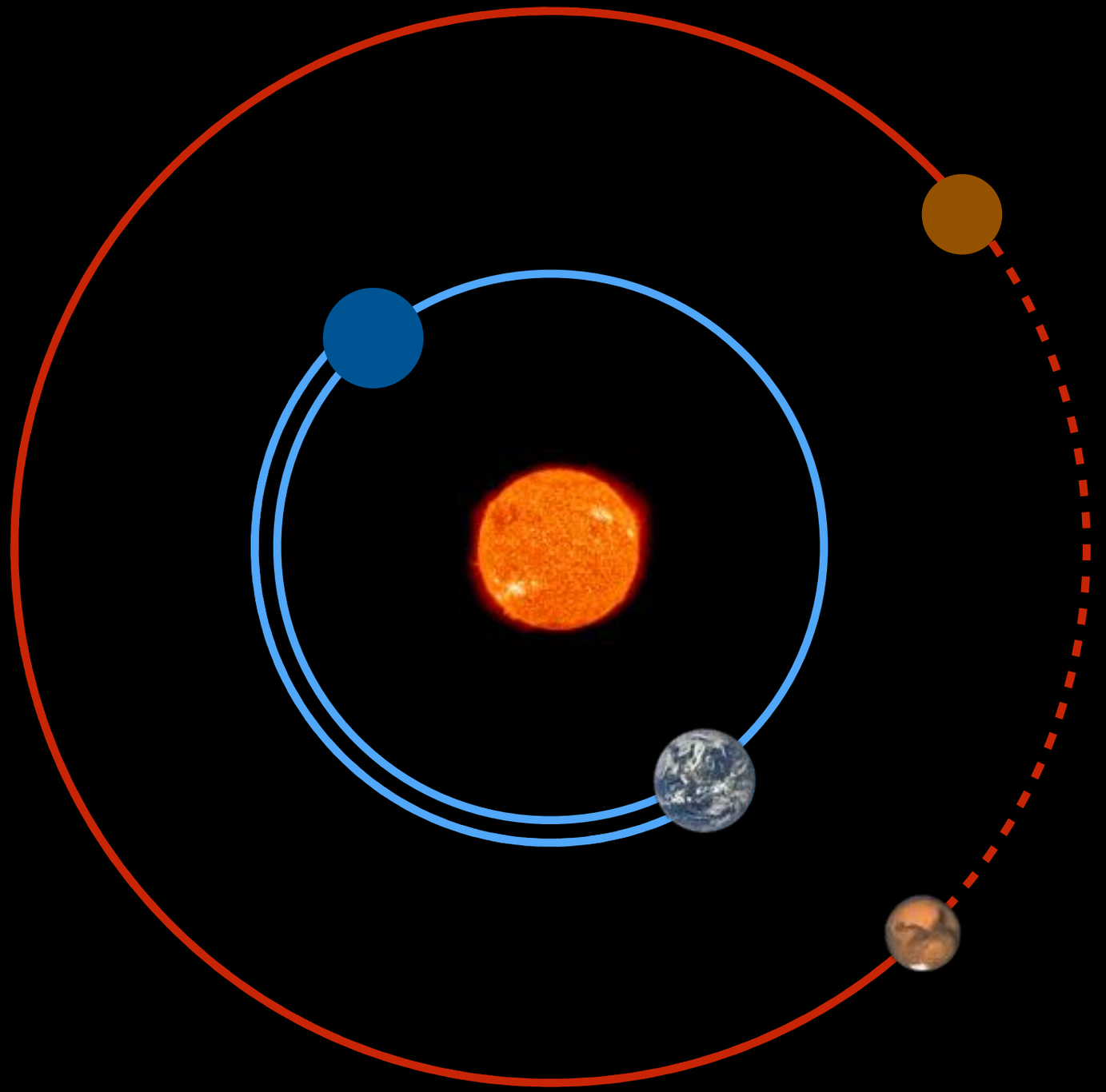
Outbound:
235 days



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

Your 2.5 Year Mission…

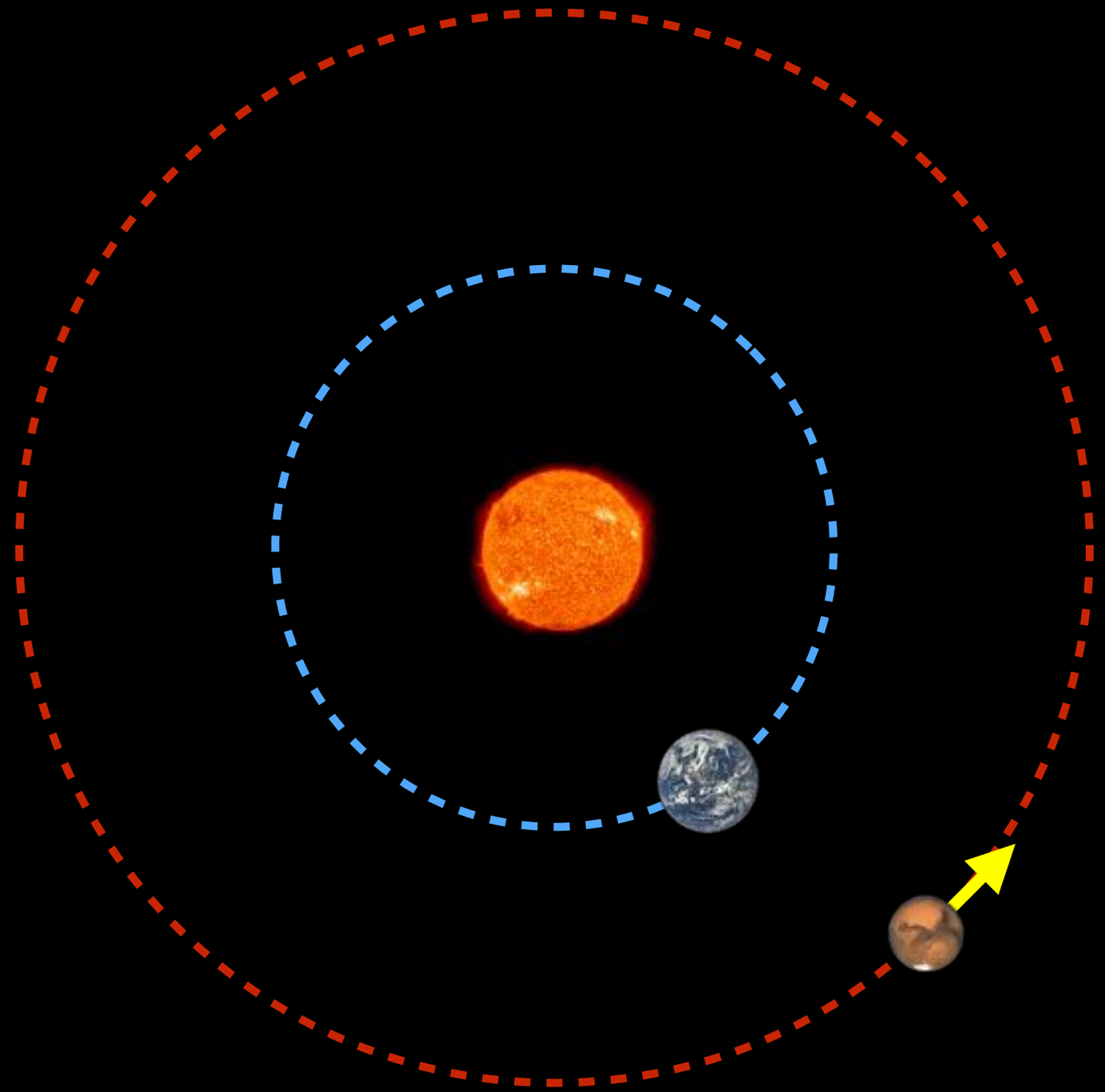
Surface stay: 516 days



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

Your 2.5 Year Mission…

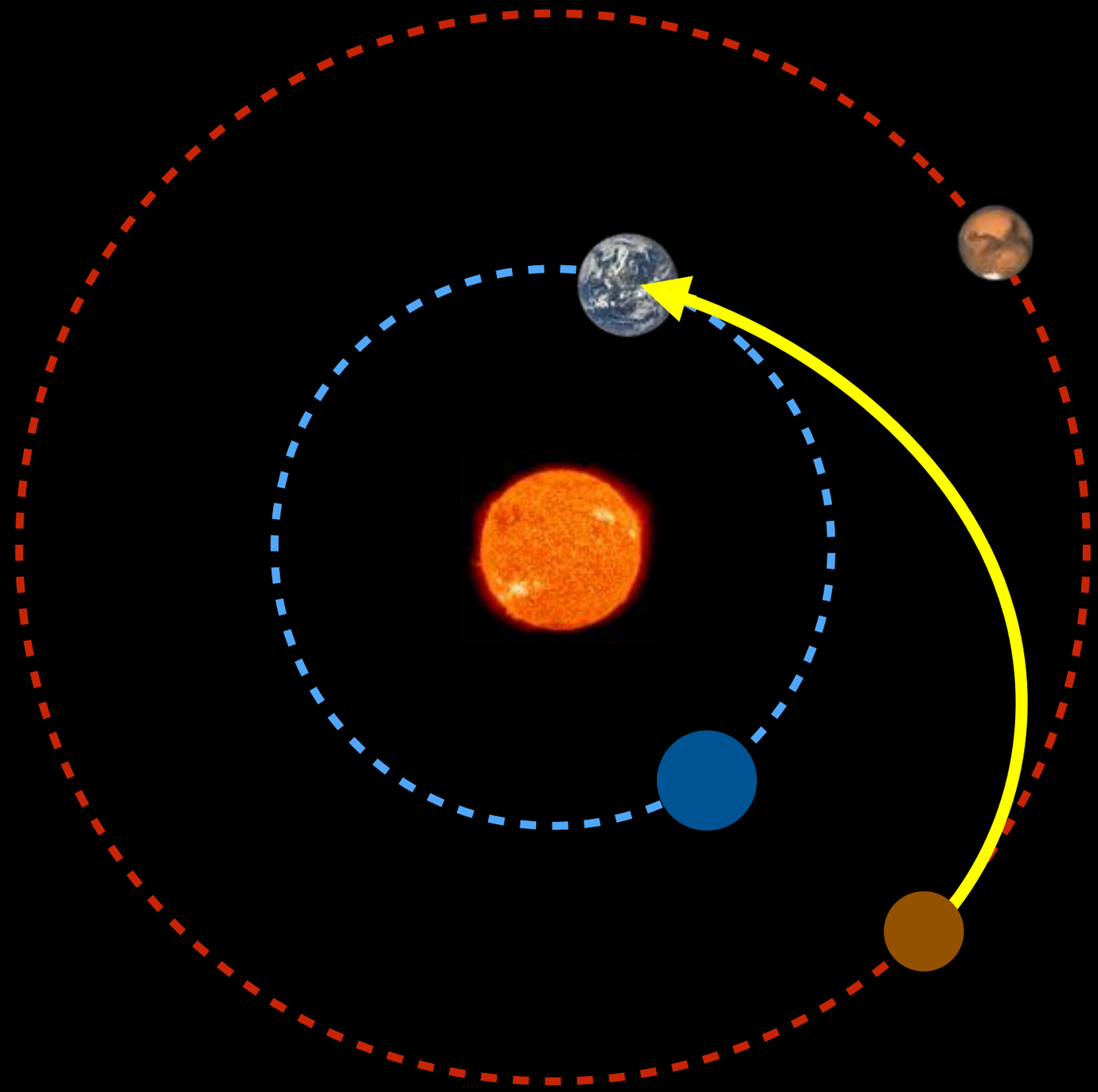
Leave Mars near Earth closest approach



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

Your 2.5 Year Mission…

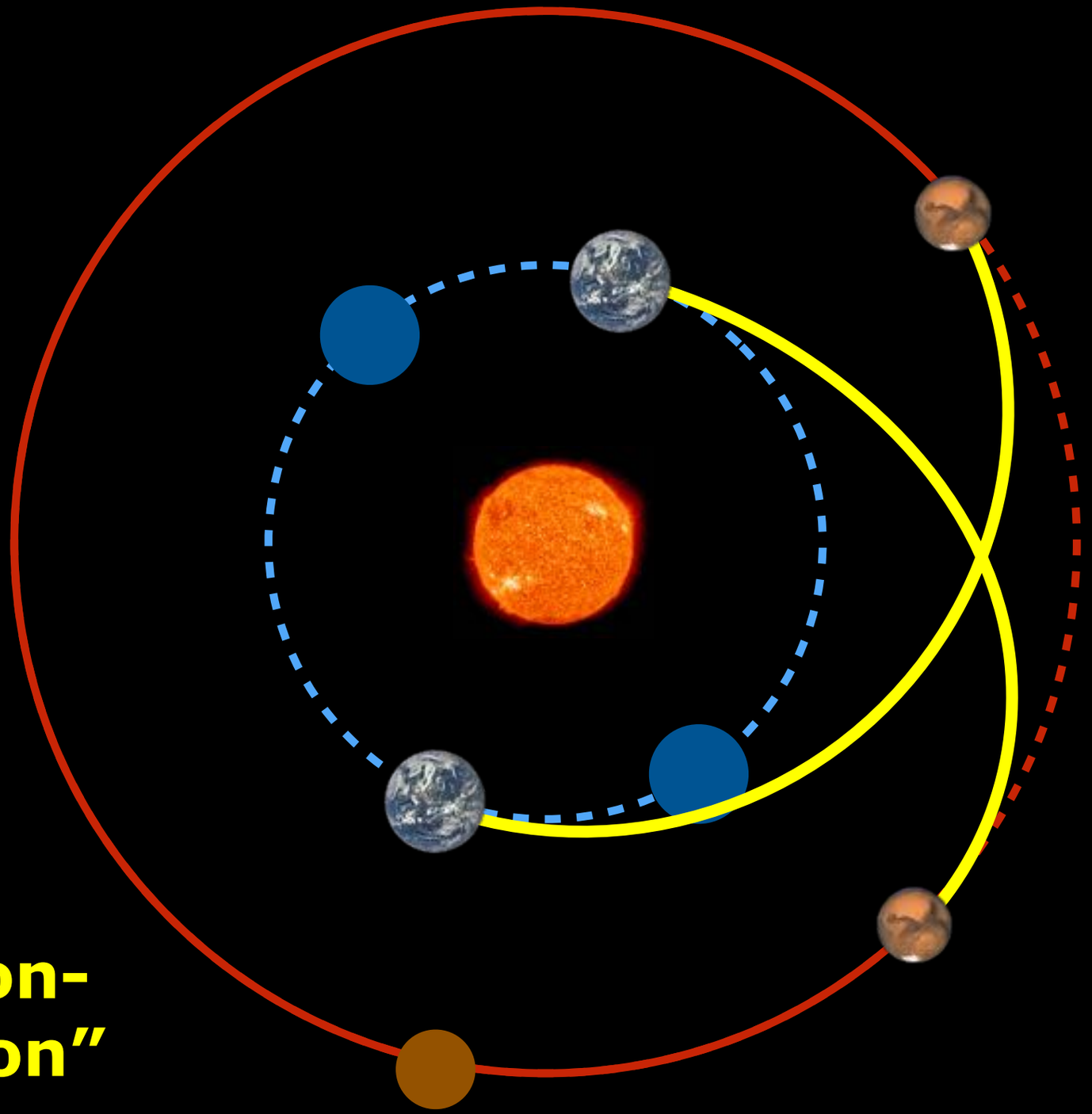
Return:
191 days



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

Your 2.5 Year Mission…

Total trip time: 942 days



http://ccar.colorado.edu/asen5050/projects/projects_2007/warren_proj/

"Conjunction-class mission"

At Least Six Months Transit Each Way

At Least Six Months Transit Each Way

A Tiny Rock Can Ruin Your Whole Day

Zero-G is Bad for You *(dammit)*

The Reality

Muscular Atrophy

Bone Loss

Vision Changes

Vision Changes

- **Multiple serious problems**
  - –Glaucoma (increased intraocular pressure)
  - –Intracranial hypertension
  - –Swelling of optic nerve
  - –Choroidal folds
- **Loss of visual acuity**
  - –Inability to read checklists!
- **Affects 60% of ISS astronauts**

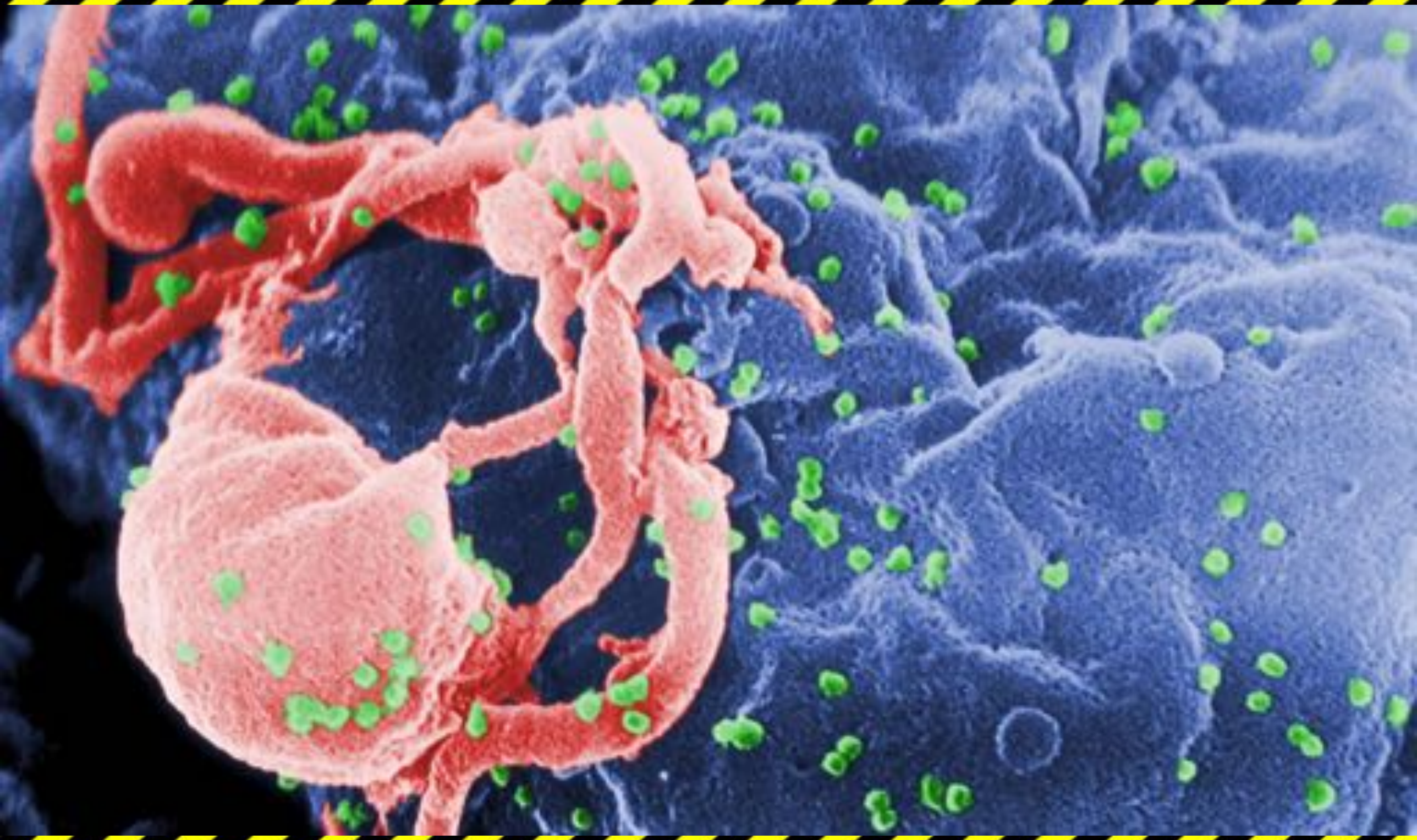
Vision Changes

“This is one that we don’t yet have a good handle on, and it can be a showstopper.”

—Mark Shelhamer
Chief Scientist
NASA Human Research Program
Johnson Space Center

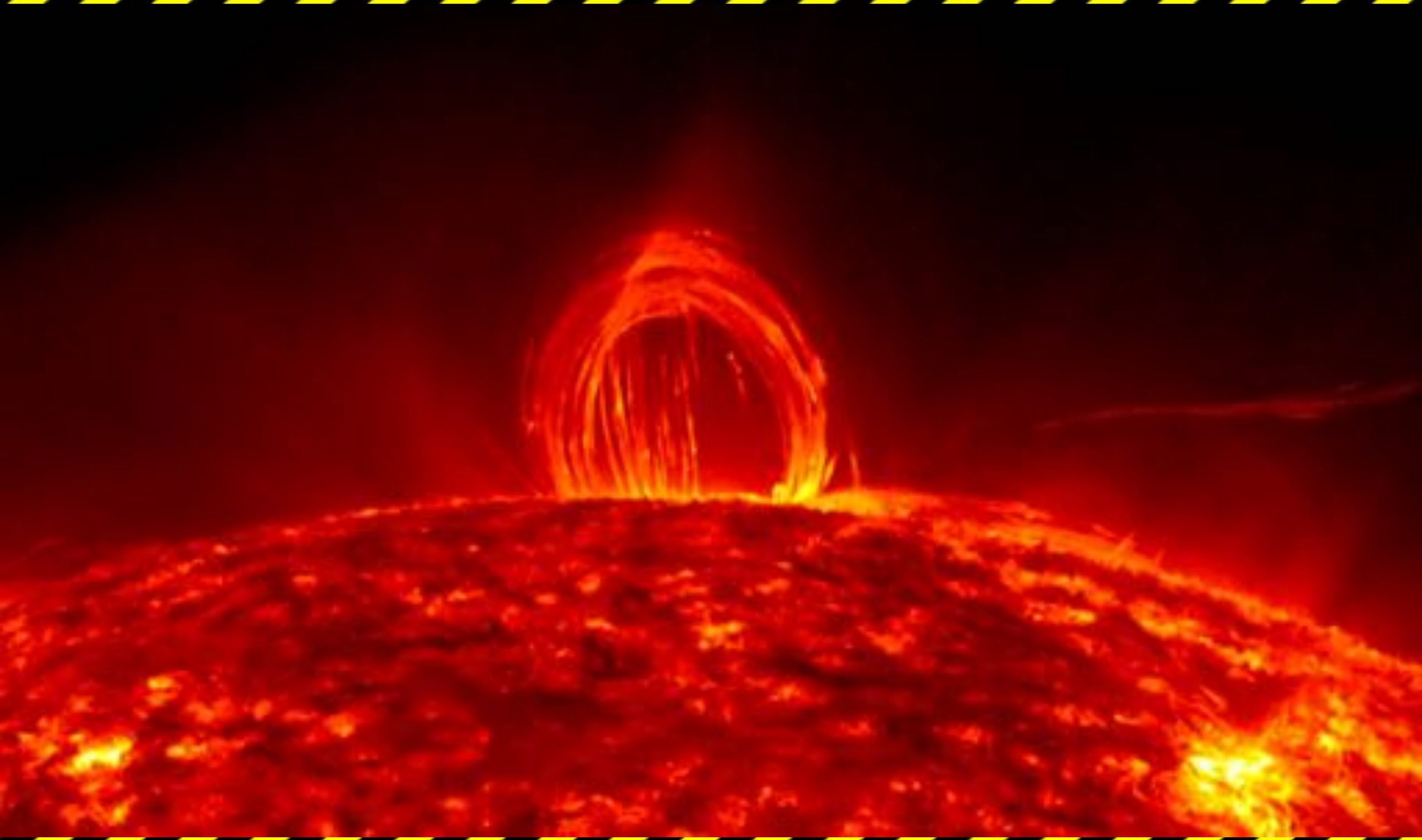
Lowered Blood Pressure

T-Cell Immunodeficiency

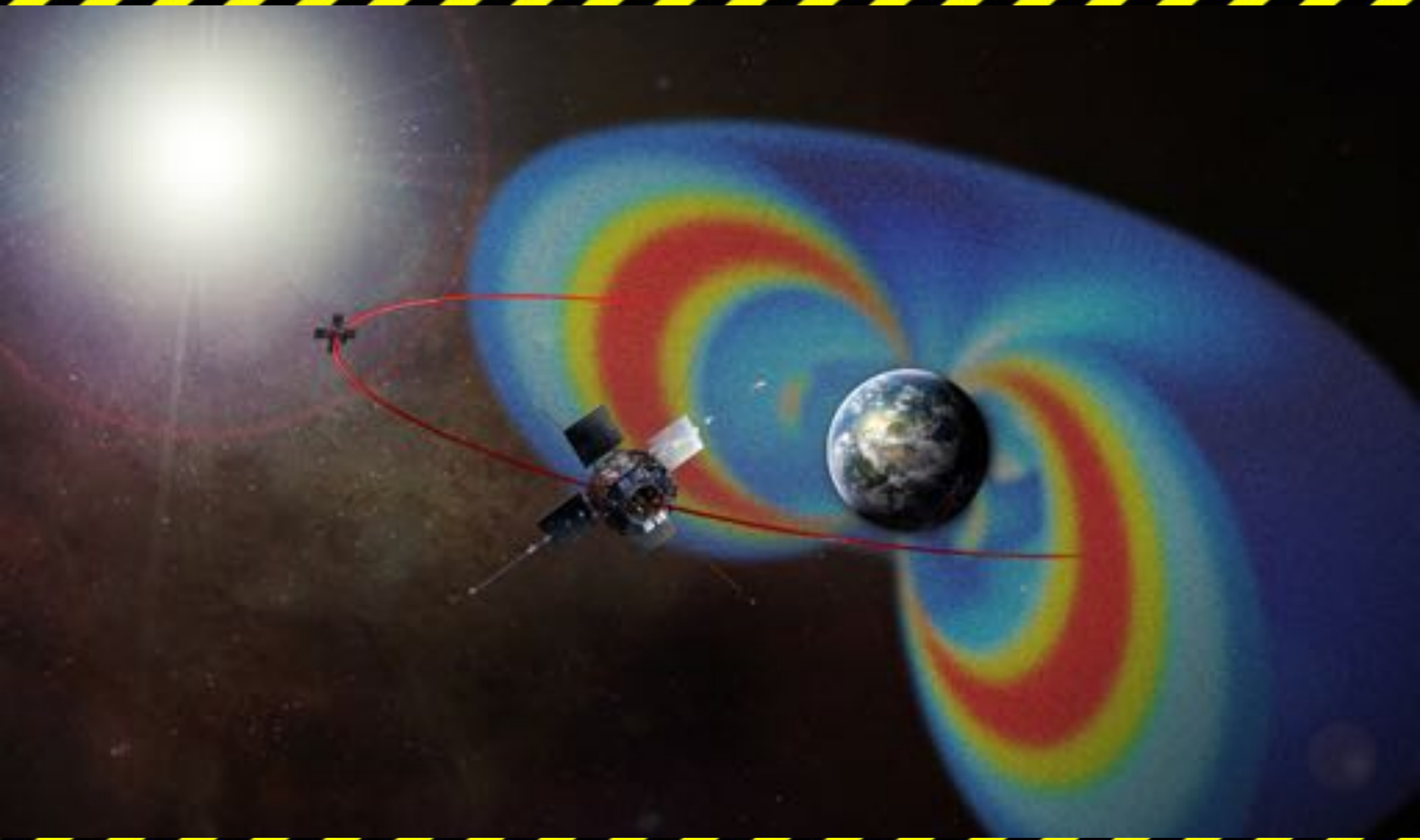


Surgery Will Be Tricky

Space is Radioactive!



DEEP Space is REALLY Radioactive!



Psychological Challenges

“If you want to instigate the art of manslaughter just shut two men up in a eighteen by twenty-foot cabin for a month. Human nature won't stand it.”

—O. Henry, 1906

“Make Him Stop Touching Me!”

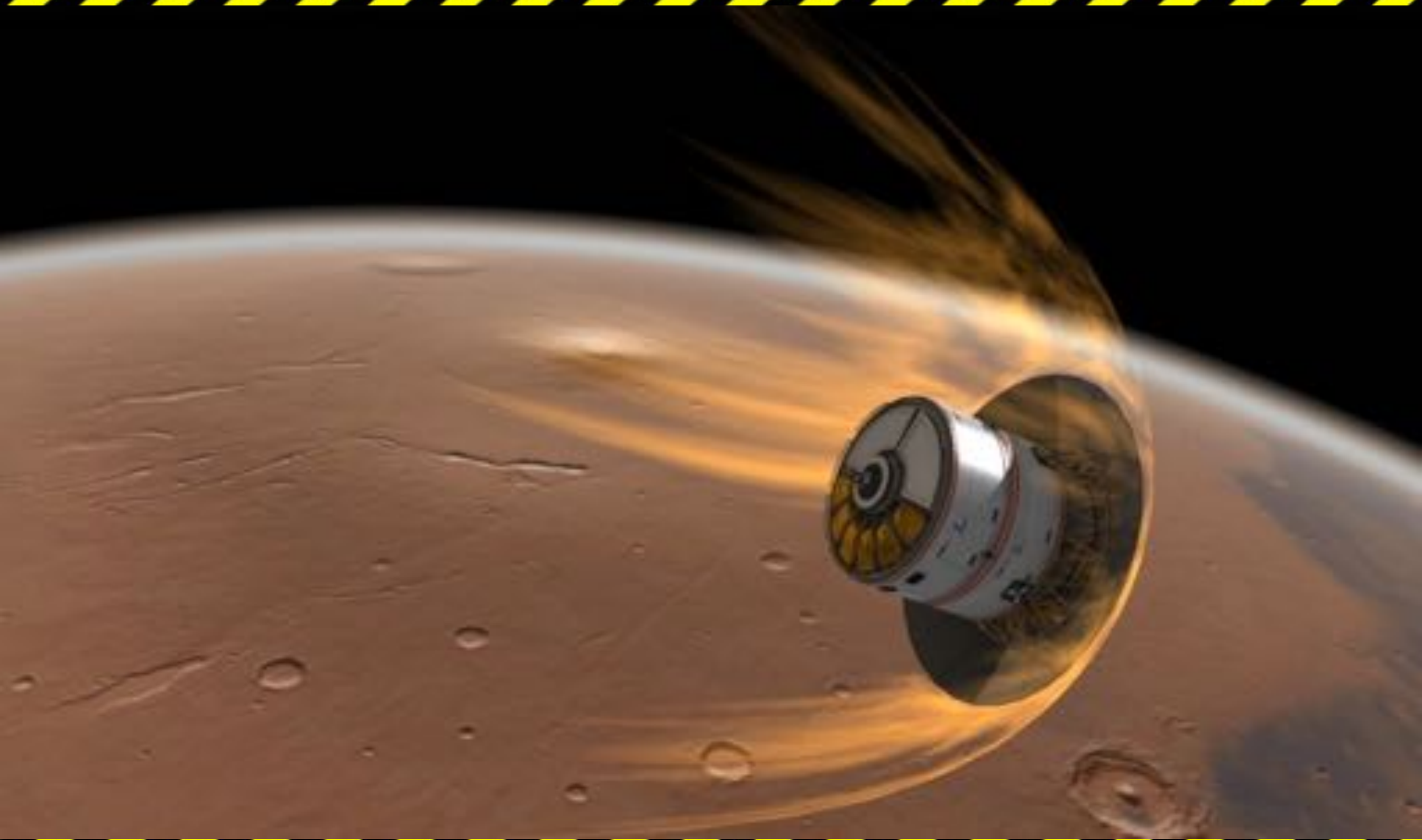
No Chance of Resupply En Route

Can’t Take Enough Water…

Can’t Take Enough Food…

…We'd Better Get Good at Recycling!

Congratulations! You've Arrived!



Seven Minutes of Terror?

SpaceX “Red Dragon”

Total mass
7.5 tons

Payload
1 ton

For Comparison…

Total mass
18 tons

How Big is Your Lander?

One good source: http://www.ssdl.gatech.edu/papers/conferencePapers/AIAA-2006-7427.pdf

Wow. This Seems Really Uncertain…

Learn.

What Would Learning Look Like?

- Focus ISS
  - Life support (ECLSS)
- Back to the Moon
  - In-situ Resource Utilization (ISRU)
  - Radiation shielding
  - Deep space at L1 Lagrange point
- LEO beyond ISS
  - More life support
  - New "G-lab" to examine gravity and physiology
- Other technologies
  - Centrifugal tethers
  - Propellant depots
  - Advanced propulsion
  - Mars deceleration
- Phobos Base
  - Real-time teleoperation

Focus ISS Research on Spacefaring

Intentionally build knowledge base, technologies, and experience necessary for deep-space missions.

ISS: On-Orbit Assembly

ISS: More ECLSS Work

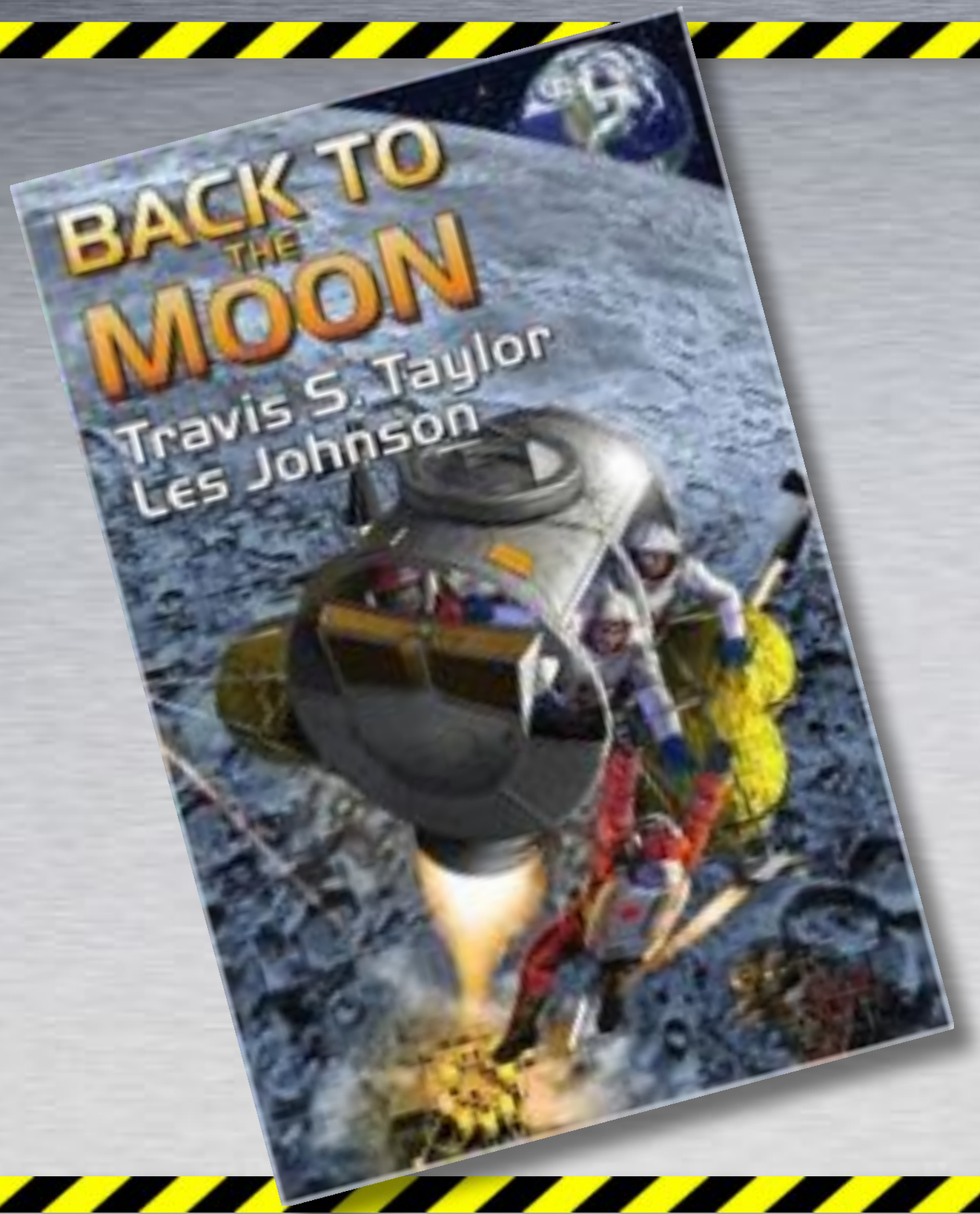
Water-only recycling: 93% efficient

ISS: Develop Closed-Loop Life Support

Earth: Habitat Simulators

HI-SEAS:
Hawaii Space Exploration Analog and Simulator

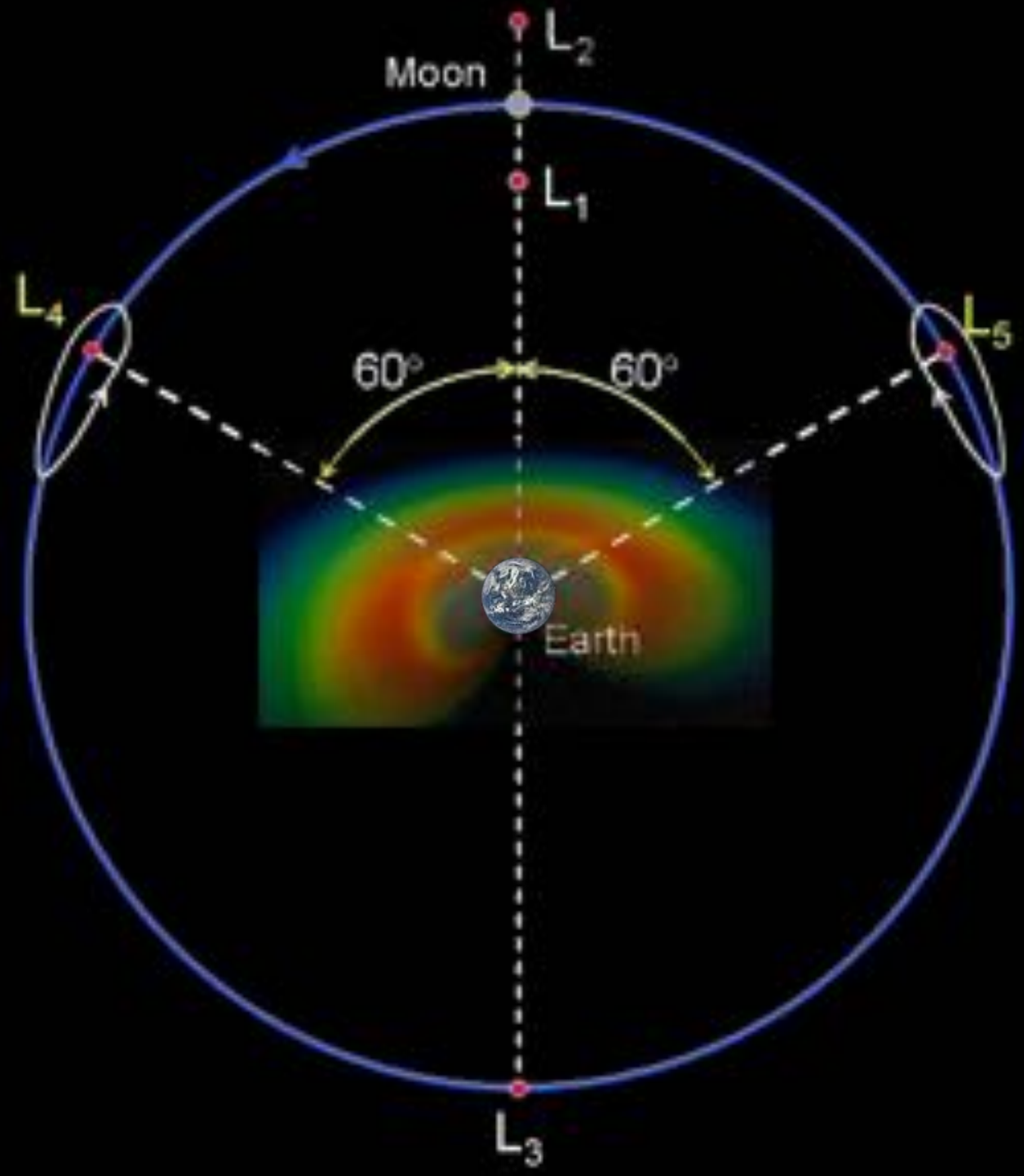
We Need to Go Back to the Moon!



Lunar Testbeds: In-Situ Resource Use

Lunar Testbeds: Radiation Shielding

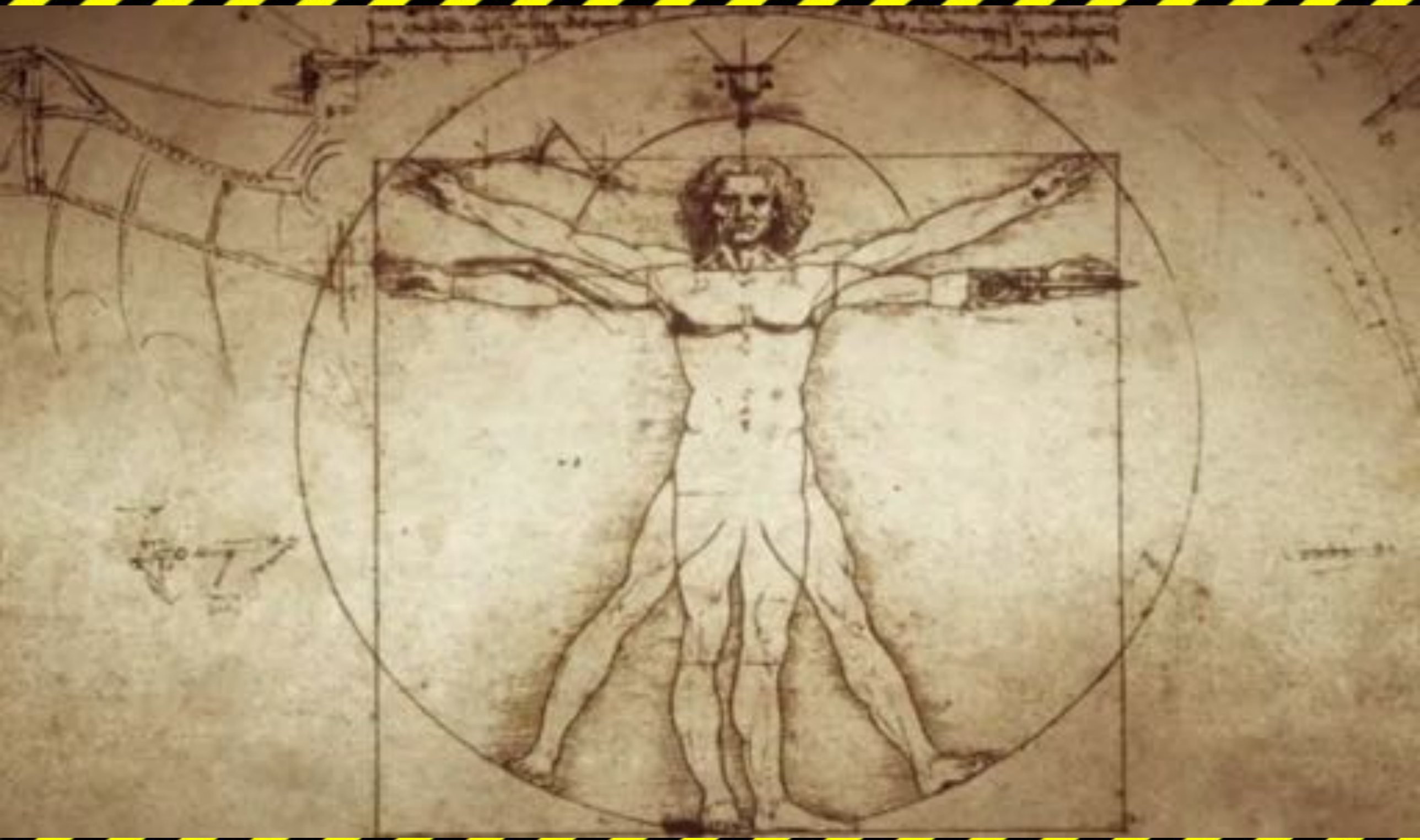
Lagrange Points



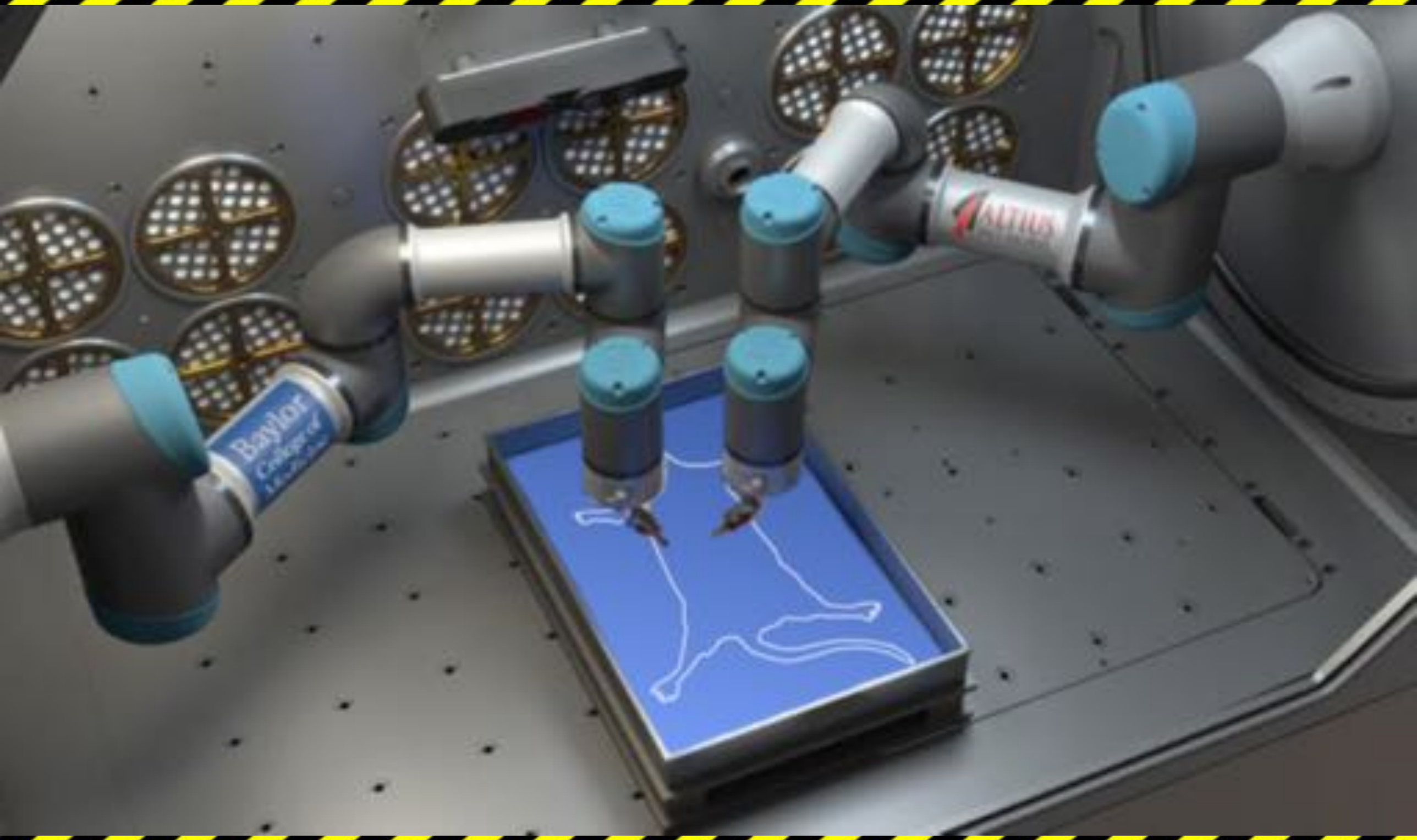
http://map.gsfc.nasa.gov/mission/observatory_l2.html

L1 Station: Deep Space Experience

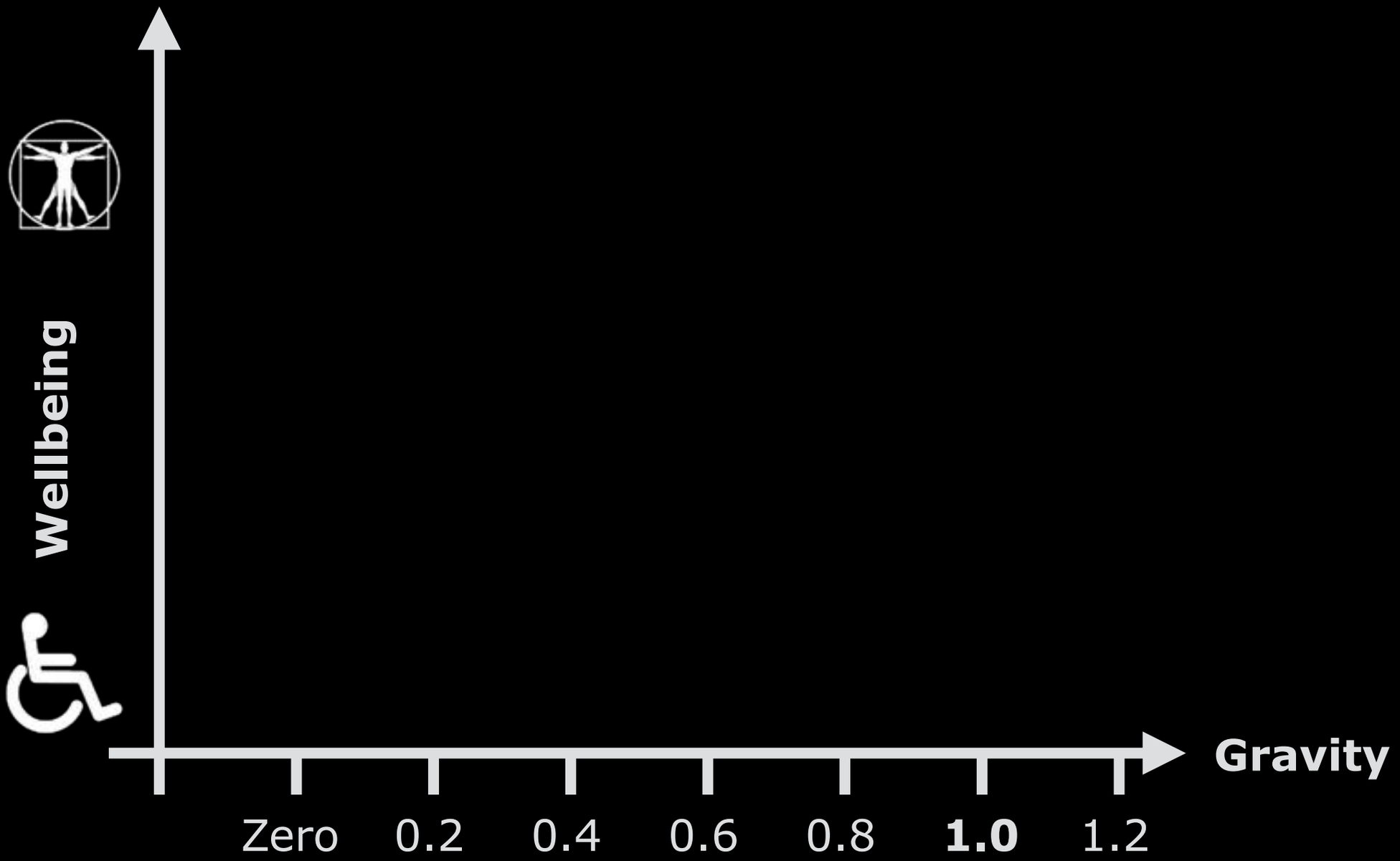
ISS: Gravity and Physiology



ISS: Robotic Animal Research

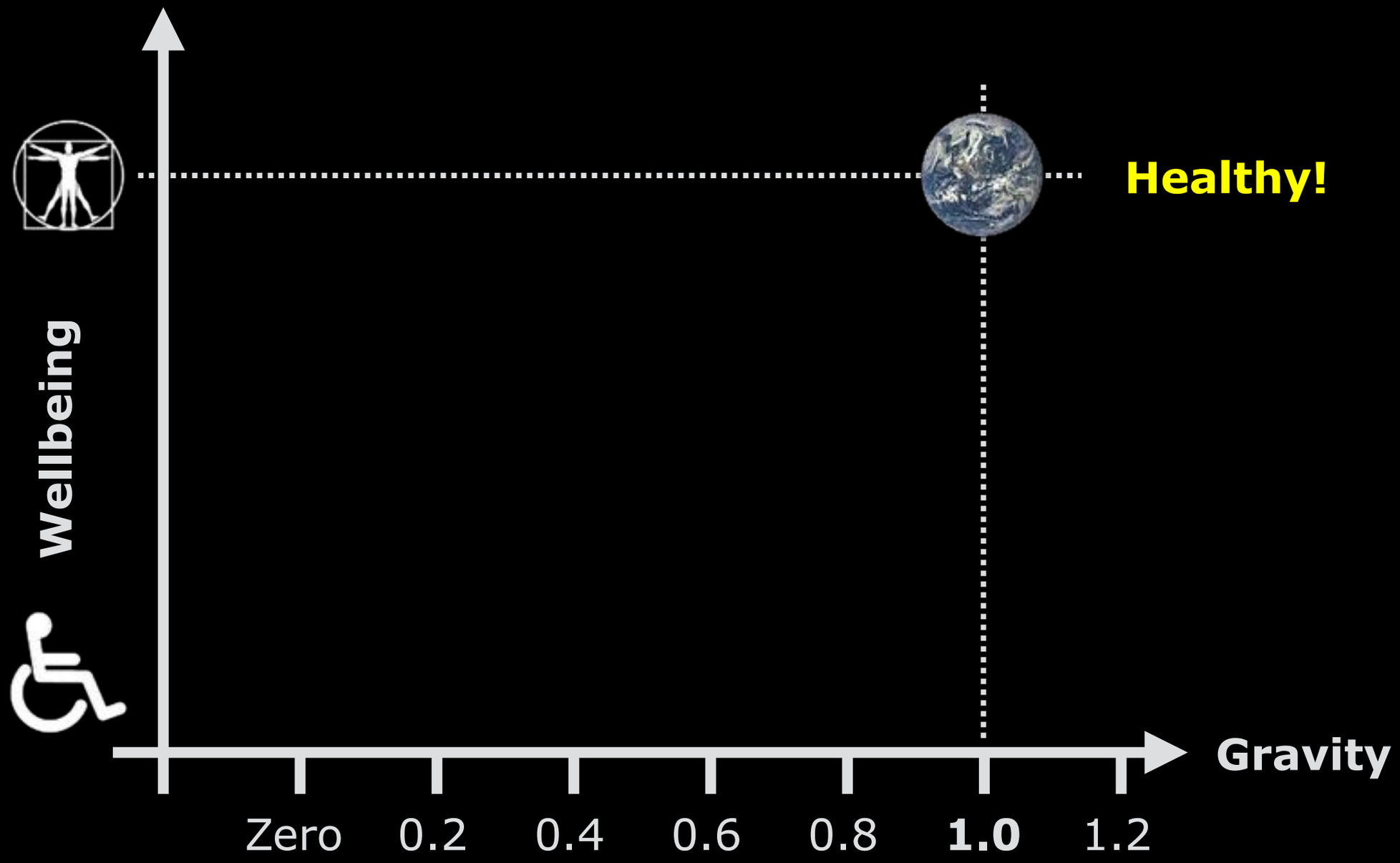


Gravity and Physiology



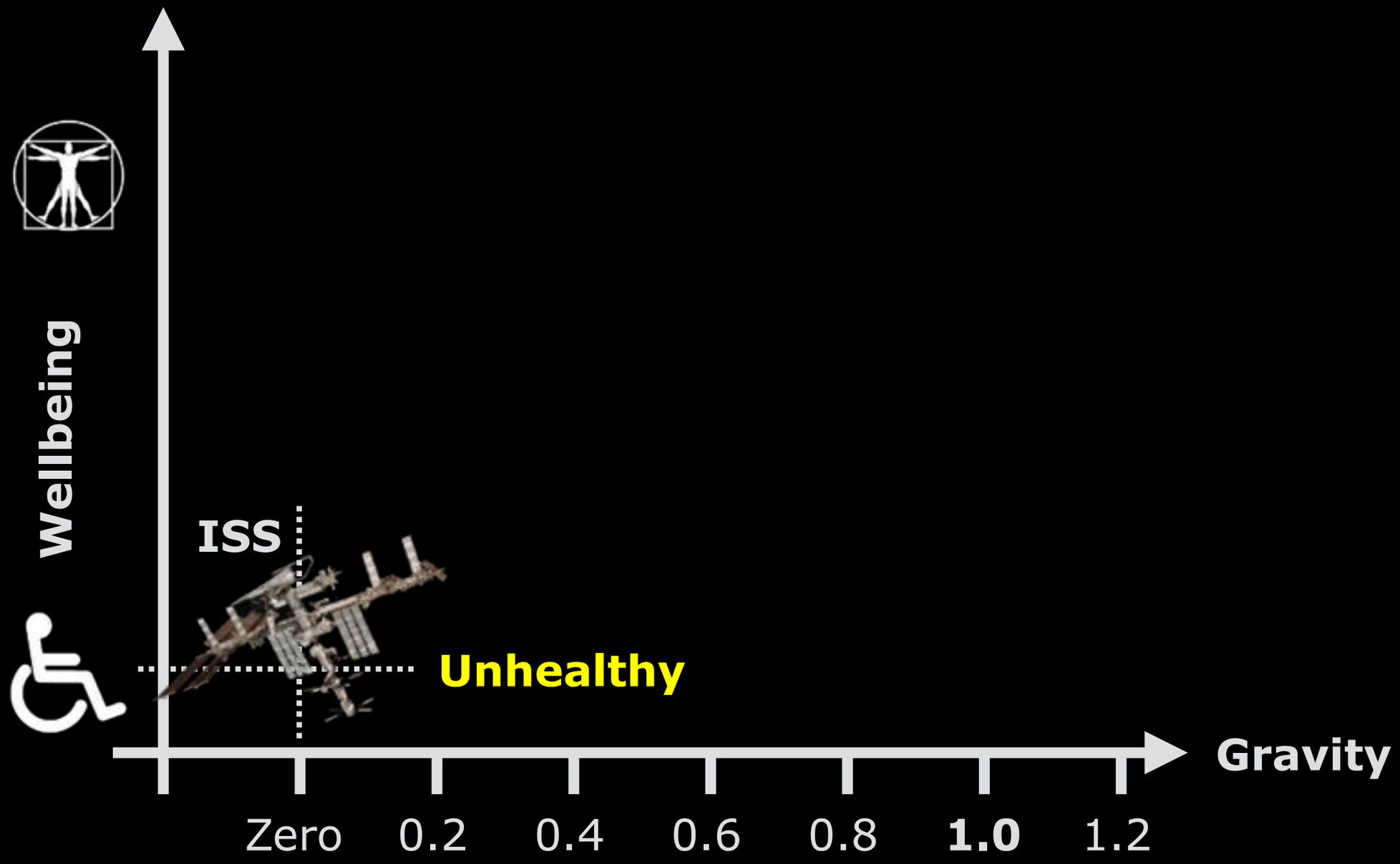
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

Earth: 1.0 G



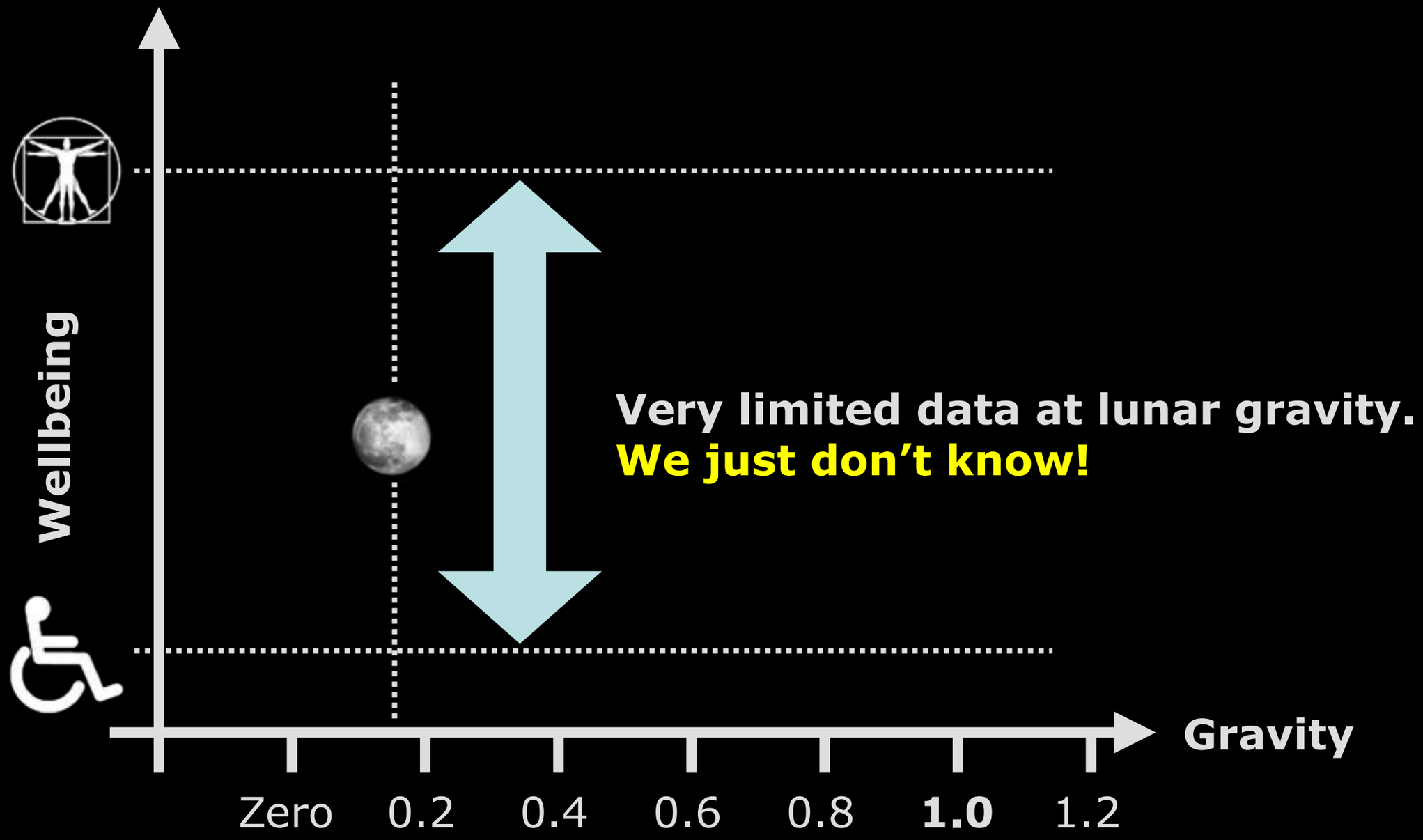
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

Free Fall: “Zero Gravity”



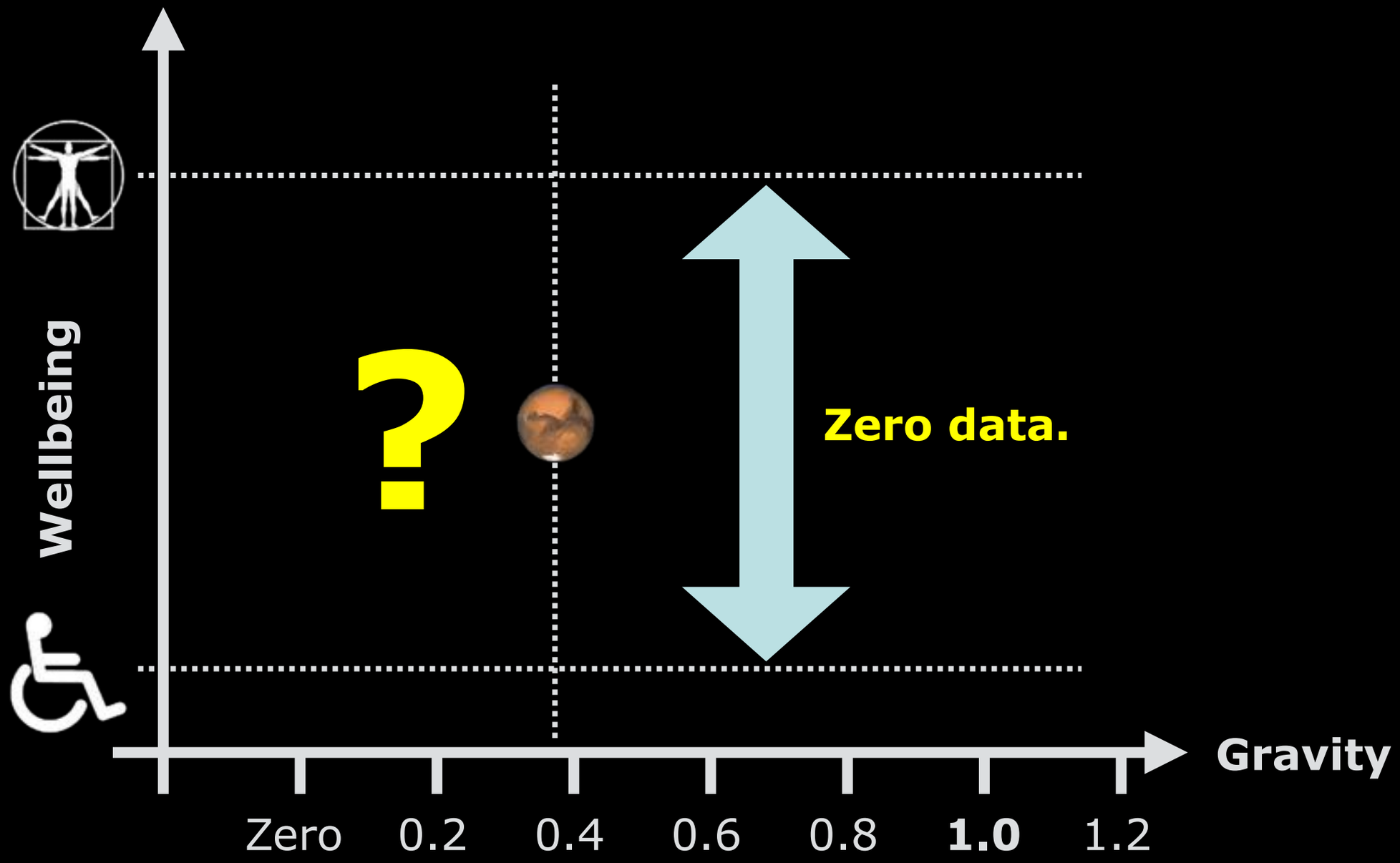
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

Moon: 0.17 G



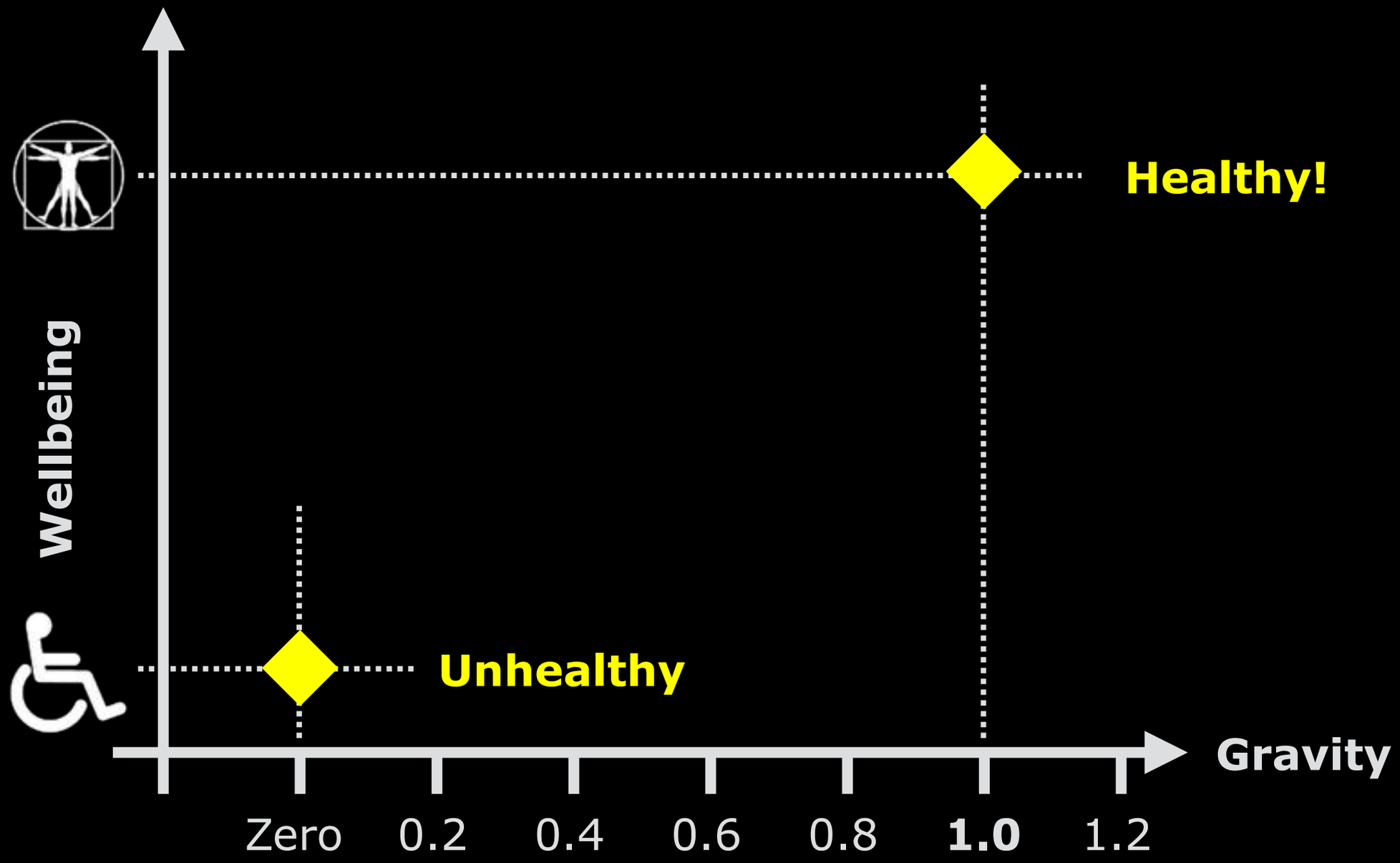
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

Mars: 0.38 G



Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

We Only Have Two Data Points!

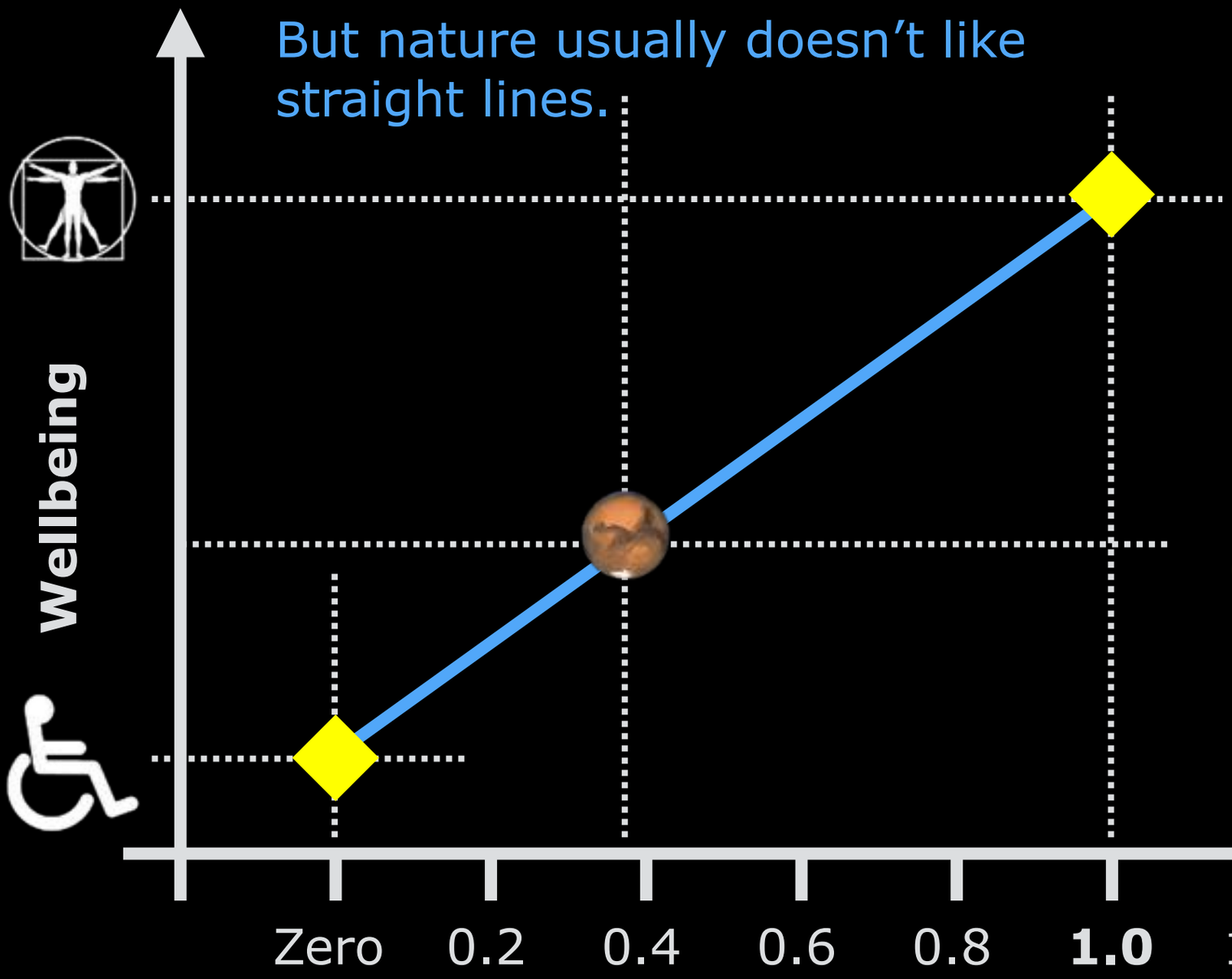


Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

Straight Line Interpolation?

Simple interpolation.

But nature usually doesn't like straight lines.



Mars isn't healthy. Outpost, but not a human world.

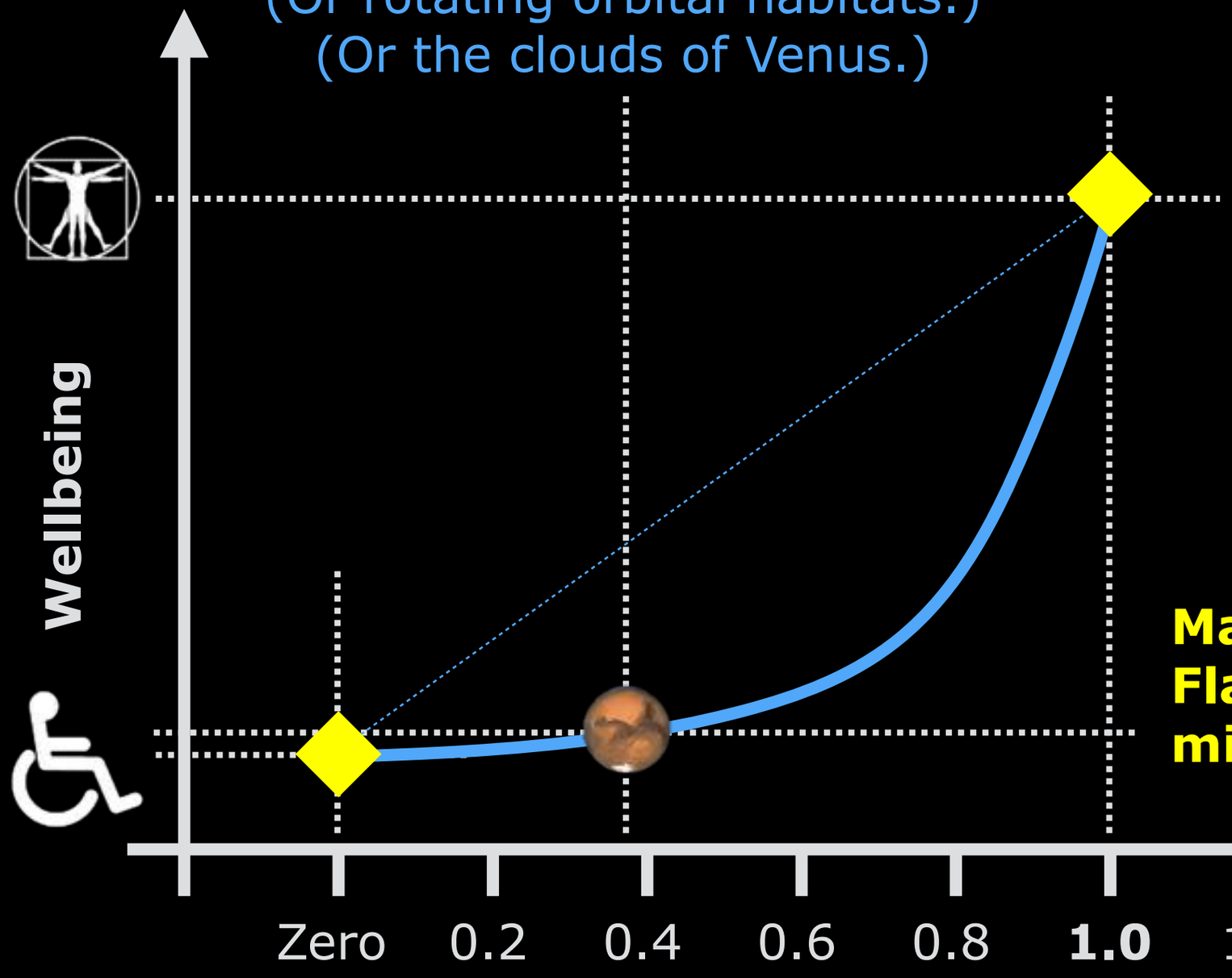
1

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

What If We *Need* Earth Gravity?

Humans need gravity. We're trapped on Earth.

(Or rotating orbital habitats.)
(Or the clouds of Venus.)



Mars is unhealthy. Flags and footprints missions only.

2

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

This Works in Free Fall. Not on Mars.

The Target Shifts from Mars to Venus

What If We *Need* Earth Gravity?

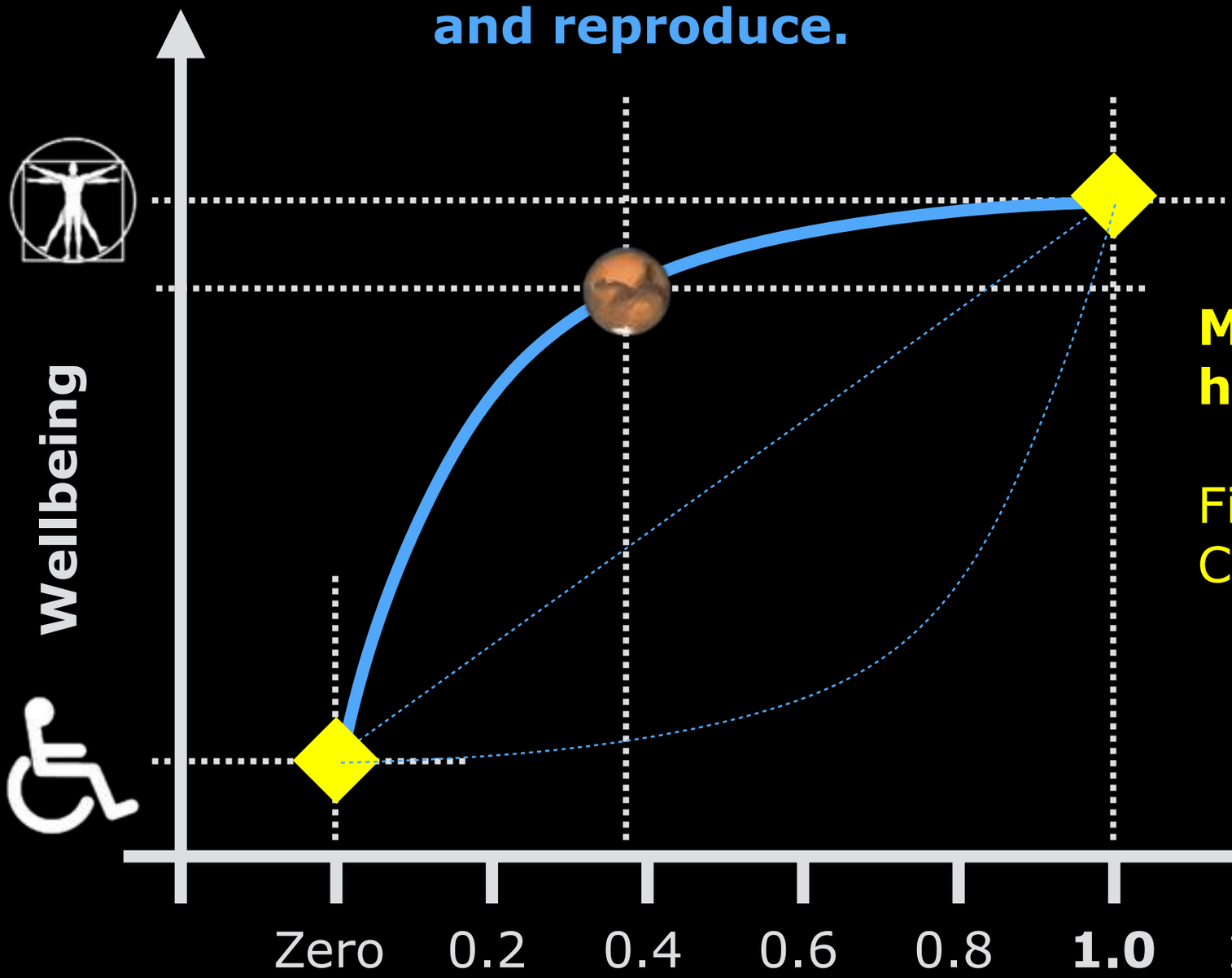
2

Anyone in 2015 who states that this scenario is false is guilty of wishful thinking.
(At the very least.)

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

What If A Little G Goes a Long Way?

1/3 G is enough to thrive and reproduce.



3

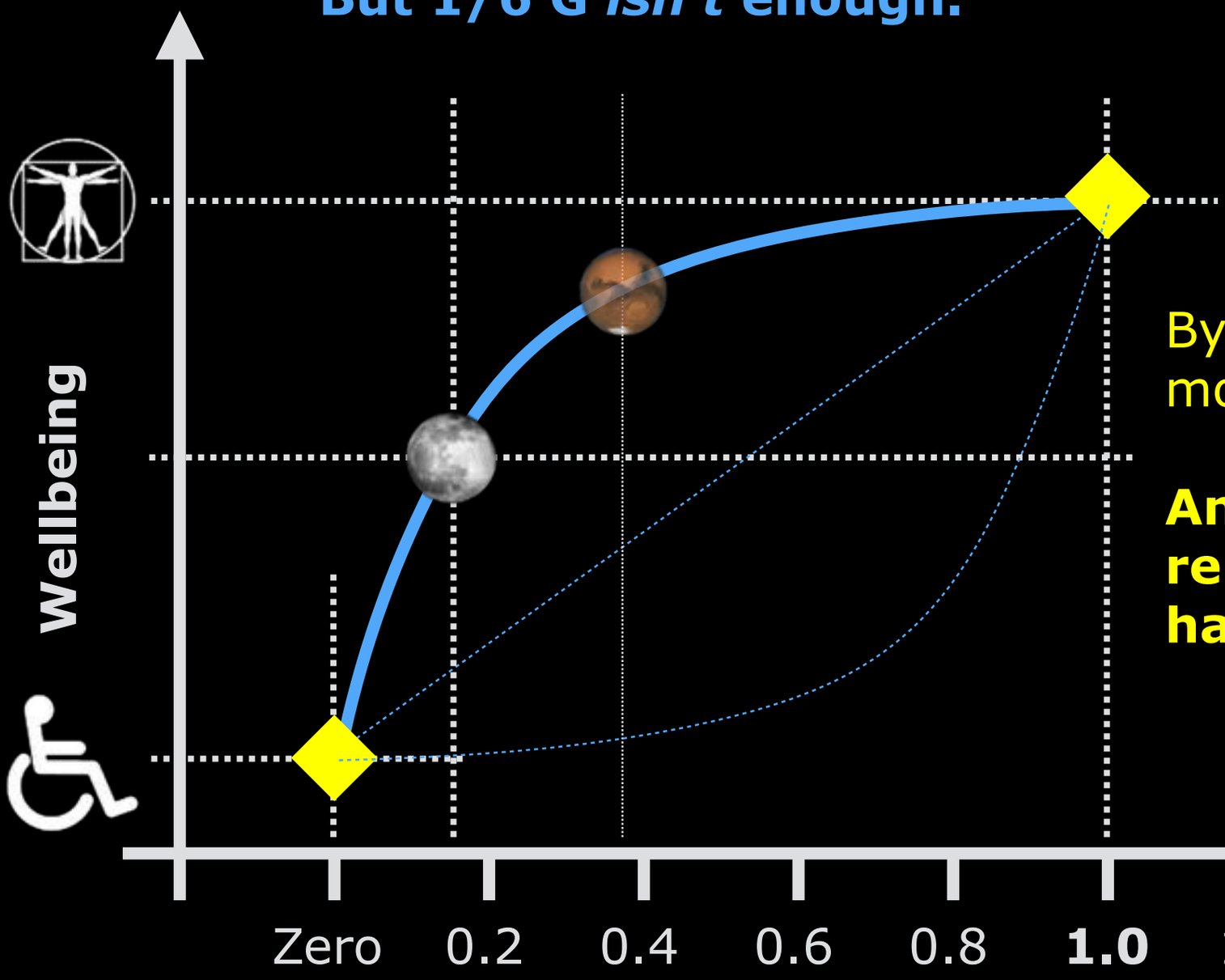
Mars is the next human world.

Fire up the Mars Colonial Transporter!

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

What If A Little G Goes a Long Way?

But 1/6 G *isn't* enough.



Bye bye, Luna, Jovian moons, Titan, etc.

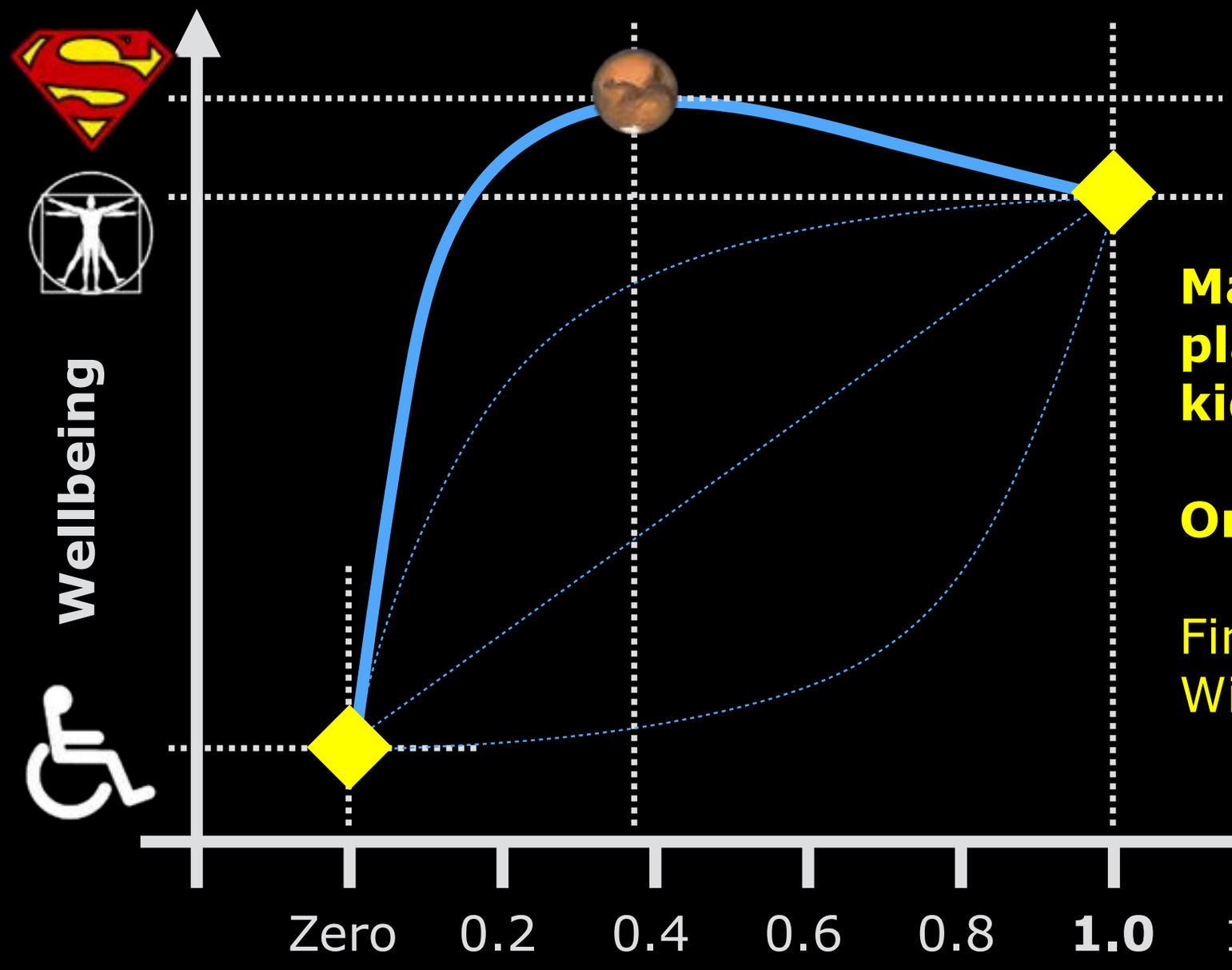
And the Moon remains a temporary hardship post.

3

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

The Martian Superman Scenario

Low-but-not-zero-G turns out to be *good* for joints, circulatory system, etc.



4

Mars IS the kind of place to raise your kid!

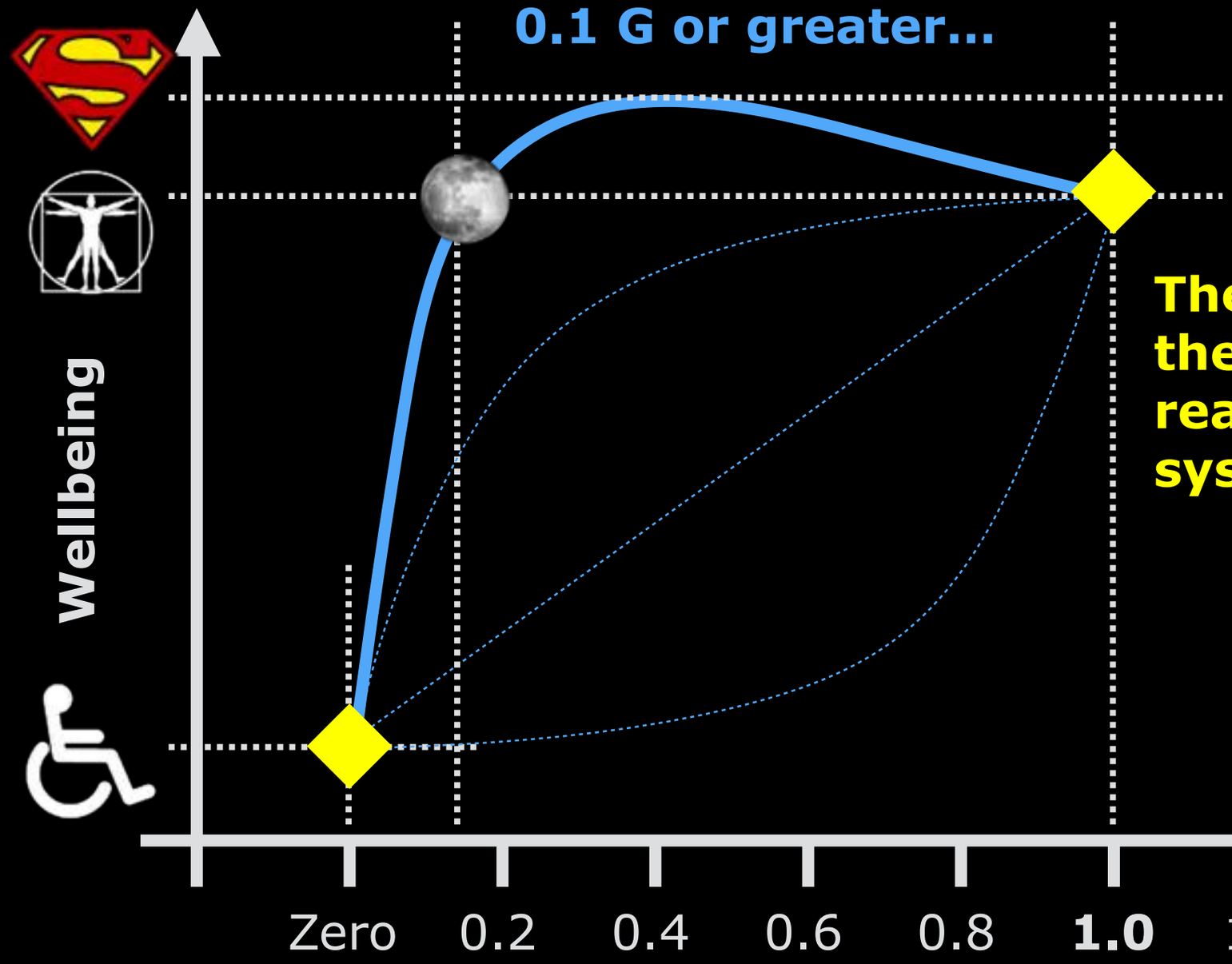
Or to retire…

Fire up the Space Winnebagos!

Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

The Human Solar System

And there are a dozen worlds with 0.1 G or greater…



The Moon becomes the most valuable real estate in the system.

4

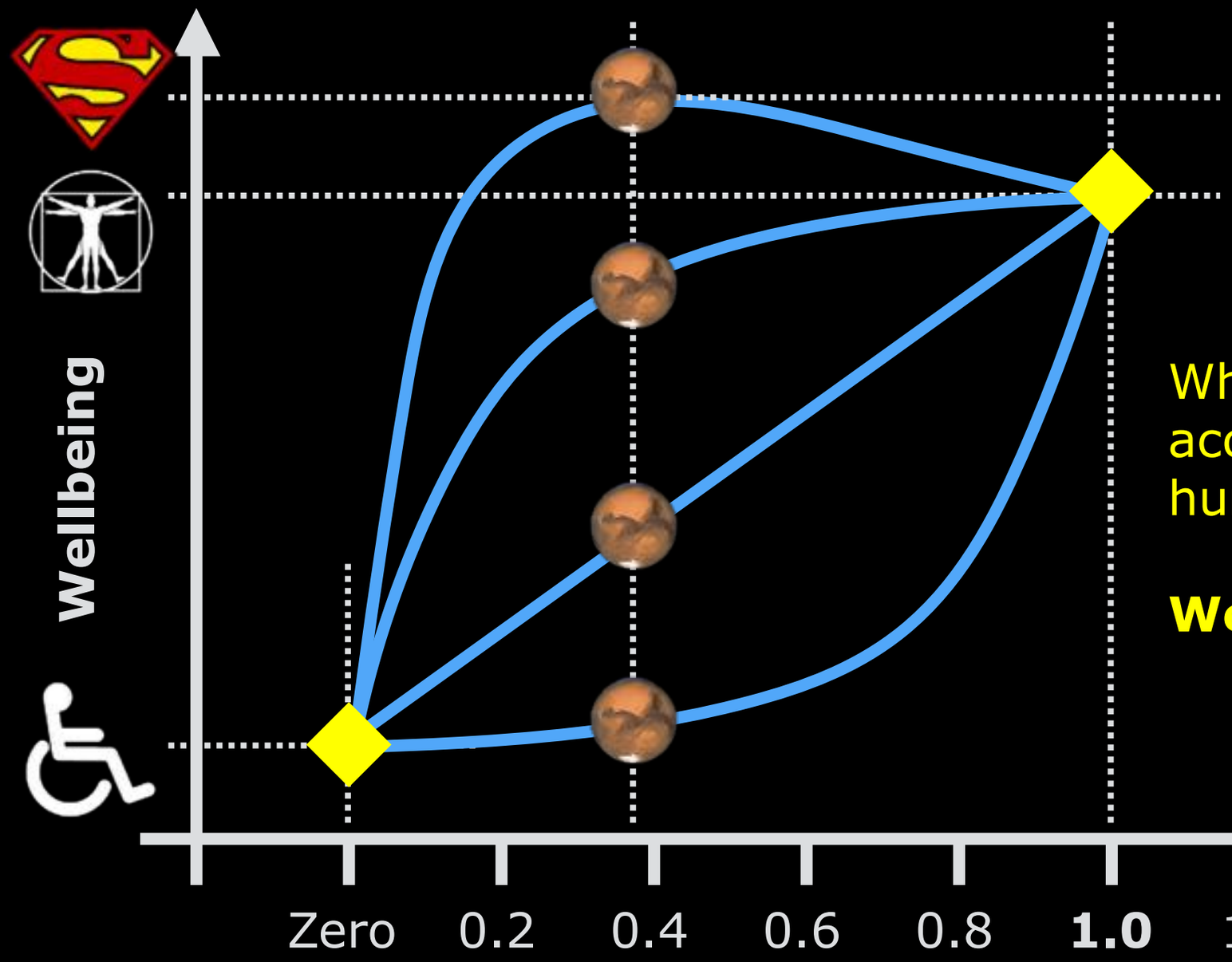
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

How Many Worlds for Humans?

Adapted from Gary Hudson, SSI.org

We Only Have Two Data Points!

Which Mars do we get?



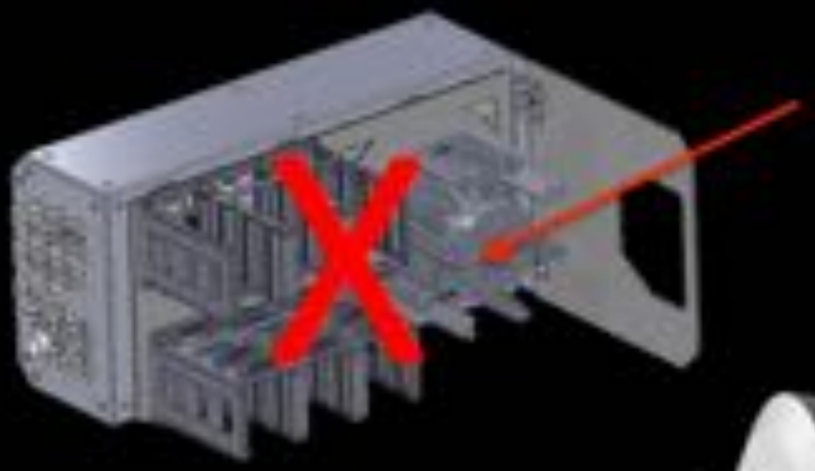
?

Which of these curves accurately represents human physiology?

We just don't know.

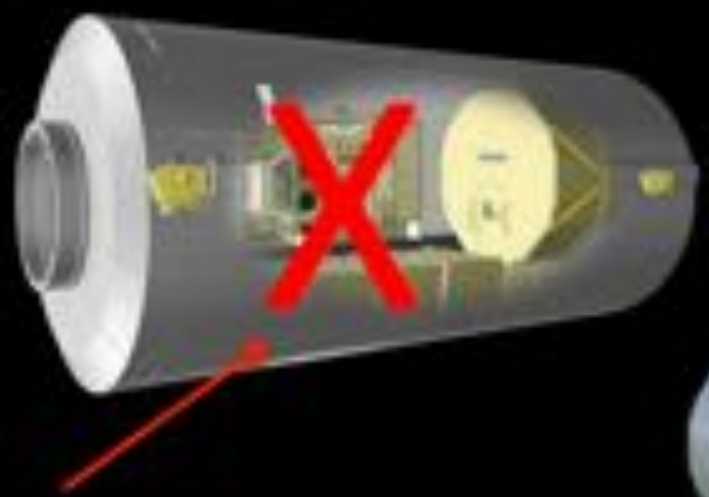
Adapted from http://selenianboondocks.com/2005/11/if-youre-going-to-be-snarky/

We Need Orbital Centrifuges!



Nanoracks / Astrium

Too small for multi-generational vertebrates



NASDA / JAXA

Too disruptive for ISS (momentum, vibration)

NASA Nautilus-X

Too big for ISS

Source: Gary Hudson, SSI.org

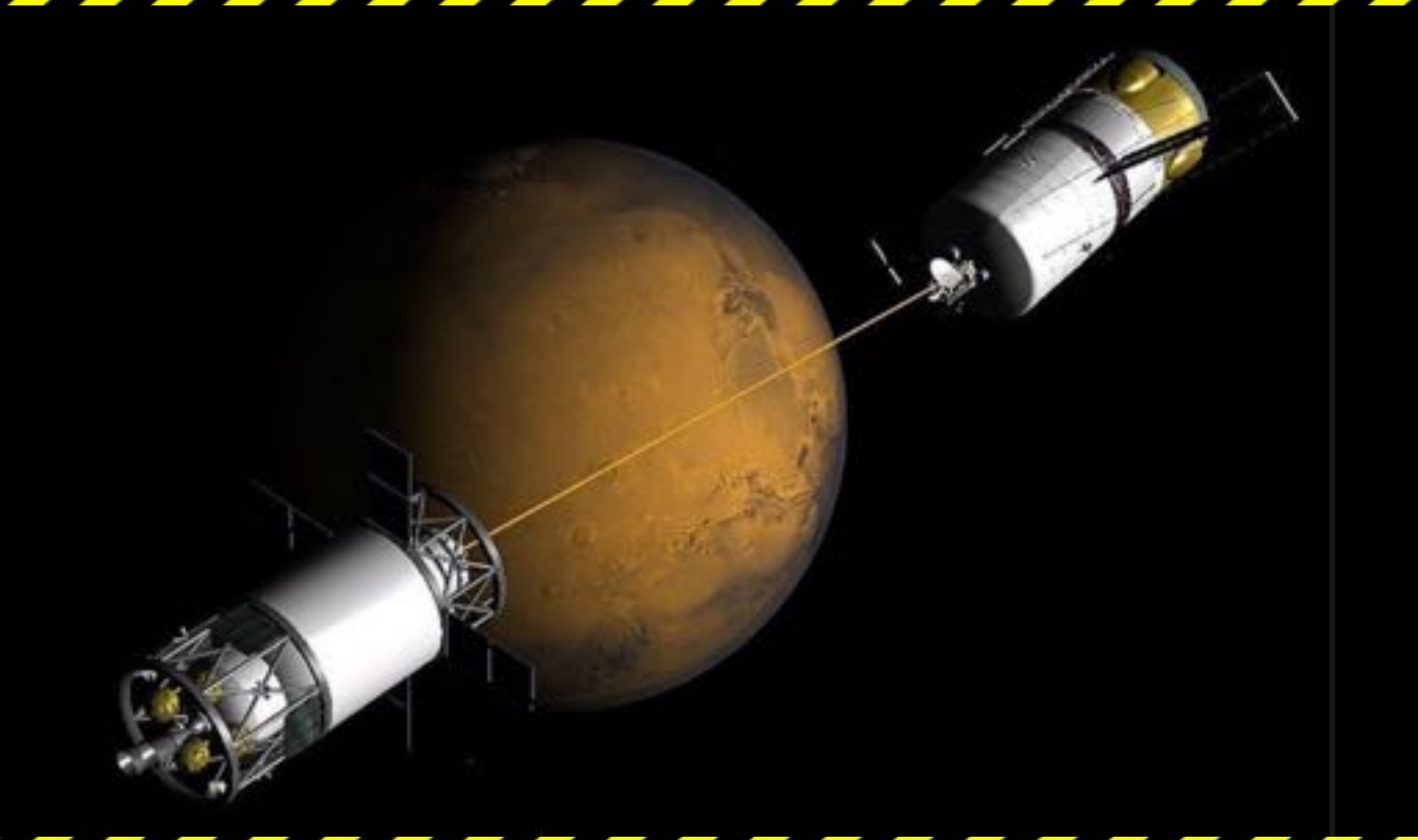
G-Lab: Orbital Centrifuge Lab

Free-flying crew-tended station near ISS

5m dia. x 15m long
Approx. cost: $100M

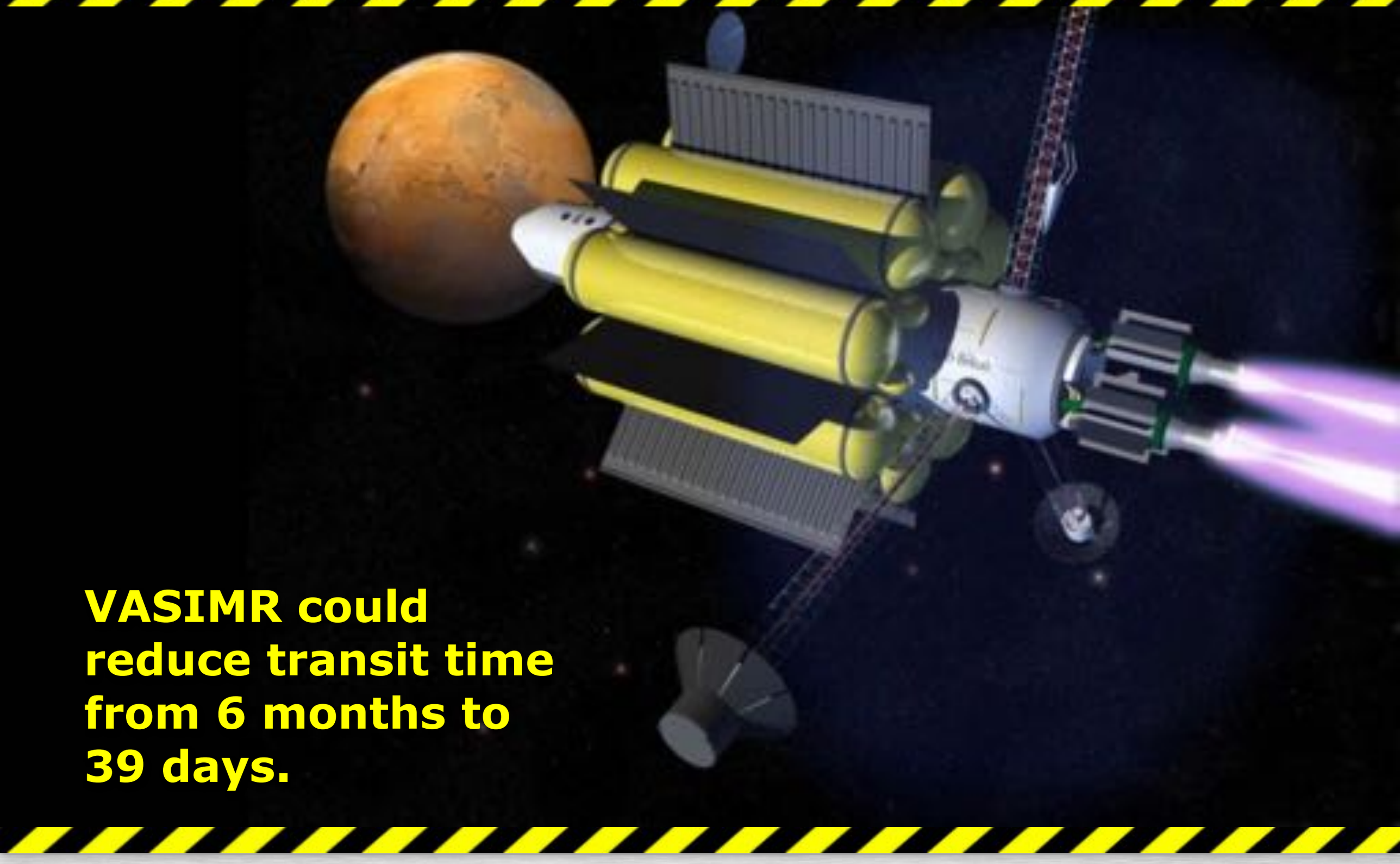
http://ssi.org/ssi-update-april-2012-introduction-to-g-lab/

Centrifugal Tethers



Propellant Depots

Advanced Propulsion: VASIMR

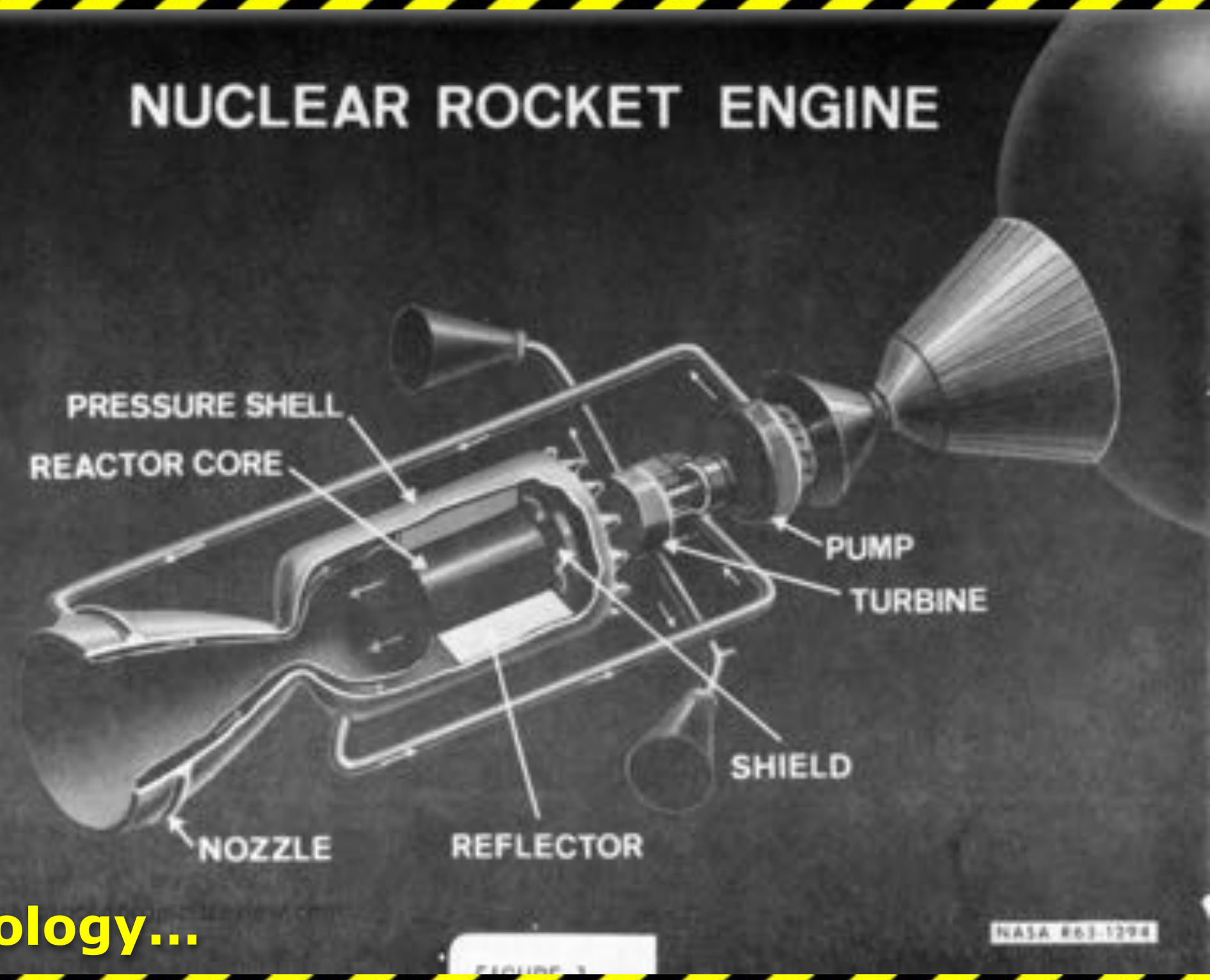


VASIMR could reduce transit time from 6 months to 39 days.

Advanced Propulsion: EM Drive

Almost certainly experimental error…

Advanced Propulsion: NERVA



1960s technology…

Hypersonic Plasmadynamic Decelerator

https://www.nasa.gov/content/magnetoshell-aerocapture-for-manned-missions-and-planetary-deep-space-orbiters/

Hypersonic Plasmadynamic Decelerator

http://www.altius-space.com/icymi-magnetoshell-vacuum-chamber-test-pictures/

Phobos Base: Real-Time Teleoperations

"Why would I want to climb out of Earth's gravity well just to slide back down another one?"

—Michael Mealling

What Would Learning Look Like?

- Focus ISS
  - Life support (ECLSS)
- Back to the Moon
  - In-situ Resource Utilization (ISRU)
  - Radiation shielding
  - Deep space at L1 Lagrange point
- LEO beyond ISS
  - More life support work
  - New "G-lab" to examine gravity and physiology
- Other technologies
  - Centrifugal tethers
  - Propellant depots
  - Advanced propulsion
  - Mars deceleration
- Phobos Base
  - Real-time teleoperation

Andy Weir at Maker Faire Atlanta!

Author of "The Martian"

October 4, 2015
12:00 noon

Free registration required.

Why We Can't Go to Mars...

...YET!

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