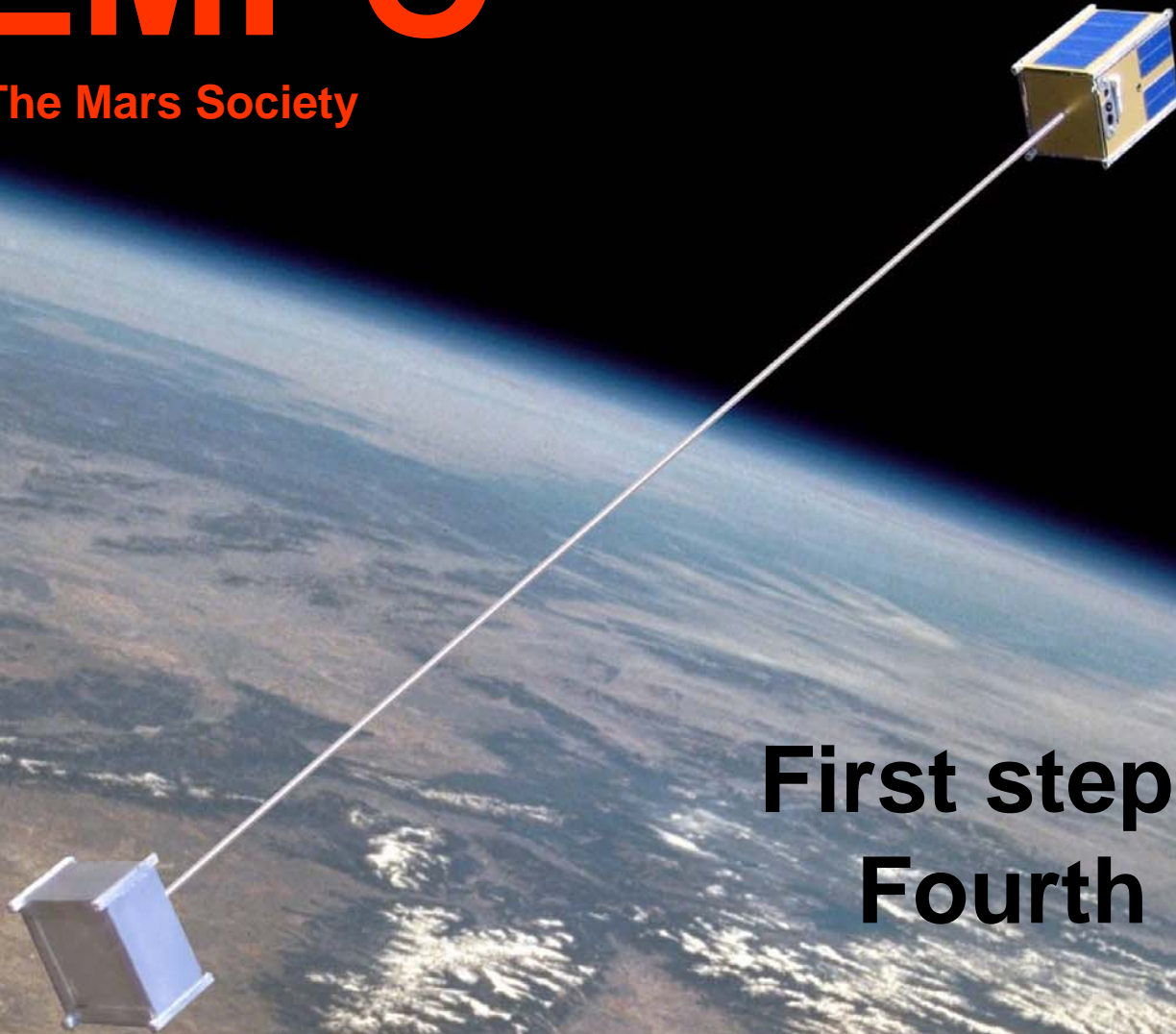


TEMPO³

The Mars Society



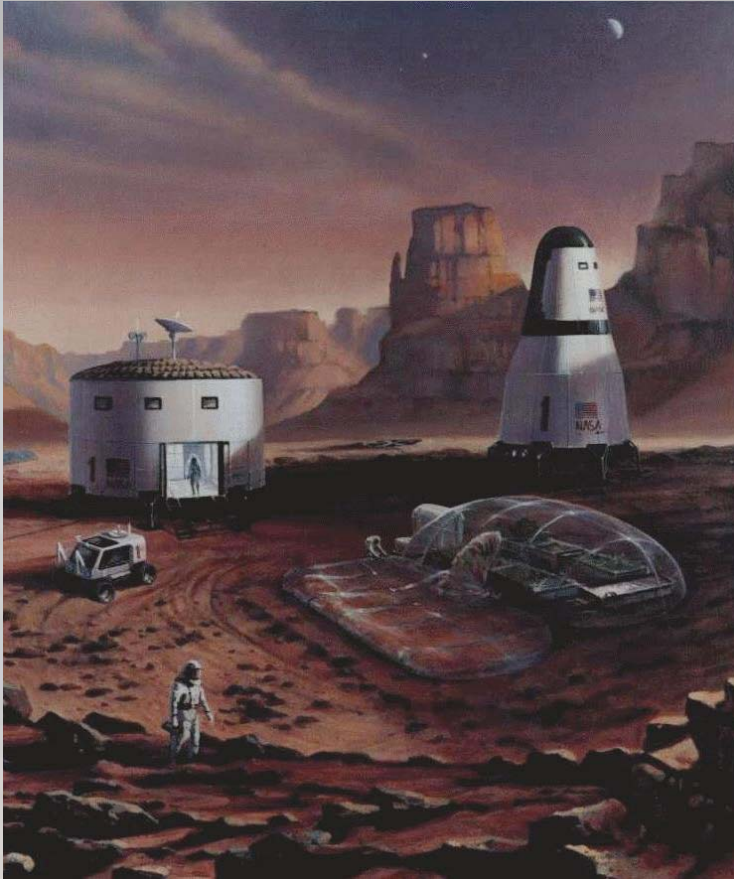
**First step to the
Fourth Planet**

Overview

- Humans to Mars
- Humans in Space
- Artificial Gravity
- Tethers
- TEMPO³



Humans to Mars – How?



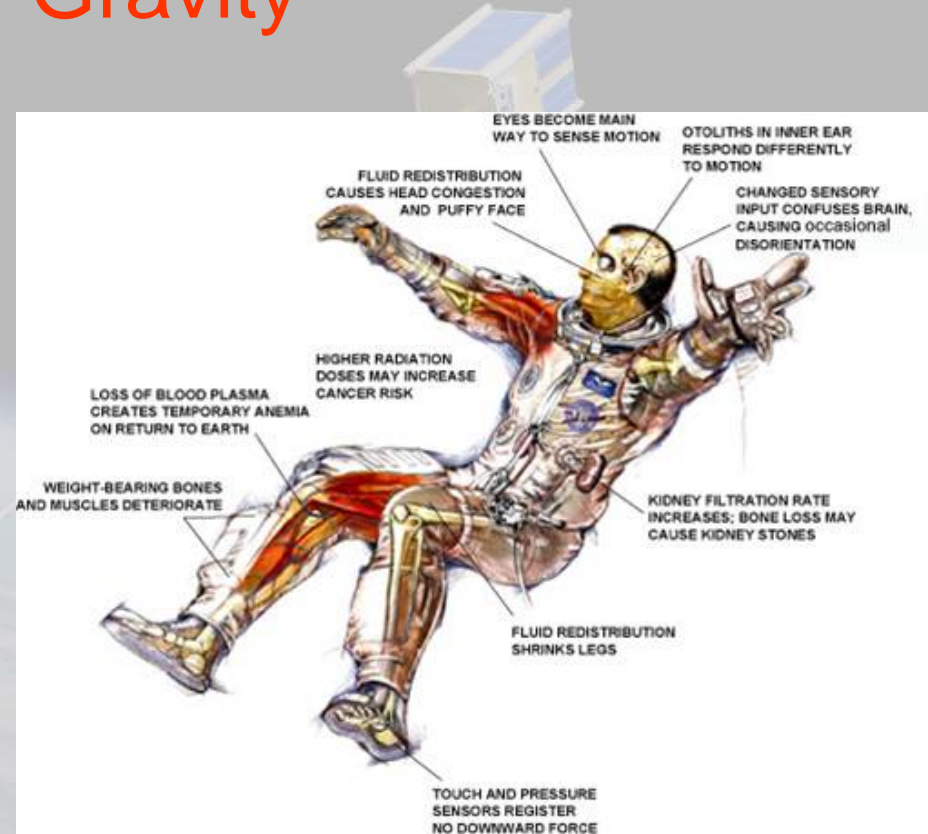
- Not “one huge ship”
 - W. von Braun
- Send return craft first
- Human crew, next opportunity
- Leaves infrastructure behind
- Live off the land
 - Return propellant
 - Water
 - Oxygen
- Reduce costs to tens of \$B

Source: *The Case for Mars* by Zubrin/Wagner, 1996

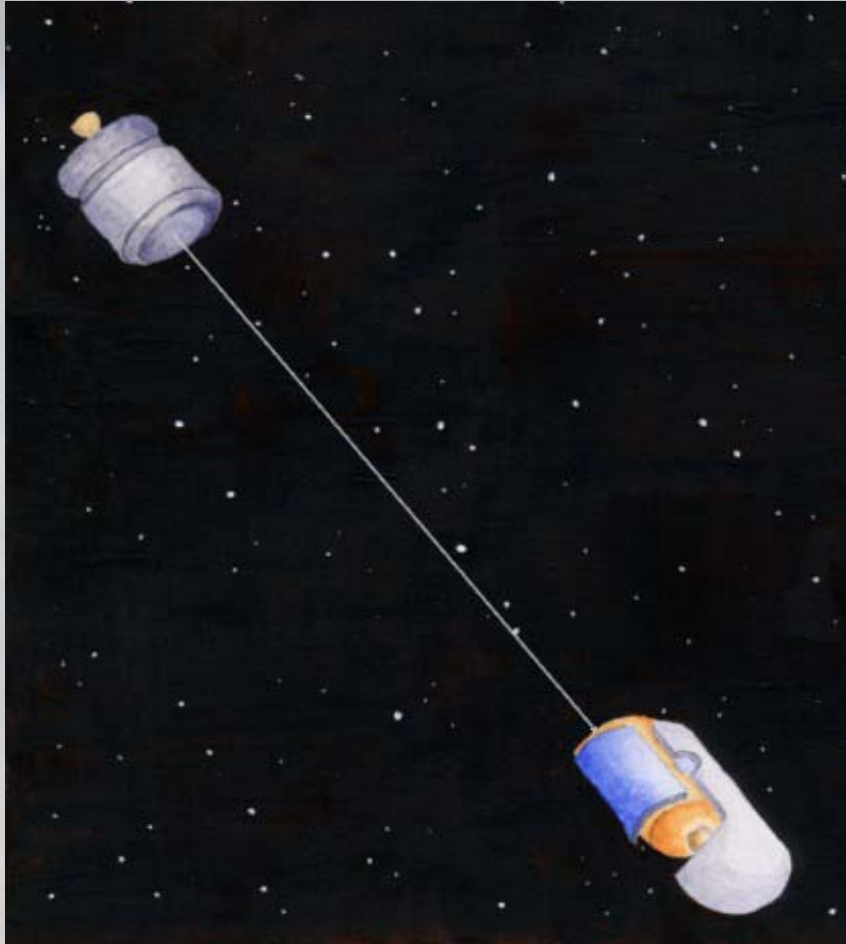
Humans in Space

Lack of Gravity

- Most known-about difference in space life
- Effects
 - Muscle atrophy
 - Bone deterioration
 - Blood changes
- Exercise helps, but...
- Crew arriving on Mars must be physically ready



Artificial Gravity



- Take gravity along!
- Possible with smaller mission architecture
- Upper stage as a counterweight
- Spin end-over-end
- Simple in concept, but
 - Tether dynamics
 - Velocity changes

Tethers

Previous Artificial Gravity Efforts

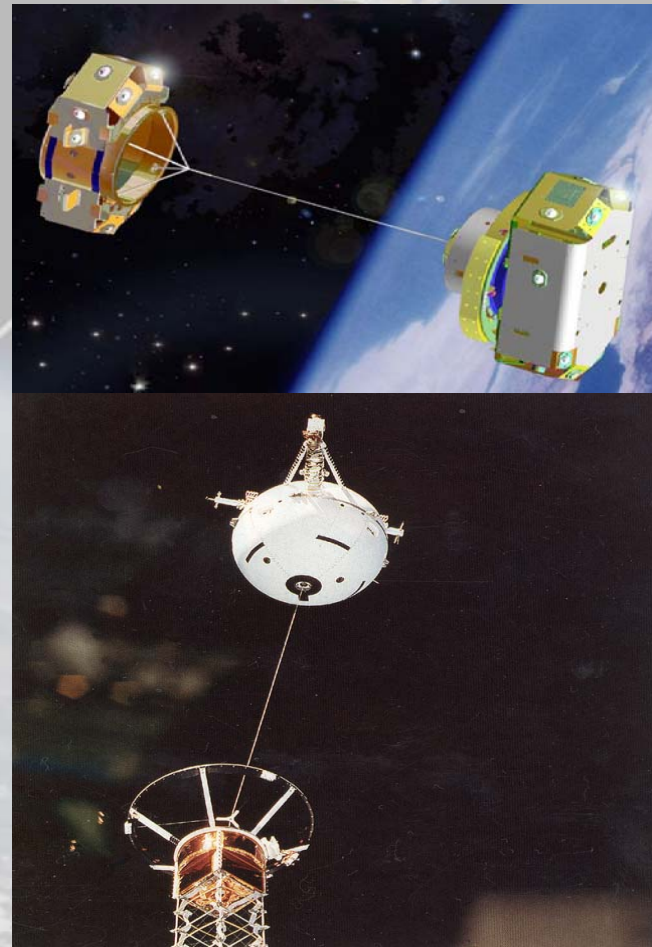
- NASA experimented in the 1960s
- Gemini 11 + 12 used target vehicle (Agena) as counterweight
- Small amount of gravity generated
- Apollo and shuttle/station eras were not conducive



Tethers

Other Efforts

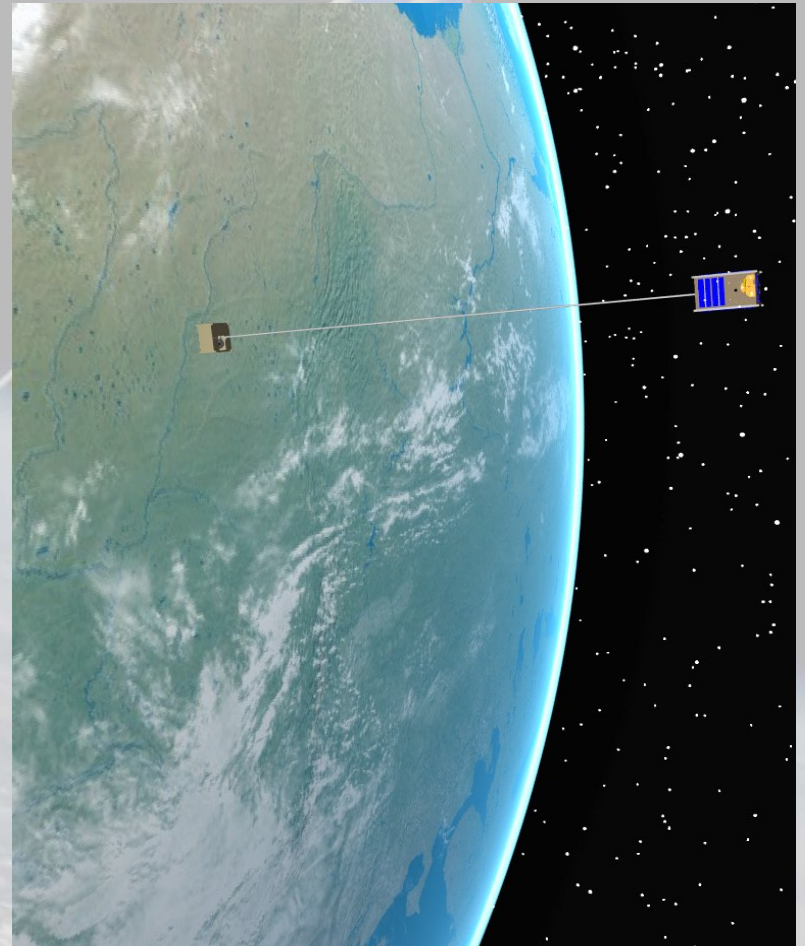
- Multiple potential uses in space
- Many tried with varying success
 - Power generation
 - Orbit change
 - Payload de-orbit
- No recent efforts for artificial gravity



TEMPO³

Goals

- “Build and test a CubeSat satellite to demonstrate artificial gravity”
- Inform the public
- Bring artificial gravity back into architectures
- Build knowledge base for future, more complex missions



TEMPO³

Mission Sequence



- Launch as secondary payload with other CubeSats
- Spin up
 - Method under review
- Deploy tether
- Transmit generated gravity measurement to receiver stations on Earth
- Other actions possible, but limited

PR/Fundraising/Science Submission

- “Join the mission” PR Effort
- Recommended Donation
- Originally Planned for mini SD Ram Chip
- Name Entered on a List for Transmission from TEMPO³
- Transmitter Functions in 10m band
 - Susceptible to Ionospheric Interference
 - Allows Exploration of Space Weather

Sub-Mission Technical Details

- Rotating Spacecraft
 - Constantly Changing Antenna Angle
- Network of Listening Stations
 - Timing Possibilities?
 - Contest?
- Multi-part Signal Helps Strength Estimation
 - Names
 - Tones
 - Beeps
- Orbit Unimportant
 - All Provide Varying Angles



Technical Considerations

- Spin-up method
 - Thruster (cold-gas)
 - Momentum wheel
 - Magnetic coil
- Transmission Signals
 - Likely 70cm Band. Possibly two Frequencies
 - Additional 10m PR/Science Signal Possible
- Spacecraft Software Development
 - Coding relatively simple, considering competition
- Spacecraft Integrator
 - Common bus designs include many required features

Development Timeline

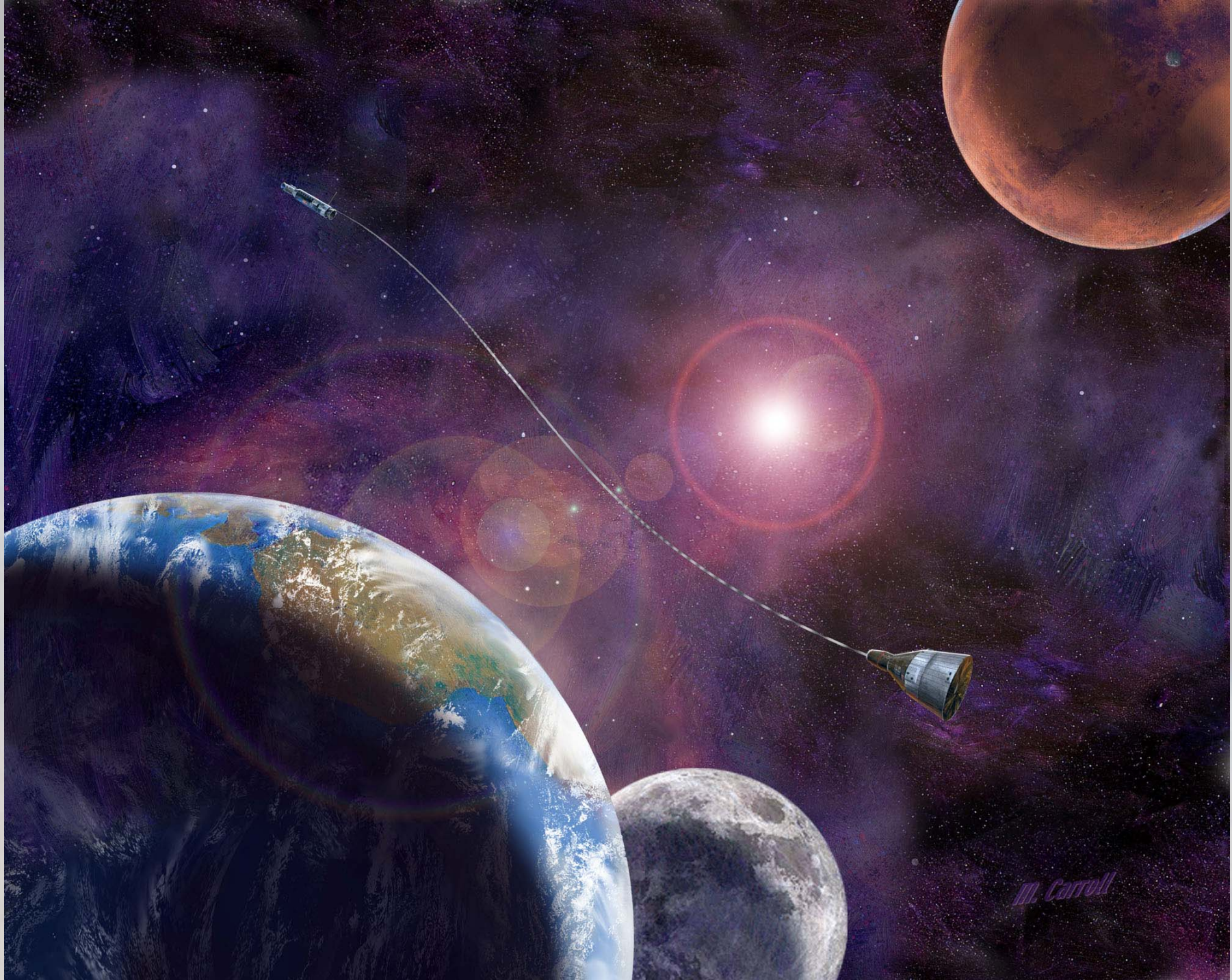
- Kickoff in Aug '08
- Concept developed, initial design work
- High-altitude balloon flight test planned late 09
- Use experience with balloon flight to plan next steps
- Launch in '11
- Follow-on satellite

Outreach

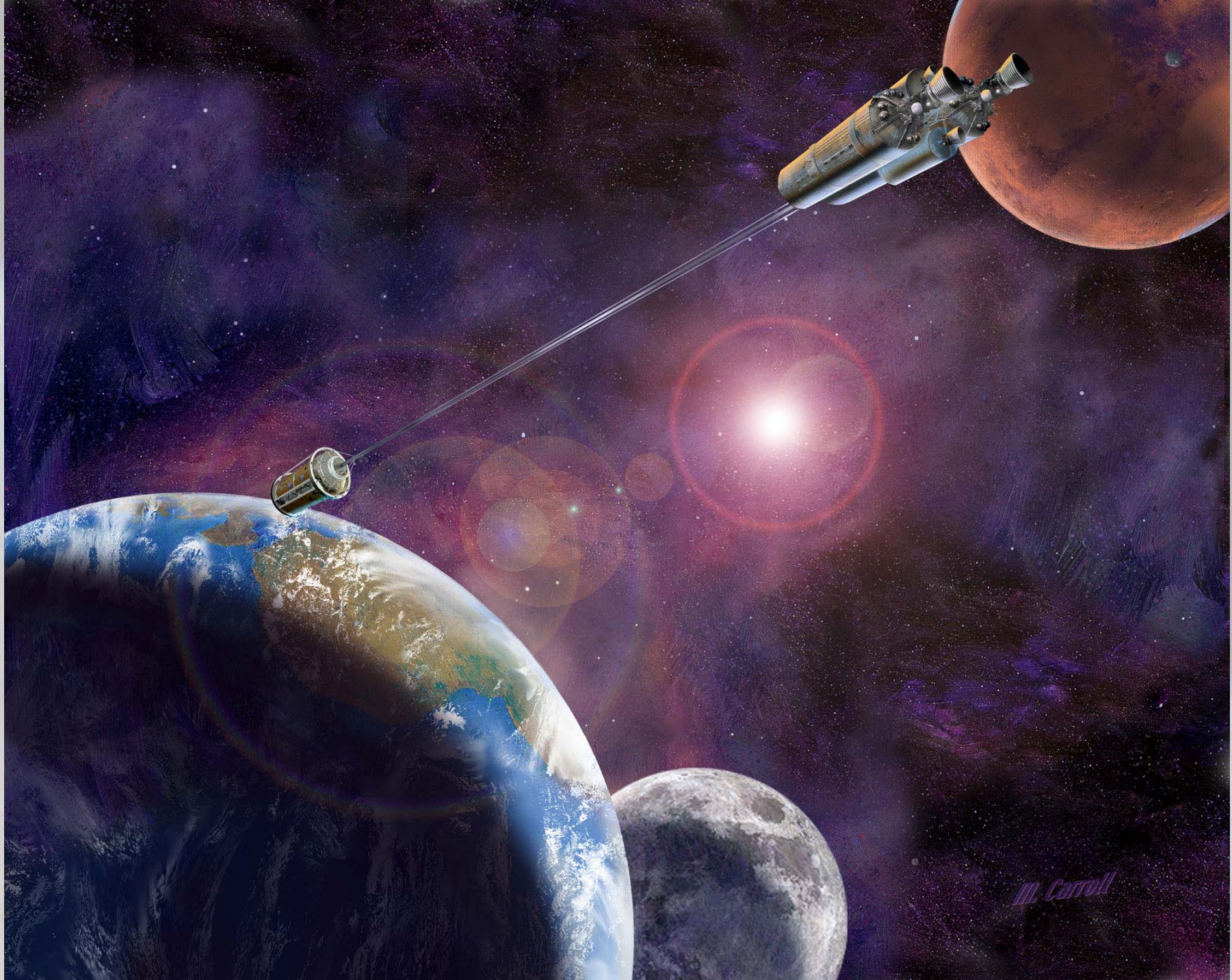
- Split into at least three areas
 - Education – Lesson plans, student contests
 - Popular media – “Name in space”, museums
 - Focused organizations – Amateur radio, pilots
- Internet-involved
 - Video updates
 - YouTube ‘shorts’ describing key concepts

Future Plans

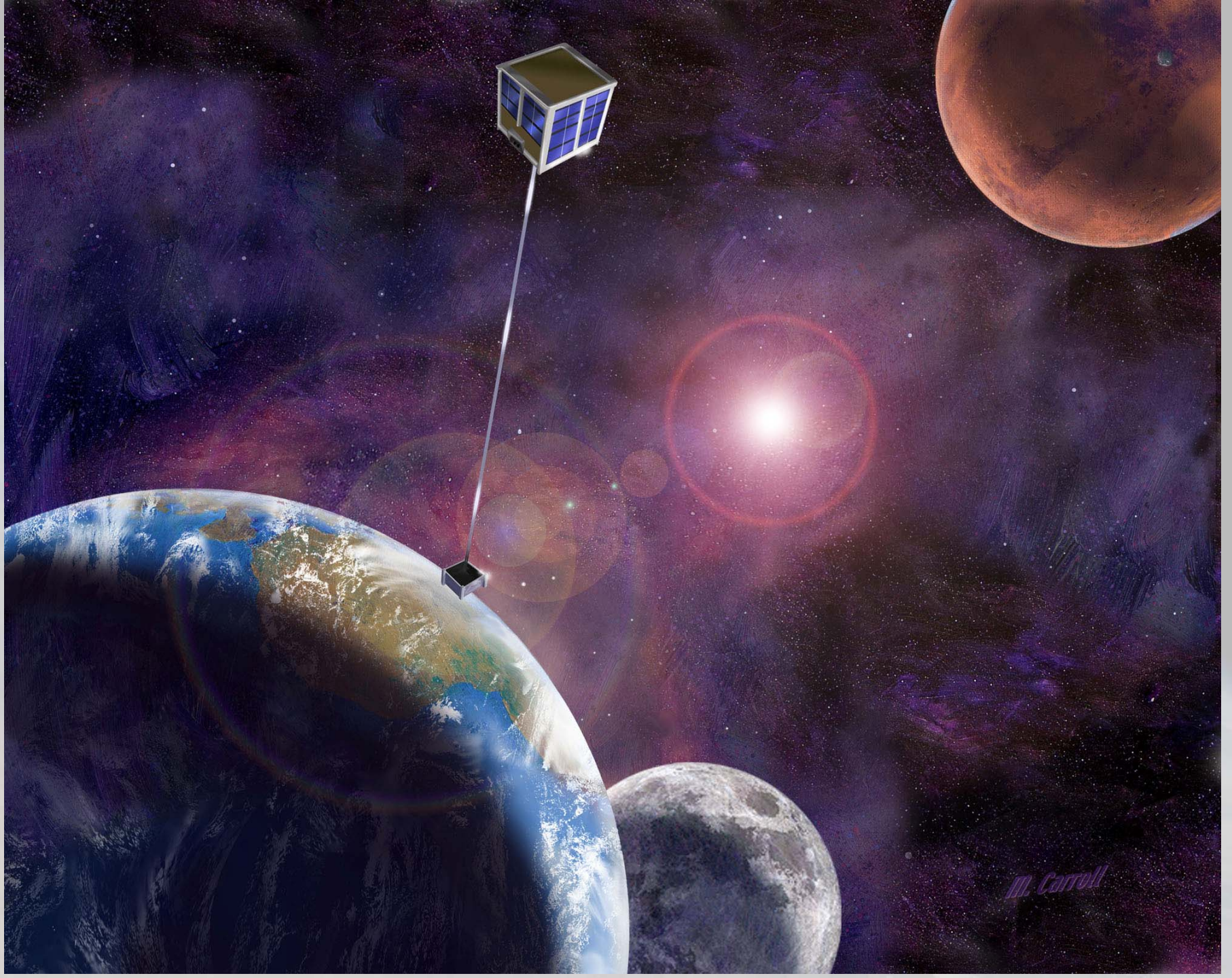
- TEMPO³ demonstrates some very basic aspects of artificial gravity generation
- Many other challenges exist
 - Realistic spin-up
 - Velocity change while spinning
 - Attitude change while spinning
 - High speed communications while spinning
 - Separation at Mars approach
- A future, larger, experiment can test these



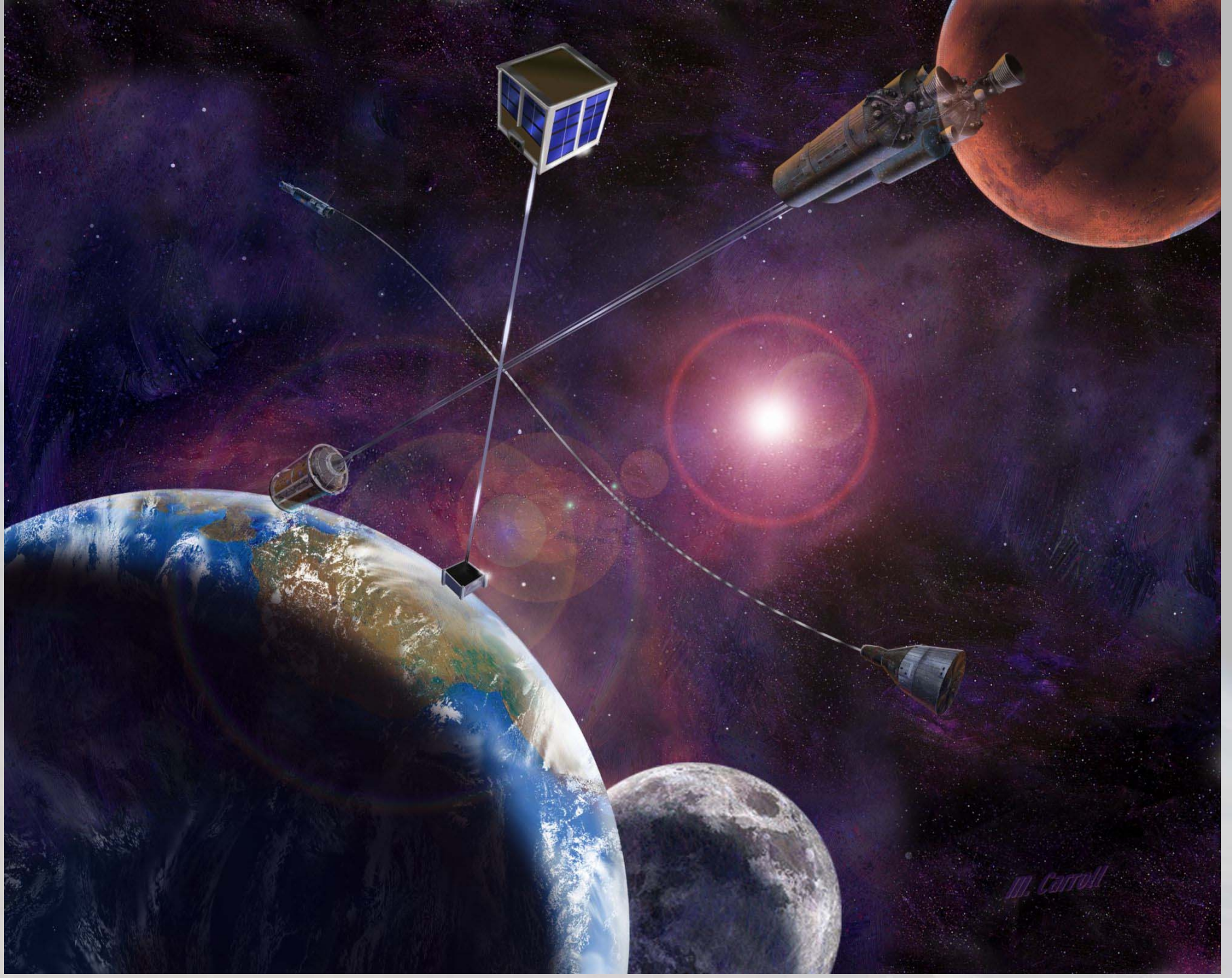
M. Carroll



M. Carroll



M. Carroll



M. Carroll



Thank you for your time!

Tom Hill

tomhill@marsociety.org

KB3RXN

M. Carroll

The Mars Society



- Founded in 1998
- Annual conferences
- Non-profit
- International
- Formation spark caused by interest in Robert Zubrin's book *The Case for Mars*

Mars Society's Other Projects

- Three Mars Research Stations Built
 - FMARS – Canadian Arctic
 - MDRS – Utah Desert
 - Additional – Built, but in storage
- Spaceflight plans
 - Archimedes - hitchhiker payload on Mars mission
 - Mars Gravity Biosatellite – expose mice to Mars gravity

